TEXTURE MEASUREMENT AND SKID NUMBER PREDICTION USING LASER DATA ACQUISITION, DIGITAL SIGNAL PROCESSING, AND NEURAL NETWORKS

By

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ABSTRACT

TEXTURE MEASUREMENT AND SKID NUMBER PREDICTION USING LASER DATA ACQUISITION, DIGITAL SIGNAL PROCESSING, AND NEURAL NETWORKS

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Real-time estimation of the skid number of pavement is difficult. Traditional methods of volumetric measurement are cumbersome and time consuming. It is desired to enable prediction of the skid number of pavement using non-contact means, and to do so using a method which provides a reasonable estimate of the pavements skid number. This research used laser data acquisition of macro-texture, Digital Signal Processing and Neural Networks to estimate the skid number of pavement to a reasonable degree. The research used Digital Signal Processing to identify potentially bad data sets, and a Neural Network model for predicting skid number on the refined data from the DSP. The method enabled relating a statistical index to the texture characteristics of pavements. The model

is based on surface roughness characteristics of pavements as measured by a laser based measurement system, and has the potential to be adapted to a real-time measurement system.

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CHAPTER 1

INTRODUCTION

1.1 Introduction and Summary

This document discusses the estimation and prediction of the Skid Number using linear regression analysis and a neural network, based on data collected with a laser based texture measurement system. Skid Number (SN) is a specific variant of general friction, as pertains to the friction between a rubber tire and a pavement surface. In general, friction is highly non-linear and difficult to predict, model, and analyze [2]*. Skid number prediction, is similarly difficult to predict largely because of the highly non-linear nature of friction.

This research focused on the analysis of the data, and investigated the correlation between the surface texture and the skid number measurement. This research used data previously gathered with a high speed laser based texture measurement experimental system that was previously developed at The University of Texas at Arlington's Transportation Instrumentation Lab.

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* All numbers appearing in brackets refer to the numbered references listed on pages 83-85.

The data collected only involved wet pavement measurements, and this research does not discuss dry pavement SN analysis. This research does not cover the development of any measurement hardware, but, for completeness, this document does review the hardware and techniques used to collect the data.

As a first attempt at correlating the surface texture data with measured SN, linear regression methods were used. Correlation of various measurements of the texture with the skid number produced some favorable results. This technique produced R^2 correlation coefficients of about 0.64, which is approximately in line with conventional mechanical volumetric based measurements and predictions.

Second, attempts at analysis were made using Digital Signal Processing (DSP), specifically, the power spectrum. The surface of the pavement was treated similar to a waveform. This technique implemented a neural network in the analysis of the data and skin number prediction. This technique proved inadequate, and R^2 correlation coefficients were only on the order of 0.22. However, one positive result from the DSP procedures shows that the power spectrum analysis of the data can show that some data sets had numerous errors in them and may lead to faulty readings. This DSP data check enables testing if any given data set was actually collected properly, and enables elimination of faulty data. The faulty data was eliminated from future analysis.

Finally, a neural network was developed using the Matlab Neural Network Toolbox, and measurements of micro-texture based on a so-called string filter. The network provided correlation and prediction of skid number from texture measurements with R^2 values of between 0.71 and 0.75, depending on what set of data was analyzed. Portions of these results were presented in [1].

Finally, the development of the analysis techniques showed the potential for improvement in measurement data collection which may lead to improved skid number prediction. Several recommendations, including data on temperature and velocity, are recommended to improve the process.

1.2 Overview

This document discusses the development of the correlation techniques used in predicting SN from micro-texture readings.

Chapter 2 begins with a review of friction as pertains to skid number, macro-texture and micro-texture definitions and measurement techniques. The hardware and file structure are presented for completeness.

Chapter 3 includes the results of linear regression analysis which showed that the correlation was possible. The discussion includes a logarithmic transformation to simplify the analysis.

Chapter 4 includes a discussion of the DSP power spectrum analysis. Although this analysis proved to yield inaccurate prediction, a secondary result enabled finding data sets with large numbers of erroneous data points and elimination of these noisy data sets for future analysis.

Chapter 5 shows the development of a neural network. The inputs to this network were measurements of texture based on a so-called string filter. This correlation and prediction technique yielded significantly better results. These results were presented in [1].

Chapter 6 gives conclusions and recommendations for further research. If future tests include additional data, such as velocity and temperature, the neural network developed in Chapter 5 may yield better results.

The Appendices include various hardware diagrams, alternative, and other data.

CHAPTER 2

BACKGROUND

2.1 Introduction

This chapter provides background information on pavement skid number measurement. The chapter begins by presenting background information on friction and how friction relates to the skid number. Then, the micro-texture and macro-texture of pavement are defined. The chapter concludes by discussing the methods hardware, and file format used for the data collection of the surface measurements and skid numbers. Included is a brief description of the laser system used to collect the data for this research, as well as classical methods. Details of this method can be found in [20]. Appendix A provides more detailed diagrams.

2.2 Friction and Skid Number

Friction is a force which acts to oppose motion. Friction is a dissipative force in that it dissipates energy in a system. Generally, there are two types of friction models, Coulomb, or dry friction, and fluid friction [2]. A general model for dry friction is given by

$$F = \mu_s N \tag{1}$$

where $?_s$ is the coefficient of static friction and depends on the type of materials in contact. $?_s$ has been found to be independent of the normal force and the contact area [2]. Rolling friction, sliding friction, and other types of contact friction behave similarly, however, are highly non-linear and may reach a maximum frictional force value.

The skid number, (SN), is a variation on friction specifically between a rubber tire and a pavement surface, and is commonly used at estimating the friction between a vehicles tires and pavement surface. Insufficiently low SN can lead to unacceptably long stopping distances, leading to automobile accidents. SN is defined as

$$SN = 100\mu = 100\left(\frac{F}{W}\right) \tag{2}$$

where W is the dynamic vertical load on the tire and F is the tractive force applied to the tire at the tire-pavement contact and ? is the coefficient of friction [3].

States government agencies generally regulate the minimum acceptable SN for highways, streets, and roads to insure commuter safety. Unfortunately, accurate measurement of SN is a timely and costly process, thus the need for a lower cost measurement of SN.

2.3 Macro-texture and Micro-texture

The surface roughness influences the coefficient of friction. A very smooth surface generally has a lower coefficient of friction than does a somewhat rough one. There are two divisions of surface roughness used to describe pavement: macro-texture, and micro-texture. The skid resistance, or frictional properties, of a pavement surface in contact with a given tire under similar conditions has been shown to be largely determined by the texture of the surface [3-6].

Macro-texture is defined as the deviations of a pavement surface from a true planar surface with the characteristic dimensions of wavelength and amplitude from 0.5 mm (0.02 in.) up to those that no longer affect tire-pavement interaction [3]. It is generally believed that macro-texture provides the drainage on wet pavement and determines the rate that skid resistance decreases with increasing speed. Pavements with more macro-texture typically show a smaller rate of decline of skid resistance with increasing speed.

Similarly, surface micro-texture is defined as the deviations of a pavement surface from a true planar surface with characteristic dimensions of wavelength and amplitude less than 0.02 inch (0.5 mm) [3]. The sharp, fine particles in a surface which make up the micro-texture penetrate the thin water film and permit contact of the tire and the pavement surface. Many consider the micro-texture to be the predominant factor in determining the skid resistance of pavement at low vehicle speed. Macro-texture is somewhat easier to measure because of the greater size.

It appears that both macro-texture and micro-texture should be considered when determining the skid resistance of a pavement. Measurements of macro texture have been reported using optical techniques, pavement profiles, and the sand-patch method [7, 19]. Micro-texture measurements are often reported using the British Pendulum Number [3, 4]. Researchers have reported results obtained from profiles using optical techniques or a mechanical stylus, but these profiles are difficult to obtain [20]. Lasers provide very accurate distance measurements and are now being used for many such measurements. A complete compilation of all the many studies for macro and micro texture are not included herein. A good report of much of the early work, as well as recent work, is provided in [20].

2.4 Classical Mechanical Texture Measurement

Classically, surface texture has been measured using the so-called sand-patch method discussed in [19]. This method uses a volumetric approach to estimate the surface texture, however, the granule size limits the accuracy, and the test is generally used to estimate macro-texture, as opposed to micro-texture. Because the test involves spreading material similar to sand on pavement and measuring the size of circle when smooth, the test is cumbersome and generally the standard deviation is about 27% of the estimate of the actual macro-texture [20, 21]. Correlating this surface texture with SN is difficult. Further, the test is generally inadequate for measuring micro-texture.

2.5 Data Collection and Preliminary Tests

The actual data used in this study were collected using a laser based scanning system developed at The University of Texas at Arlington's Transportation Instrumentation Lab in a previous study [20]. To different systems were developed, one for collecting mico-texture, and the other for macro-textrue. Background information on the equipment used is discussed below. The macro-texture data was collected at various sites in Texas in February and June of 2000. These sets of data will be referred to hereafter as the "02" and "06" data.

A high resolution laser scanning system was developed to obtain accurate measurement of the micro-texture, but could not be used at high speeds. Thus only macro-texture was measured for the high speed 02 and 06 data. The next section will discuss the micro-texture system followed by a description of the high speed macro-texture measurement system.

Prior to collecting micro-texture data on pavement, a simple laboratory test was conducted to test the resolution by scanning four different types of sandpaper with grits of 36, 50, 80, and 120. The results show that the different sandpaper grits could be clearly differentiated and measured. The laser can measure up to 0.2 micrometers.

During preliminary testing, office tile joints were also tested. Figures 2.1, 2.2, and 2.3 show the results of these tests.

In preparation for collecting the data, a representative 15 foot (4.6m) section of the particular pavement type to be measured was selected. A trace was marked to obtain repeat runs and 2 markers were placed on the path at approximately 10 and 11 feet (3 and 3.4m) to validate the collection speed. Details of these results are given in [20].

2.6 Measurement Hardware and Embedded Systems

This section reviews the laser scanning system hardware and software used to collect the data. A complete parts list, operation procedure and parts specification is given in [21].

The prototype scanner system included two 150mm travel translation tables with a precision distance measurement laser. The translation tables have a one micrometer step size and at a maximum speed of 2500 micrometers per second. The laser measured distances within a ±3 mm distance from a 30 mm standoff from the target with a 0.2 micrometer resolution. The laser spot size varies from (0.05 by 0.12 mm at -3 mm), (0.07

by 0.03 mm at 0 mm), and (0.15 by 0.07 mm at +3 mm) from the 30 mm standoff distance.

Figure 2.1: Office tile joint used in test.

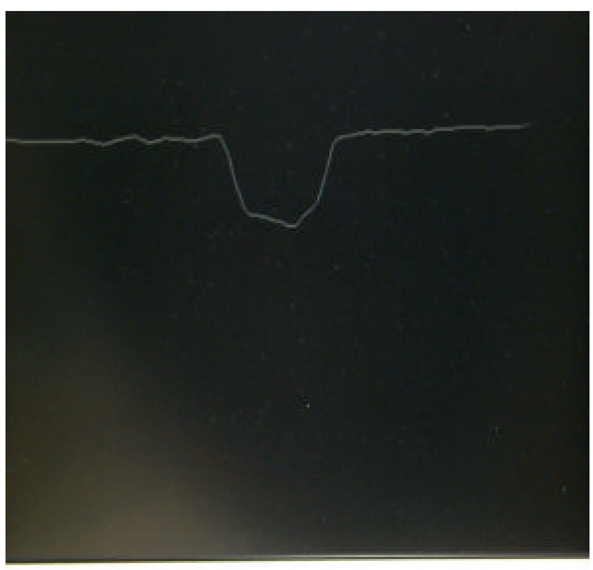


Figure 2.2: Texture Scan of two joints.

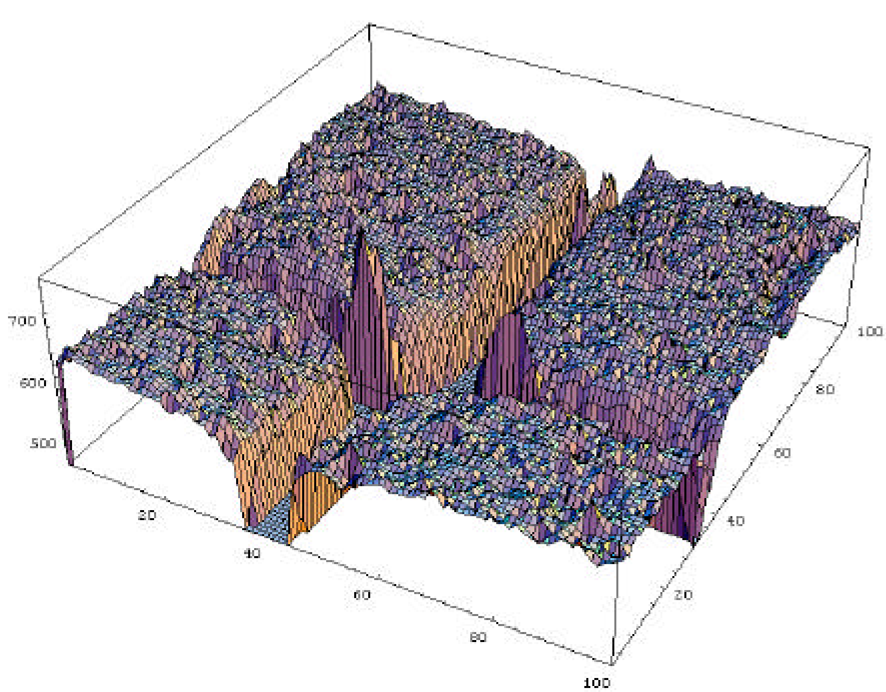


Figure 2.3: Scan of office tile joint.

The user specifies the number of X and Y samples and the sample spacing to the scanner program. The software scans the target in the X direction at the various Y positions, and samples the laser output at one micrometer steps in the X scan direction and stores the average sample distance within the specified X sample spacing. The results are stored as an ASCII file on disk.

The Scanner Controller consists of a HC11 microprocessor, a 16-bit A/D converter, and various circuits for synchronization with the MM2000 Universal Interface Box and a LPT port of the PC. The controller used a Motorola M68HC11EVBU Universal Evaluation Board as the micro-processor system for the controller operation, which provides the A/D conversion of the LM200 analog signal. The system places a 32-bit integer representation of the analog signal into a FIFO, which can be read, with the LPT port of the PC. The LPT port is used for sending values and commands to the controller. A bi-directional LPT port is not required to interface with the Scanner Controller.

A few minor modifications were made to the BD-F15 connector to provide X-axis encoder signal to the A/D Acquisition and Laser Interface Controller.

2.7 A High-Speed Texture Measurement System

The primary sensor used by the system for the high speed macro-texture measurements is the Selcom texture laser. A diagram of the components in this system is illustrated in Figure 2.4. Currently, Selcom lasers are used by the majority of road profiling measurement systems both in the United States and internationally. Selcom also offers a high resolution laser that is now being used for high speed texture measurements on other systems. The Selcom lasers have proven to be very reliable and effective devices for displacement measurements in the road measurement environment. Efforts were made in the early part of the project to find suitable candidates for texture measurements, but none were found to be significantly better than this laser. Because of the lack of other candidates systems, the pilot study described earlier, and the fact that the Selcom texture lasers are used elsewhere for texture measurement the Selcom laser 78KHz -16 micrometer laser was selected. This section discusses the high-speed texture measurement system developed for the project. The discussions will include the system architecture, followed by details on the various modules used for texture measurements. The characteristics of the sensor data are also described. Finally, the laser interface system is discussed. The next chapter describes the program and procedures that were developed for collecting texture data.

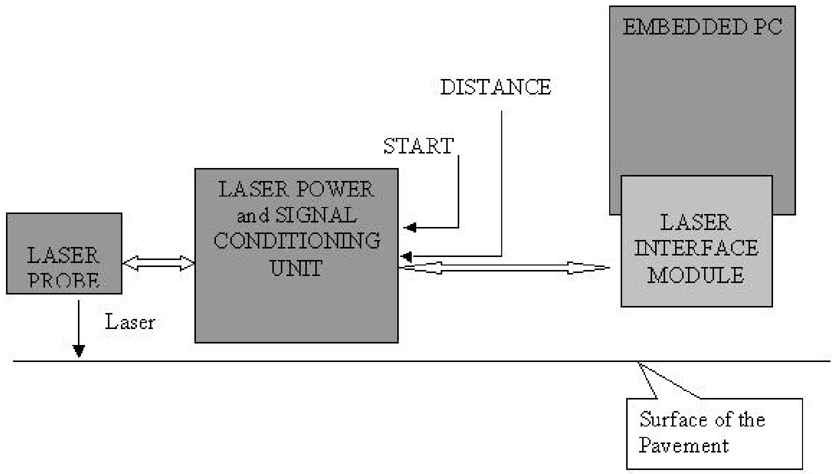


Figure 2.4: Diagram of components.

As indicated, the laser, distance and start signals are interfaced to the PC via the PC Laser Interface Module or PCLIM. During the first year of the project, efforts were made to locate appropriate data acquisition equipment for both the micro-texture and macro-texture measurements. Selcom offered a VME based system board for their lasers, where the laser displacement readings could be read either as an analog or digital displacement reading. The digital values could be obtained directly in digital form via the VME bus, or the displacement values could be read directly from the laser optocator as a synchronous serial data stream. Initial efforts were directed toward reading the signal in analog form, and then digitizing the results by the data acquisition system so they could be recorded or processed. At that time, most profilers and texture measuring systems obtain laser data for the various surface measurements in a similar manner. After investigating the analog and averaging method used by Selcom for providing the analog laser readings, and because of the VME board requirements, it was decided to build a special board for this application. where the laser displacement readings were obtained from the serial data stream and converted to a parallel value for direct input to the PC via the ISA or PC104 bus. The requirements for the board design included a direct interface between the serial data stream sent by the laser probe and the PC via the system bus. Thus, the method would provide a reduced noise advantage in that noise or errors introduced by taking the digital displacement readings, converting them to an analog form, and then once again back to digital would be avoided.

The Selcom system provided a selectable running average on a special averaging board that provided averaged displacement readings. It was decided to include the averaging function and allow the software to specify the amount of averaging. As will be later discussed, averaging the continuous laser readings is common and usually necessary in most laser systems. The Selcom averaging board discards readings that are detected as bad from the laser probe. That is, during measurements, if one of the continuous laser readings were found bad (a laser return signal was not received), it would be discarded and replaced by the previous reading (assuming it was good). If readings are discarded, then the number of time-readings between two consecutive distance-readings could vary for the same speed, thus making it impossible to obtain accurate longitudinal wavelength information. The above considerations became requirements for the PCLIM board. The system would let the software determine how to average the laser readings, as well as maintaining wavelength integrity. The PCLIM provides a way to read the laser values directly into memory via the ISA or PC104 data bus (via an ISA to PC104 adapter). The next section provides details on the architecture of the Laser Power and Signal Interface Unit. Figures 2.5 and 2.6 shows the laser components and bus, and Figure 2.7 shows the laser installed on the trailer used in the data acquisition. Several tests were made at various test sites in Texas.

Figure 2.5: The Selcom laser system.

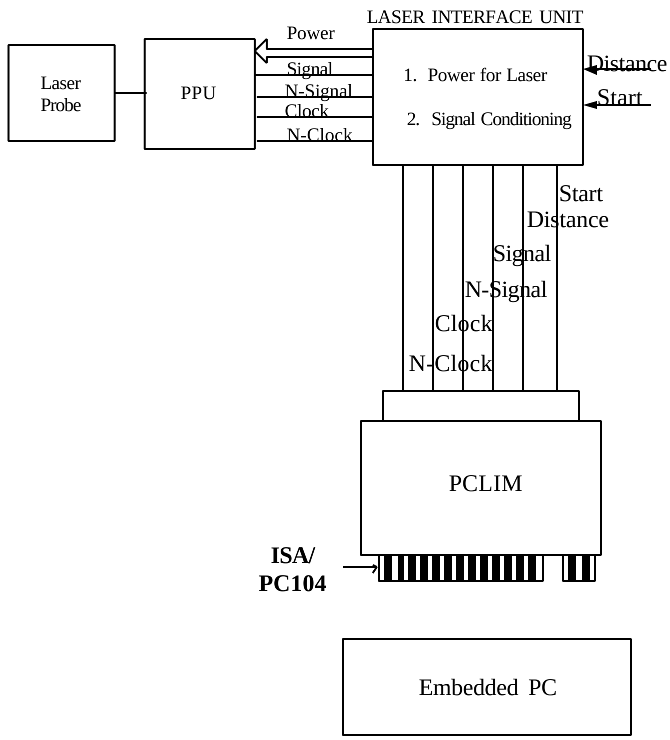


Figure 2.6: Bus schematic.

Figure 2.7: TxDOT trailer with laser.

2.8 Data File Format

Each section of pavement scanned was stored in file of data referred to as a data set. The raw test data was stored in files of the format shown in Figure 2.8. Files were stored in the format MMDDHHmm.SS where MM is the month, DD is the day, HH is the hour, mm is the minute, and .SS is the second. For example file 08031433.19 was collected on August 3rd at 14:33:19. These files contained the raw profile data read by the laser along with header information. The header information includes various parameters governing the laser setup and other information. The first four bits of each data point were a set of flags set when the point is taken. These flags indicate if there is something wrong with the specific data point. These points were later analyzed by the string program, discussed in the next section. Bad points were ignored. However, as will be discussed in Chapter IV, sometimes entire data sets (files) were also bad. These data sets contained so many faulty readings that in some cases the data processing programs could not even process the data, and in other cases, the power spectrum was significantly altered. If significant faulty data was found to be in the file, to the point where calculations of MPD and other measurements could be in significant error, the file was discarded. This process will be discussed in Chapter 4. Individual bad points in a data set were removed when analyzed by checking the flags in the first four bits.

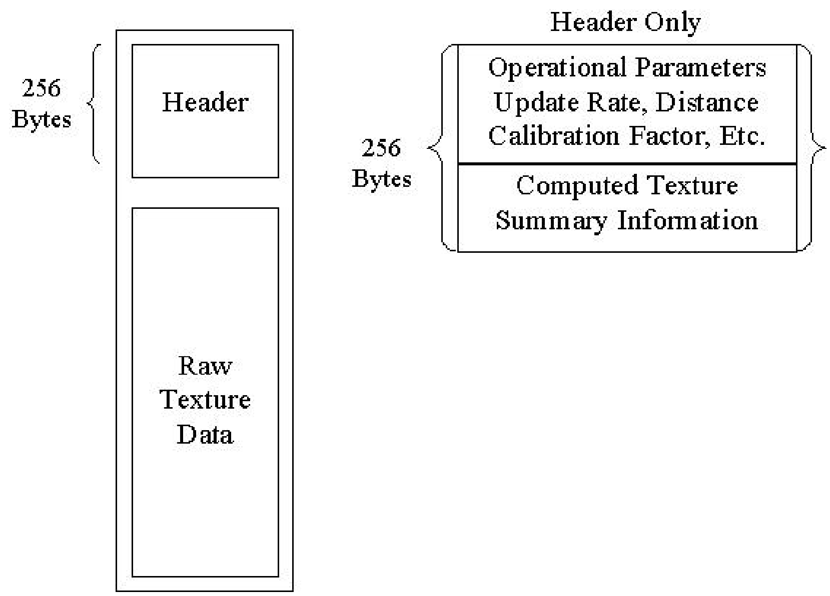
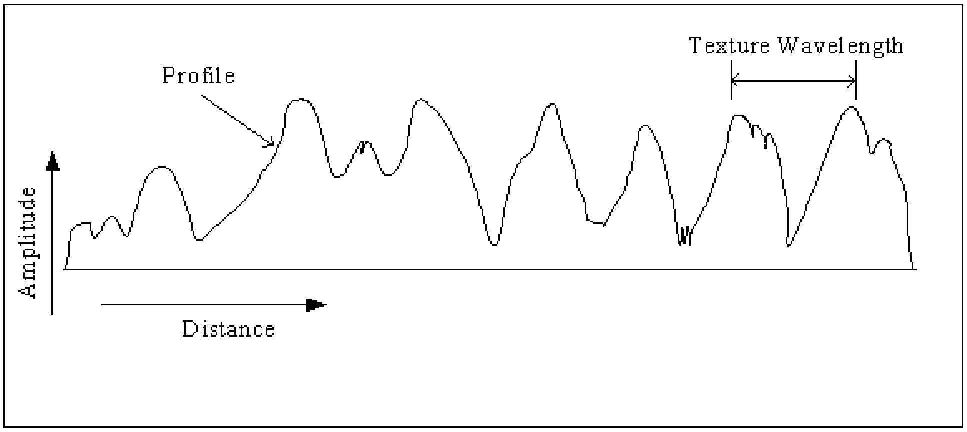


Figure 2.8: Data file format.

2.9 Texture Variables and String Filtering

A statistic frequently used in describing texture is mean profile depth or MPD. The computation of this statistic has been well defined both by the ASTM and the ISO. The two dimensional surface profile for a small section of a pavement is illustrated in Figure 2.9. The profile is given in terms of amplitude and distance. Inertial reference profilers provide an estimate of the surface profile with long wavelength information removed. An estimate of the true profile can be measured by rod and level. There is considerable information defining profile frequency or wavelength, amplitude, as well as the measurements methods of road profilers and thus these concepts will not be repeated here. Texture Profilers provide measurements of the very short wavelength, related to the definitions in section 1 for micro and macro-texture. These systems must use a horizontal (sampling frequency) and vertical displacement measuring method such that the definitions of the bandwidth ranges for micro and macro-texture are met.



Figue 2.9: Diagram of pavement surface.

For longer wavelengths such as 0.5 feet to 500 feet, the combination of a displacement measuring laser and accelerometer are used to remove the influence of the vehicle suspension system in Road Profilers. For the much shorter wavelength range of surface texture, the vehicle influence is simply filtered out.

Figure 10 shows the Mean Profile Depth statistic. This statistic is simply the average value of the profile depth over a specified distance (window or referred to as the baseline). Estimated Texture Depth (ETD) is used to estimate mean texture depth and is defined by the equation:

$$ETD = 0.2 + 0.8 * MPD \quad (3)$$

The baseline is typically 100 mm or 3.94 inches (related to the diameter of the spreader tool used in the volumetric method). It would seem that ETD is a primarily a measure of macro-texture and not micro-texture, because of the much greater amplitude range of the longer wavelengths, although the effects of micro-texture could perhaps be included if the horizontal sampling is sufficient.

After the profile data was read in from the tests, investigations to see if the skid number could be predicted using this profile data were conducted. The data was first pre-processed using various methods. One method found to be useful is based on the so-called sand patch method discussed in [3]. Here the surface texture is related to the diameter of a specified volume of sand-like substance distributed over the pavement. Although somewhat crude, this method yields surprisingly good results.

Similarly, as developed in [11], a string-filter method used for computing rut is a similar method of modeling the time-surface interaction. The string filter is applied as illustrated in Figure 2.11. The filter requires two parameters, base length or BL, and string length, SL. The filter is somewhat similar to the European String Method used for rut measurement, in which an imaginary string is stretched across a set of points, P_1 to P_{16} as indicated in Figure 2.11. The set of points between SL are replaced with a new set, where all points making contact with the string have a zero value and those that fall below the string are replaced with the difference between the point and the imaginary string. The new set of 'string filtered' points are then further divided into one or more subsets, where the length of the subset is BL. In Figure 2.11, the set of filtered SL points consists of 3 subsets, BL_1, BL_2, and BL_3. A second variation of the string filter consists of including in each subset BL_i, only those points that do not make contact with the string. Although not necessary for use with each statistic, one or more of the above statistics can be computed for each BL subset and an average of the statistics for the SL set determined. For example, using the RMS statistic (also referred to as STD) and using the second variation we get for the first two subsets:

$$SL = (P_1, P_2, P_3, ...P_{14}, P_{15}) \tag{4}$$

$$BL_1 = (P_1, P_2, P_3, P_4, P_5, P_6) \tag{5}$$

$$BL_2 = (P_4, P_5, P_6, P_7), \text{ etc.} \tag{6}$$

$$STD_1 = \frac{\left[\sum_{i=1}^{3} a_i^2 - \frac{\left(\sum_{i=1}^{3} a_i \right)^2}{\sqrt{2}} \right]^{1/2}}{\sqrt{2}} \tag{7}$$

$$STD_2 = \frac{\left[\sum_{i=4}^{7} a_i^2 - \frac{\left(\sum_{i=4}^{7} a_1 \right)^2}{4} \right]}{\sqrt{3}} \tag{8}$$

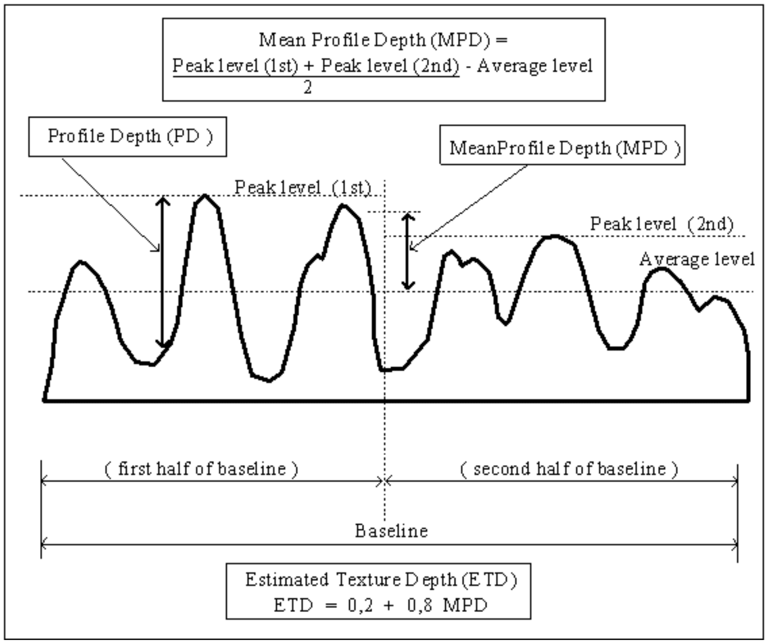
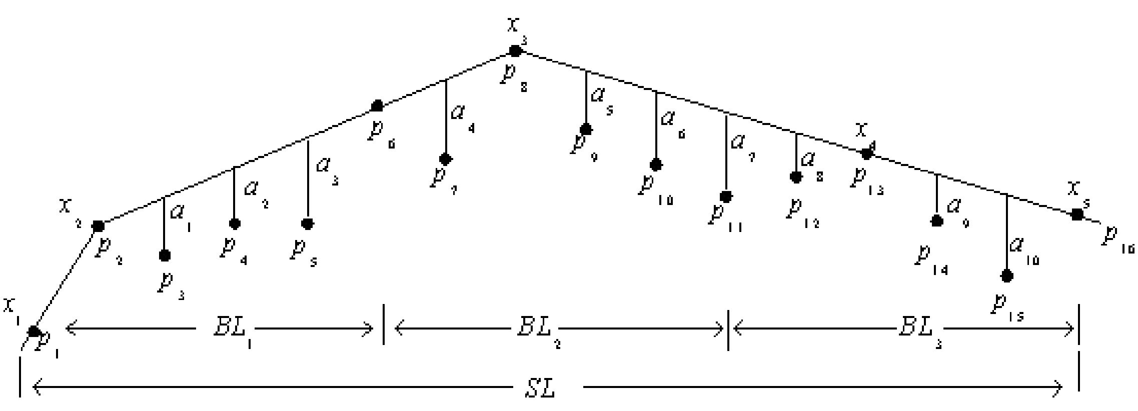


Figure 2.10: Definition of terms.



P_i = i^{th} texture profile point in segment less th SL_j

a_i = displacement from string to point

Figure 2.11: Diagram of the string filter.

CHAPTER 3

INITIAL MODELING EFFORTS

3.1 Introduction

Linear regression methods were used as a first attempt to correlate parameters used to measure surface texture and SN. This chapter reviews the results of the linear regression analysis. It was found that the STD discussed in Chapter 2 covering the entire data set (overall STD) produced reasonable correlation with the measured skid number after the data was transformed using a logarithmic transformation. The regression and transformation techniques used are discussed in [12, 13, and 14].

One of the characteristic of this method is that only one texture measurement technique is correlated with the measured SN Combining numerous variables will be discussed in Chapter 5.

3.2 Initial Analysis

Various forms of texture measurement, such as MPD, discussed in Chapter II were run on the 02 data, to see if any correlation with SN could be achieved. All of these statistics were based on the string filter using various base lengths and string lengths. Through experimentation, it was found that a base length of 10 and a string length of 150 produced some form of correlation in the form of a logarithmic curve. Figure 3.1 shows one of the logarithmic type curves generated by using the overall STD for string sections and the given correlation with the measured SN from the 02 data. Similar results were found for MPD, ETD, and Average STD. The R^2 correlation coefficient of 0.61 is marginally acceptable, but there is some correlation with the SN. The R^2 correlation coefficient is defined as the square of r given by

$$r = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}} \tag{9}$$

Because of this initial hint at correlation, a logarithmic transformation was implemented to attempt improvement of the data with a linear correlation. The derivation of this transformation and the results are presented below.

3.3 Logarithmic Transformation and Data Correlation

To facilitate the data analysis, a logarithmic transformation was developed and is derived below. For this model, a general inverse exponential curve given by

$$y = a - \frac{d}{x^b e^{c-d}} \tag{10}$$

Rearranging gives

$$a - y = \frac{d}{x^b e^{c-d}} \tag{11}$$

Taking logarithms gives

$$\ln(a - y) = -b \ln x + (\ln d - c + d) \quad (12)$$

Through experimentation, it was found that letting a ? 60, y ? SN, -b ? a, x ? STD, and lnd -c + b ? B, the following transformation was generated.

$$\log(60 - SN) = a \log(STD) + B \quad (13)$$

It was found that a=1 and B=0 enabled better correlation. Table 3.1 lists some of the data used after the transformation and Figure 3.5 shows a plot of the data with correlation. The overall correlation increased to 0.64. However, further improvements are desired. Similar plots were made for MPD, ETD, and Average STD, and these results are presented in Figures 3.6, 3.7, and 3.8. A similar transformation as above was used to generate the data for these plots.

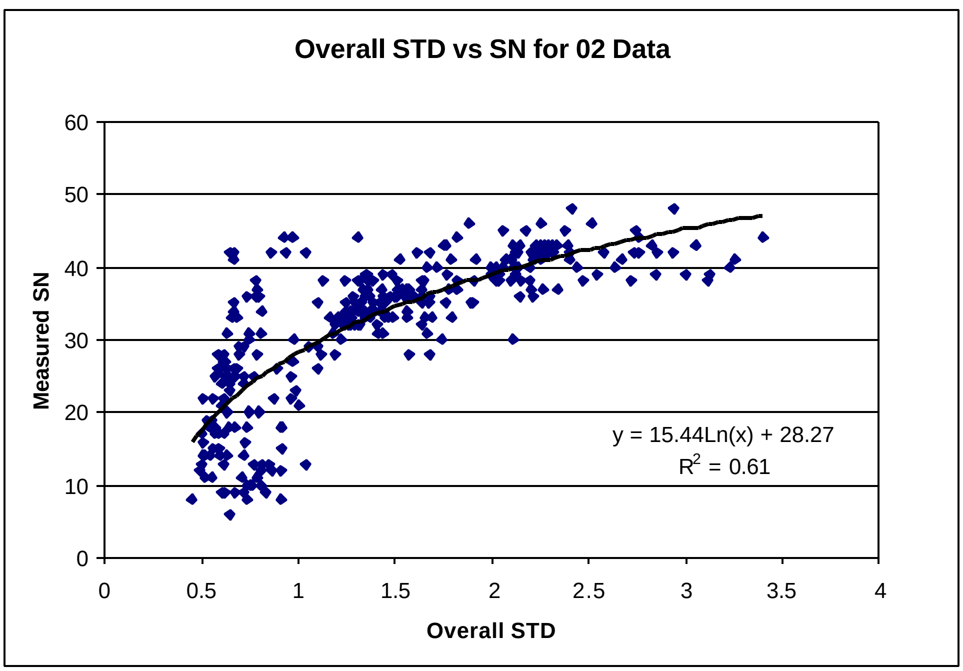


Figure 3.1: Initial Correlation between Overall STD and SN.

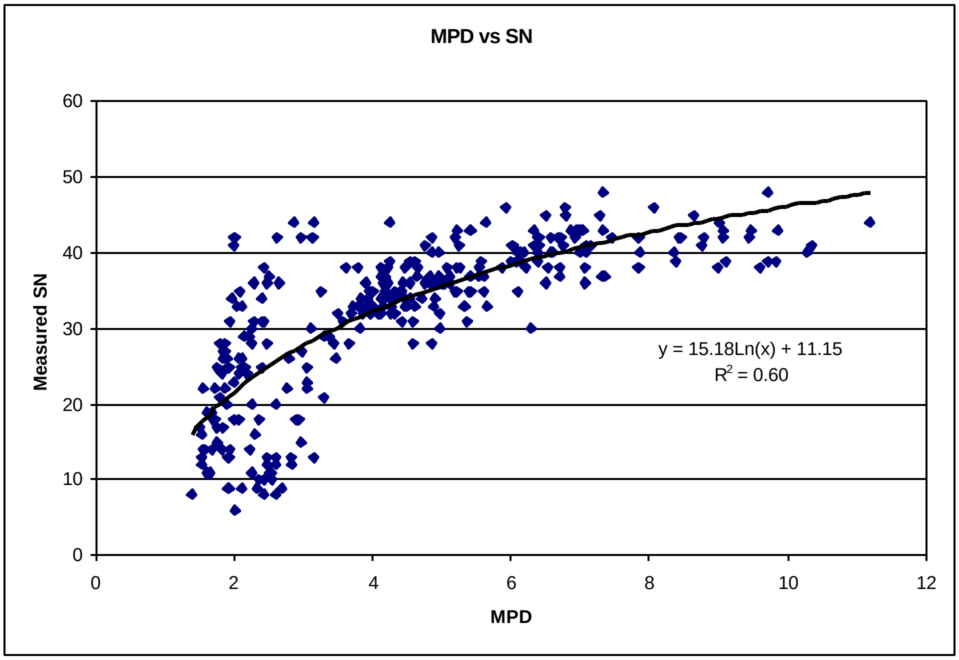


Figure 3.2: Initial correlation between MPD and SN.

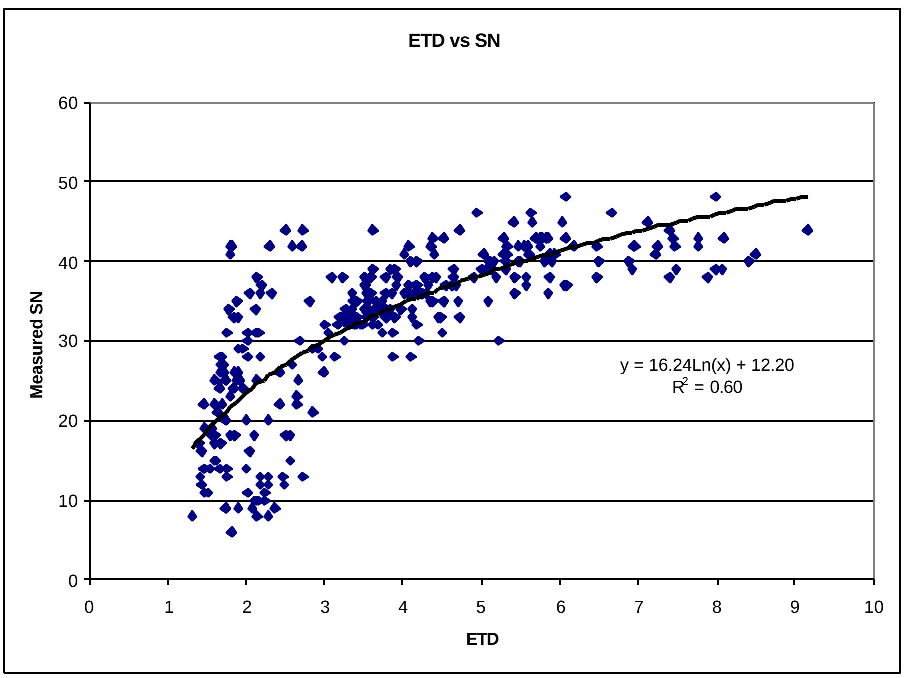


Figure 3.3: Initial correlation between ETD and SN.

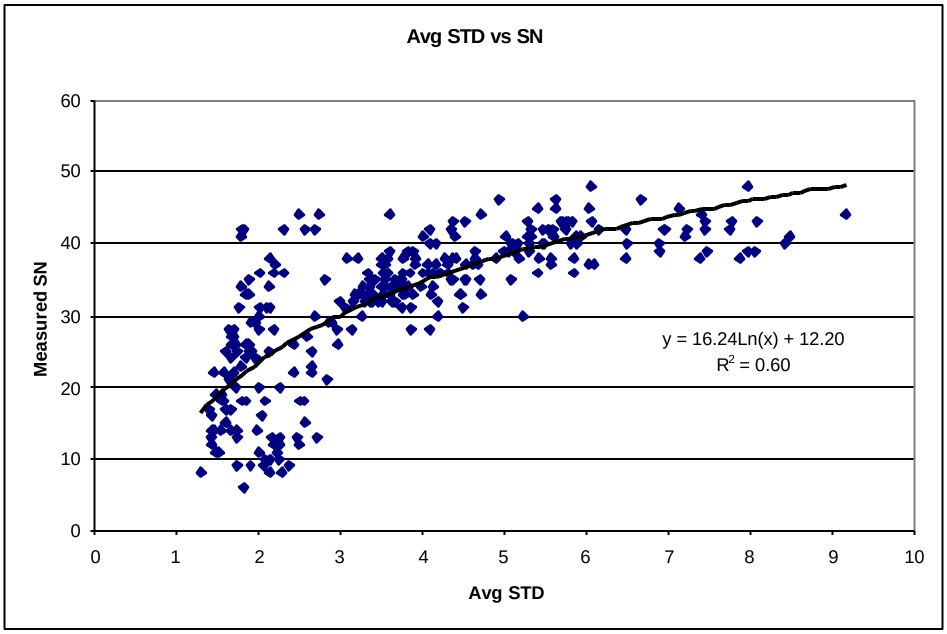


Figure 3.4: Initial correlation between Average STD and SN.

Table 3.1: Example Samples.

Filename	MPD	ETD	Av. STD	Overall STD	Log(STD)	SN	Log(60-SN)
2091052.47	5.407	4.525	1.612	1.889	0.2768	35	1.398
2091052.55	3.445	2.956	1.038	1.122	0.050	28	1.505
2091053.01	4.979	4.183	1.503	1.638	0.2147	32	1.447
2091053.08	6.704	5.563	1.978	2.202	0.343	37	1.362
2091053.15	7.839	6.471	2.261	2.405	0.3811	42	1.255

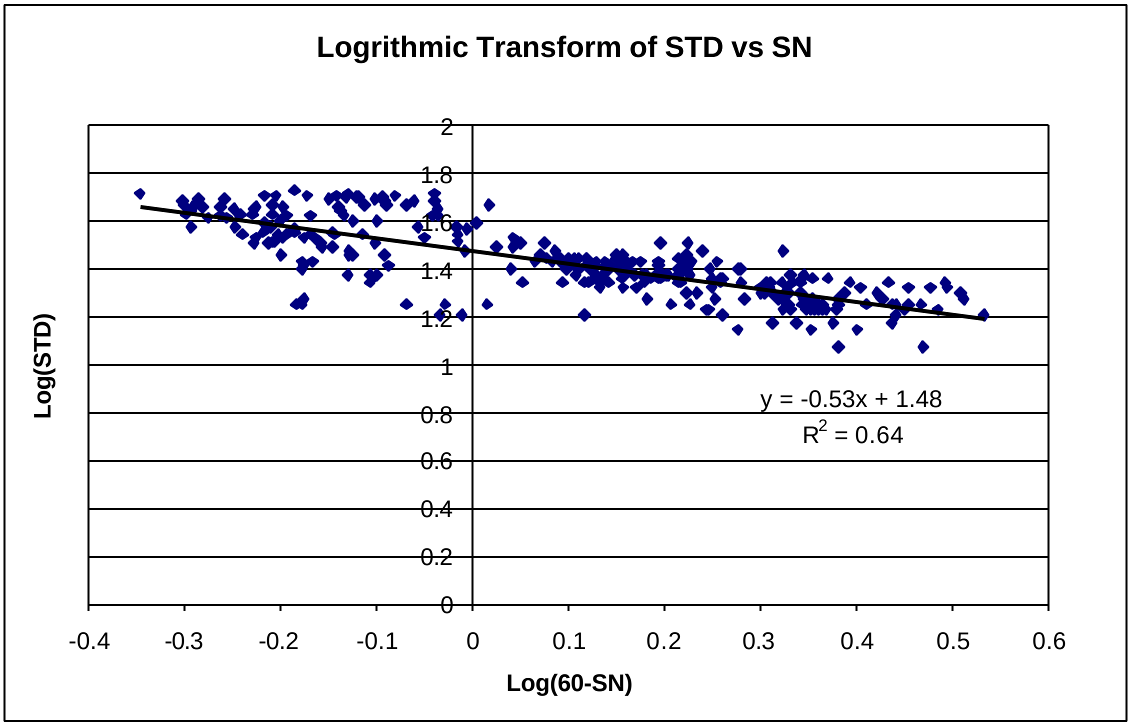


Figure 3.5: Transformed STD vs SN.

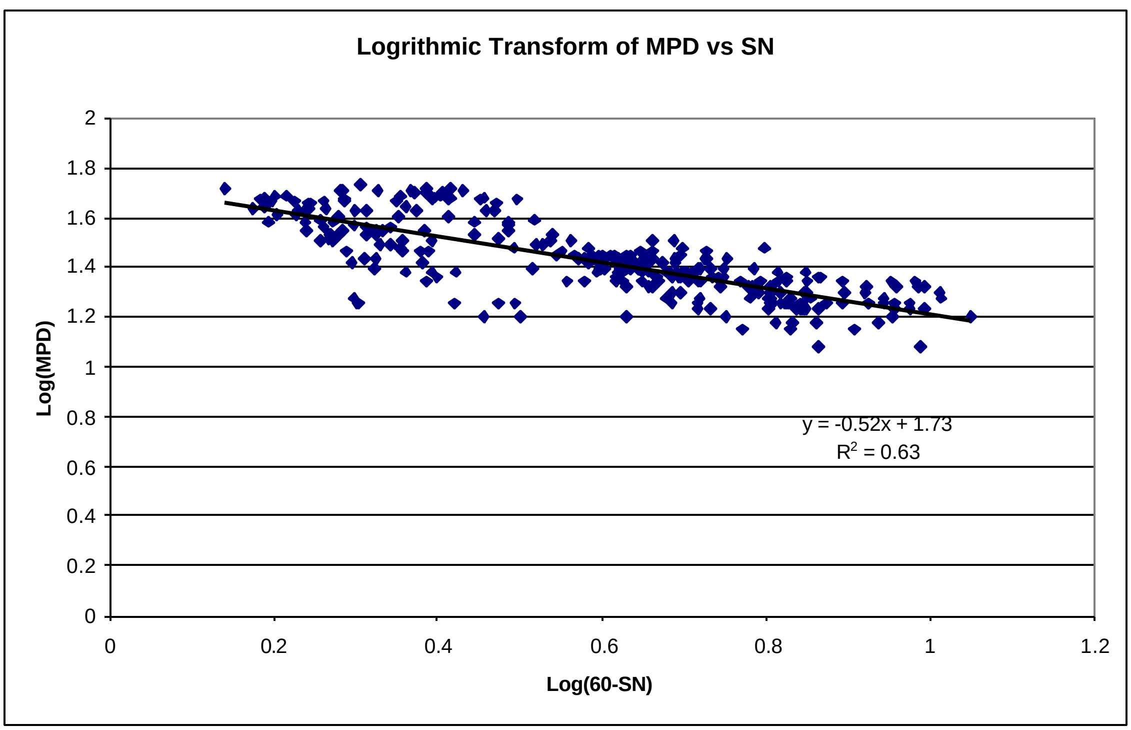


Figure 3.6: Transformed MPD vs SN.

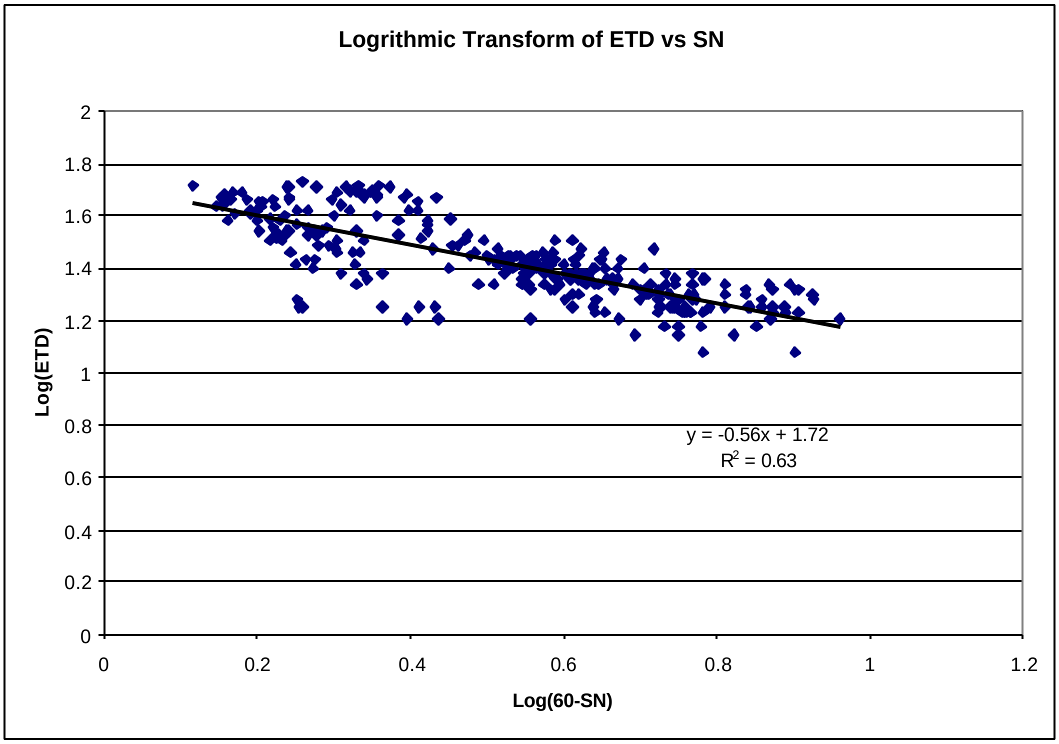


Figure 3.7: Transformed ETD vs SN.

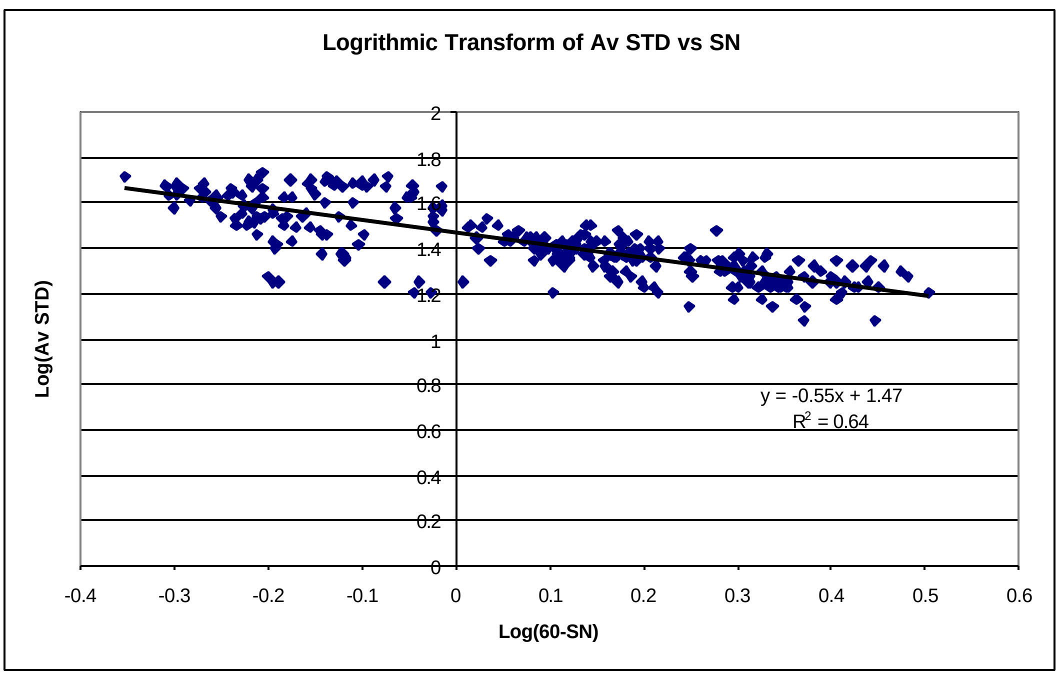


Figure 3.8: Transformed Av STD vs SN.

3.4 Linear Regression Conclusions and Limitations

The best R^2 correlation obtained, as shown in Figure 3.2 was 0.64, which sows that there is some form of correlation between the string parameters discussed in Chapter 2 and the SN. This correlation is slightly better than most other methods used in practice however, it is desired to improve on the correlation if possible. One of the limitations of the linear regression techniques is that one variable is correlated to the SN, when if fact, several variables may be applicable. A combination of these variables will be shown to give better results using a neural network in Chapter 5.

CHAPTER 4

DSP AND POWER SPECTRUM ANALYSIS

4.1 Introduction

Chapter 2 discusses the micro-texture parameters such as MPD and STD. Figure 4.1 shows that the surface contour is similar to a wave, and thus, may have an average wavelength over a section, and may be approximated by an associated Forier series. Based on this observation, it was conjectured that Digital Signal Processing, DSP, methods may lead to some correlation between the surface texture and the SN. The power spectrum of the data was developed using methods and routines in [11]. This power spectrum was then fed into a neural network previously used in the Transportation Instrumentation Lab of the University of Texas at Arlington. However, the results of this study did not yield good results, and produce poor correlation.

However, it was discovered that the power spectrum of some of the data sets (files) were very unusual in character, with some having numerous frequencies reduced in a pattern resembling a wave form. Further examination showed that some of the data sets may contain numerous bad data points. This could have been caused by a known problem with electrical power during data collection. Thus, the power spectrum plots were useful in that they could be used to identify bad data sets. These data sets were eliminated in future studies.

4.2 DSP and Power Spectrum Results

This section discusses the examination of the use of the power spectrum of the actual data points describing the surface roughness and texture. The surface of the pavement can be estimated to be a waveform. A waveform can be described by a Fourier series. Each data point in each data set is an estimate of the position of the pavement at that location. This series of points describes the waveform of the texture, as shown in Figure 4.1. A set of such points enables the use of a power spectrum to describe the surface, as discussed in [11].

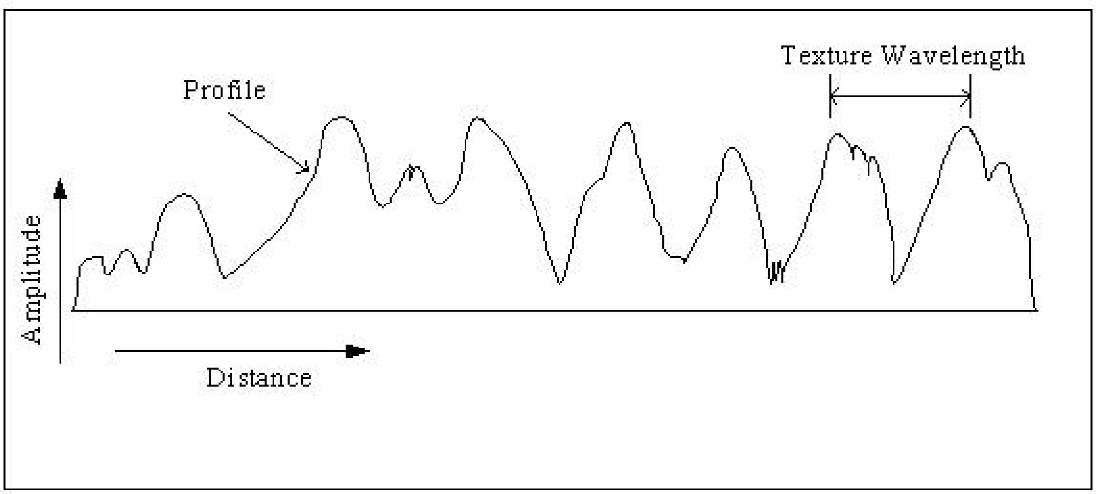


Figure 4.1: Texture described as a waveform.

Using the subroutines and functions developed in [11], a MATLAB program was developed to read the data of each point in a series of data set (set of files for the 02 and

06 data) and an associated power spectrum was generated for each data set. Because of the nature of the frequencies and data, the log of the power and frequency was used. The value of each power spectrum frequency was put into a training file. These values were used to develop a training set and a test set. The training set had not only the power spectrum, but also the measured skid number for the specific training set. Appendix B give an example of a training set. Similarly a test set file was developed, however, the test set did not include the measured skid number.

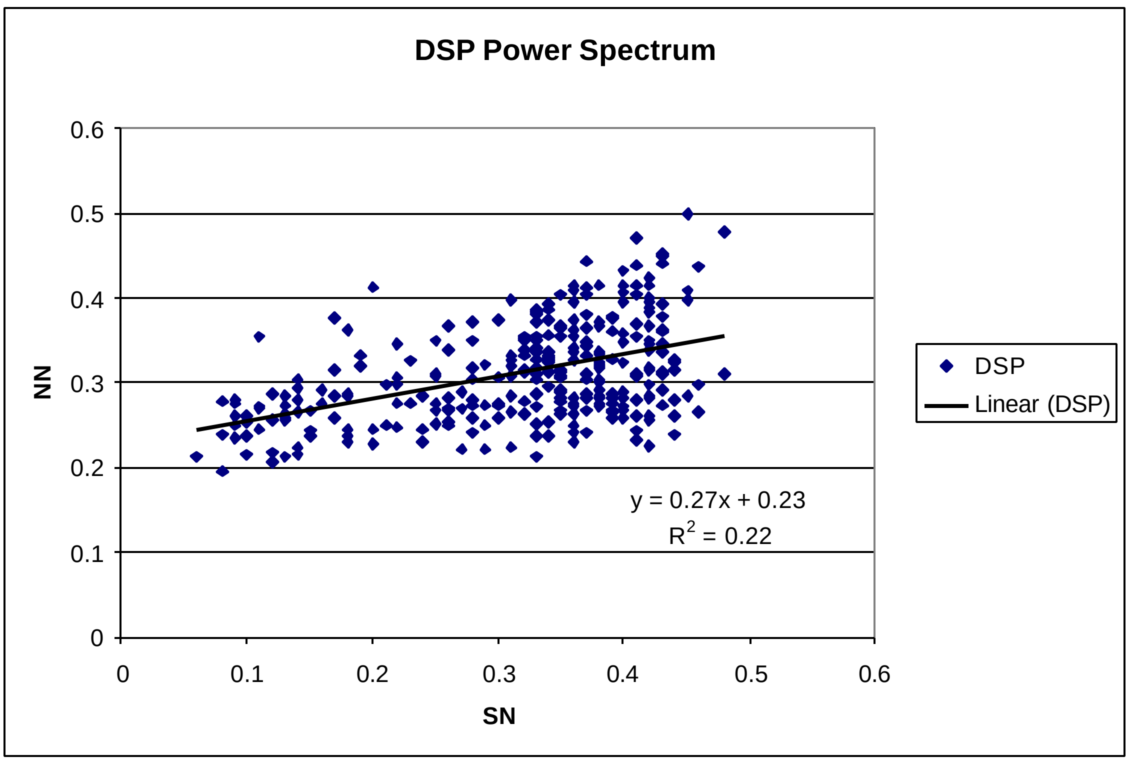


Figure 4.2: Results of attempted correlation using DSP.

A neural-network similar to one previously developed in C, based on [22] was used to test for correlation between the power spectrum of the surface and the skid number.

Tests were conducted on sub-sets of the 02 and 06 data. The results were marginal at best. Figure 4.2 shows the results of one of the tests, giving poor correlation.

4.3 Use of DSP to Reject Faulty Data Sets

Although the DSP methods did not yield good correlation, the power spectrum of individual data sets did reveal important information. Figure 4.3 shows the power spectrum of a typical data set.

About 85% of the files generated power spectrums that appeared as Figure 4.3. This is a "normal" power spectrum and was expected. It was also observed that the string program used to calculate MPD, STD, and other parameters rejected some of the data sets. If the program encountered numerous data points which were flagged as bad, the program could not compute a string section, then the file had to be rejected, and the program printed out the name of the file, rather than calculate MPD, ETD, and STD. For example, if every point in a string section is a substitute for a bad point, then all the points are he same in that string section, and the program terminates, printing out the file name. This was due to the fact that to many of the individual data points inside the program had faulty flags. As shown in Figure 2.8, the data section has 16 bit data. The first four bits are flags used to mark the data and data errors. If one of these bits (flags) are set, then the individual data point is faulty, and rejected. If there are numerous faulty and flagged points, then the entire file is rejected by the program, if computations of MPD, etc. cannot be completed.

These rejected files by the string program had power spectrum that did not look like Figure 4.3. All the files rejected by the string program had unusual power spectrum, but some of the files with unusual power spectrum were not so corrupted that they would cause the string program to terminate. Because of this observation, the files with unusual power spectrum became suspect, in that it is known that there is bad data within the file, based on the unusual power spectrum, but it cannot be ascertained easily how many bad data points are in the file. The more bad data points are within a file, the more error there will be in calculation of MPD, ETD, and the STDs. However, how big this error is cannot be computed easily.

Thus, the files with unusual power spectrum were suspect, and rejected in further analysis. The 02 data did not have many rejected files (about 10%). However the 06 data had many more rejected files (about 20%) and, in general appears to be "dirtier" than the 02 data. Figures 4.4 through Figure 4.6 show some of the power spectrum anomalies.

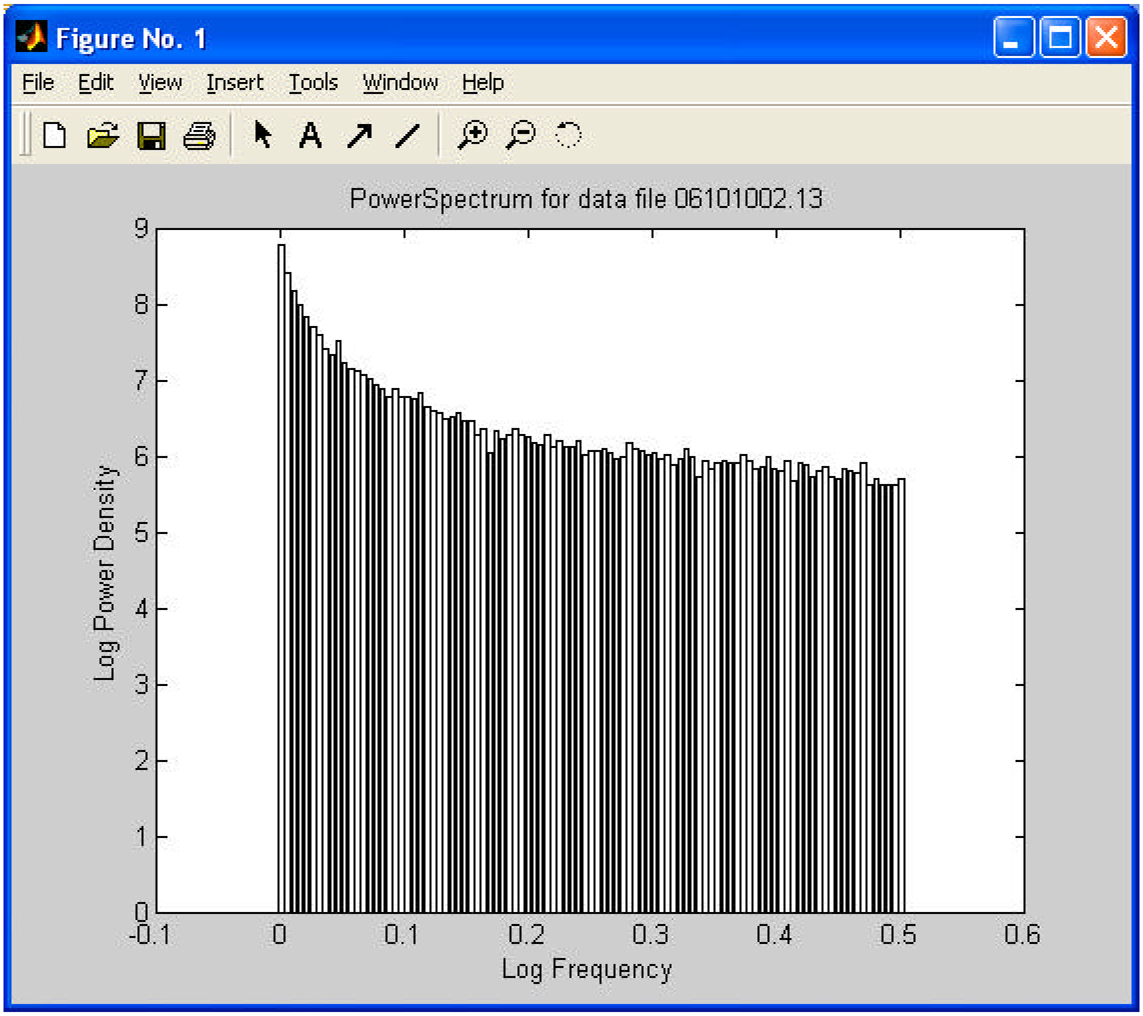
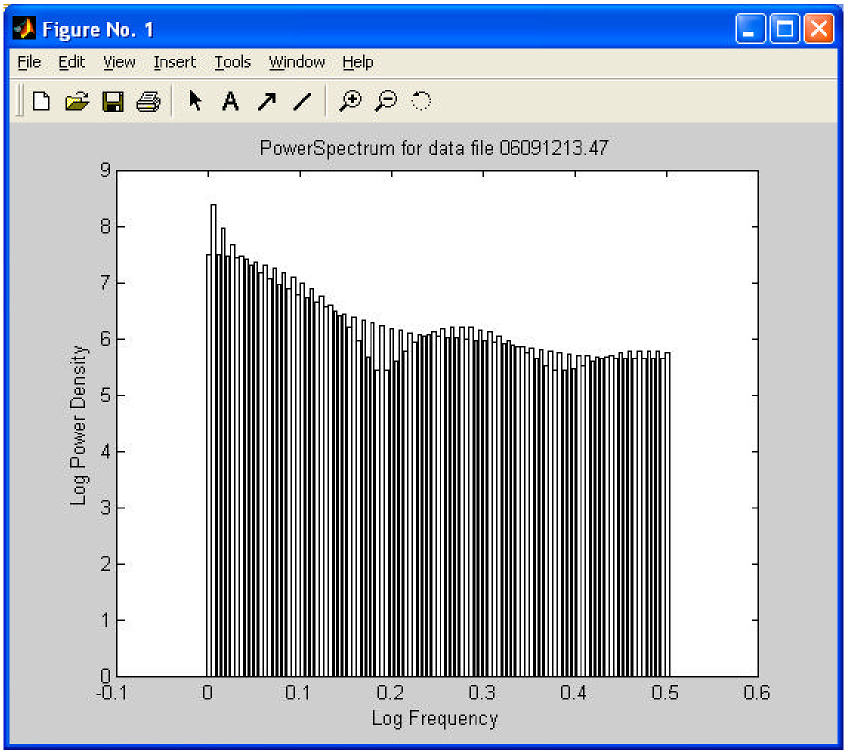


Figure 4.3: Typical power spectrum.



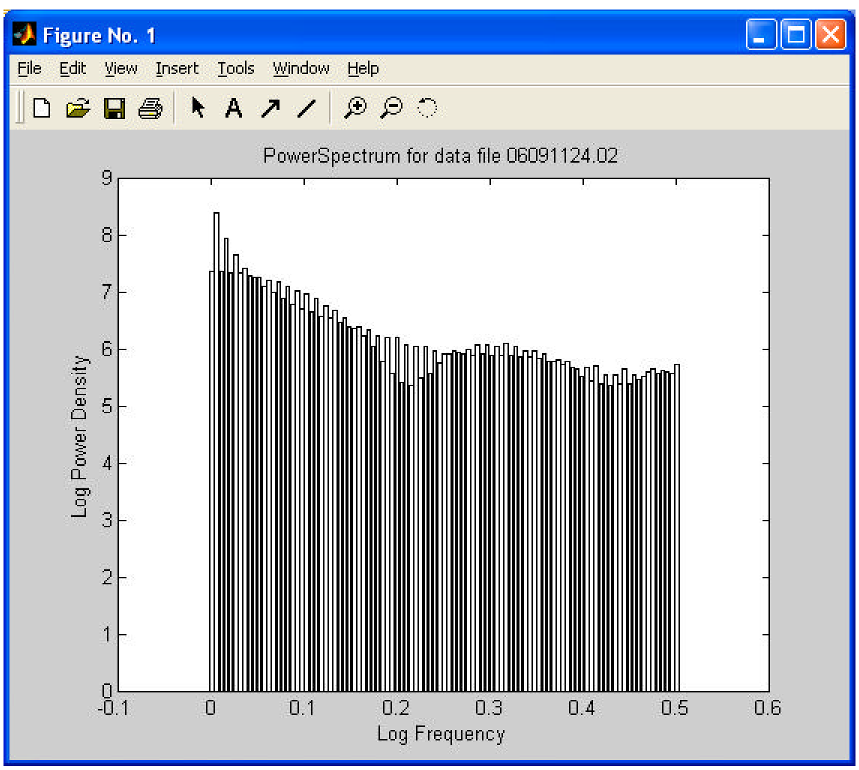


Figure 4.4: Two examples of a wave pattern.

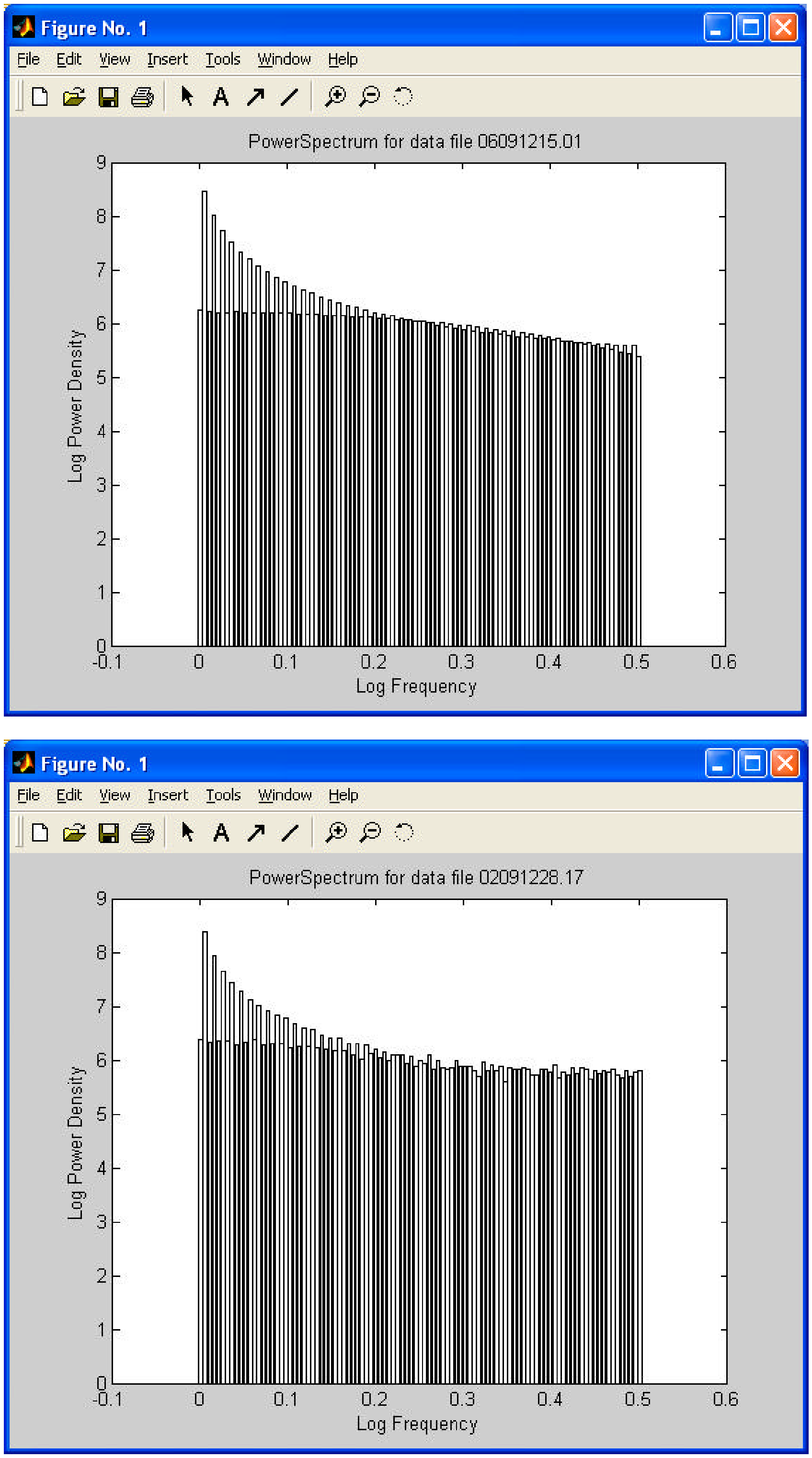
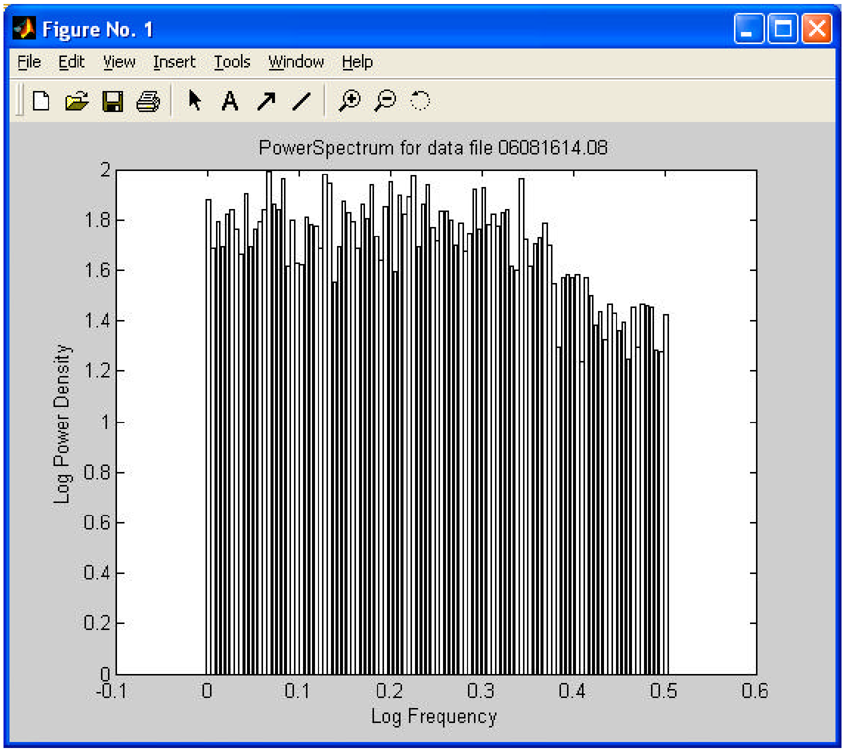


Figure 4.5: A cut frequency patter. Note both 02 and 06 data had these.



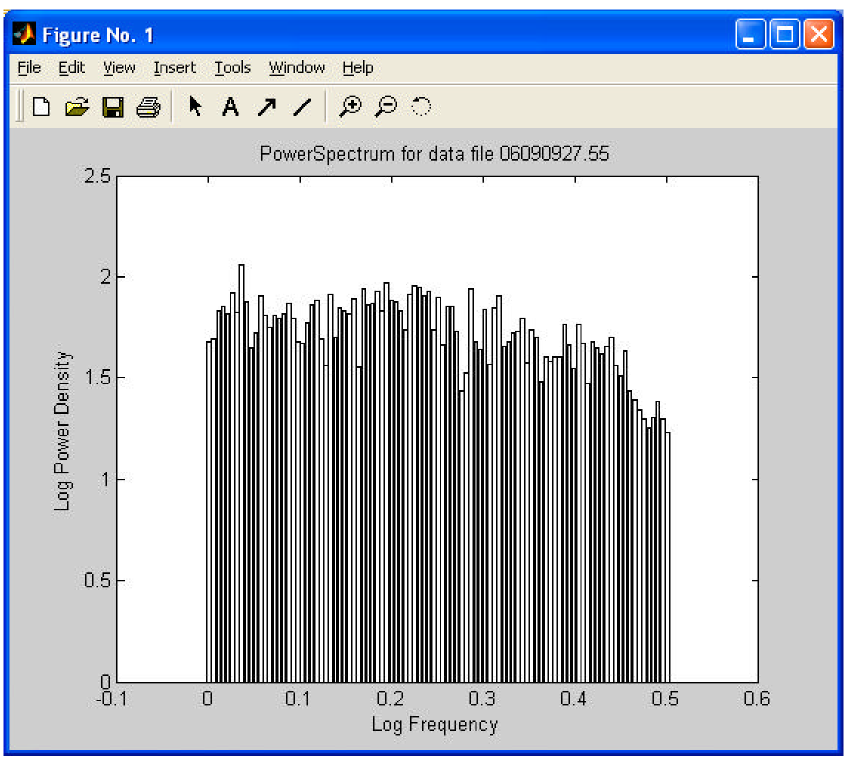


Figure 4.6: Noisy data pattern.

CHAPTER 5

DATA ANALYSIS USING A NEURAL NETWORK AND STRING FILTERING

5.1 Introduction

This chapter discusses the use of a neural network and a so-called string filter to predict and correlate the skid number with the surface texture. A string-line method is commonly used in Europe to estimate ruts and other characteristics. Based on the string-line method, a so-called string filter was developed in [21] to estimate the surface roughness. A neural network was developed that used as input four parameters calculated from the string filter. The neural network was a two-layer, feed-forward, back-propagation network. A training set was developed from all the data, comprised of one hundred points. Two test sets were selected: one from the 02 data and one from the 06 data. Although the 06 data was considerably more noisy and had a considerably large portion with skid numbers above 40, both data sets produced correlation of over 0.70. This chapter discusses the development of the neural network model, discusses the development of the training set and test sets, and presents the results of the neural network, including estimates of the R^2 correlation coefficient.

5.2 The Neural Network

To improve on the process developed in Chapter 3 by incorporating numerous inputs, multi-input neural networks were examined. Rather than use the neural network package used in Chapter 4, the MATLAB Neural Network Toolbox was used. The back-propagation neural-network used in Chapter IV was written in C++ and adapted from [16, 22] and proved cumbersome to use, requiring re-compilation for any modifications. Because MATLAB had been adopted by the Transportation Instrumentation Lab, MATLAB products were preferable. Further, because of its interpretive nature, the MATLAB toolbox enabled quick experimentation with different forms of networks and different inputs. Further, MATLAB enables downloading the network to a microprocessor, so the trained network can be incorporated into an embedded system for future automation of this process.

Through experimentation, it was found that a two layer back-propagation neural network yielded good results. MPD, EPD, Average STD, and Overall STD were computed and fed into the network for each data set. The data was divided into a training set and two tests sets, one for the 02 data and one for the 06 data. The network, after being trained outputs an estimated skid number for each test data set and does not have to be re-trained. These SN were then compared to the actually measured SN. The network used had bias, a log-sigmoid layer and a linear output layer. Figure 5.1 shows a schematic of the neural network used based on the back-propagation network examples in [10, 13, 15, 17], with R = 4 inputs, S1 = 4 neurons, and S2 = 1 neuron.

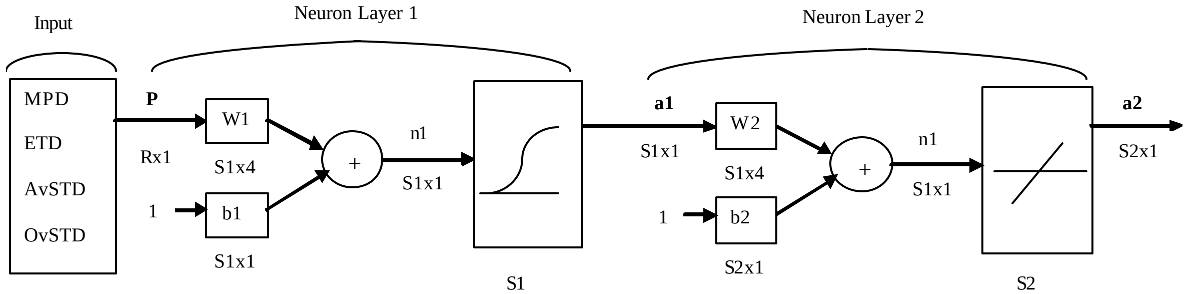


Figure 5.1: Neural Network.

5.3 Neural Network Parameters

During the development of the neural network, several different forms and parameters were examined by experimentation, including a single perceptron, and a linear network. The network of Figure 5.1 using [0 12; 0 10; 0 4; 0 4] for the range of MPD, ETD, STD1, and STD2, 1000 epochs, and net.trainParam.lr = 0.01 worked well. No significant improvement was noticed using a three layer network.

5.4 Training and Testing Set Development

In order to train the neural network, a training set was developed. In general a training set needs to be arbitrarily selected, so as to represent unbiased data. Initially, the first half of the 02 data was used as a training set, with varying results. It was observed that most of the SNs in that set were between 30 and 40. Thus, there was very few data points below 30 and above 40 to train the network, which lead to a poorly trained network. In general, the training set should be representative of overall data which can be expected to be input [10, 13, 15, 17].

Because of this situation, a pseudo-random set was developed from all the 02 and 06 data combined. The only restrictions on this training set were that it included values from the entire range of SN from below 10 up through 55, and that it not include any data sets rejected by the DSP power spectrum discussed in Chapter IV, so that no faulty readings were input into the training set. The final training set comprised a total of 100 data sets from the 02 and 06 data of approximately 50% each. Appendix C gives the training set inputs.

The training set included two files. One file listed the MPD, ETD, Average STD and Overall STD for the training set, and the second file included the target skid numbers for each of the training data sets. This single training set was fed into the neural network and tested on a set of 02 data and a set of 06 data.

The test sets were developed in a similar fashion. All the remaining data from the 02 set was used, except those that were suspect based on the DSP power spectrum analysis. These data sets and the data sets used in the training set were the only points eliminated from the 02 training set. A few data sets with unrealistically large MPD were also eliminated as discussed below. The 06 training set was developed in a similar manner.

The limits on the input range for the neural network were 11, 10, 4, and 4, for MPD, ETD, Av. STD, and Overall STD respectfully. The network performance was greatly affected by these maximum ranges. A few points had unrealistically large MPD and ETD (about 4 times the average). These points had to be rejected because they were clearly out of the range of measurement and appear to have resulted from an unrealistically rough section of pavement. The total points rejected for large MPD was less than 1% of the data. Appendix C gives sample data.

5.5 Results of Neural Network Skid Prediction

The results of the neural network are presented in Figures 5.2 and 5.3. The 02 test data resulted in a R^2 correlation coefficient greater than 0.75, which is very acceptable. The 06 test data resulted in a R^2 correlation coefficient of 0.71. This is a significant improvement over the commonly used sand-patch method or the linear regression methods developed in Chapter 3.

For the 02 data, over 200 data points were used to test the neural network. These points include all the points that were not used in the training set and were not eliminated by the DSP methods discussed in Chapter 4. Thus, the test sets were approximately twice the size of the overall training set. However, it appears that the training set did cover a good spectrum of possible data values.

However, there are several observations that may adversely affect the results. First, the neural network tends to slightly under estimate SN high values. The reason for this is unknown. Second, the network tends to over predict low SN. This may be caused by faulty measurements and low velocity of the vehicle and needs further investigation. Further, it should be noted that around measured SN of 50, in the 06 data, there appears to be a flat line in the actual test data which is visible in Figure 5.3. This line may be a limit in the reliability of the measurements above 50. In general, skid numbers below 30 and above 50 are suspect in that this leads to a very high or low friction coefficient.

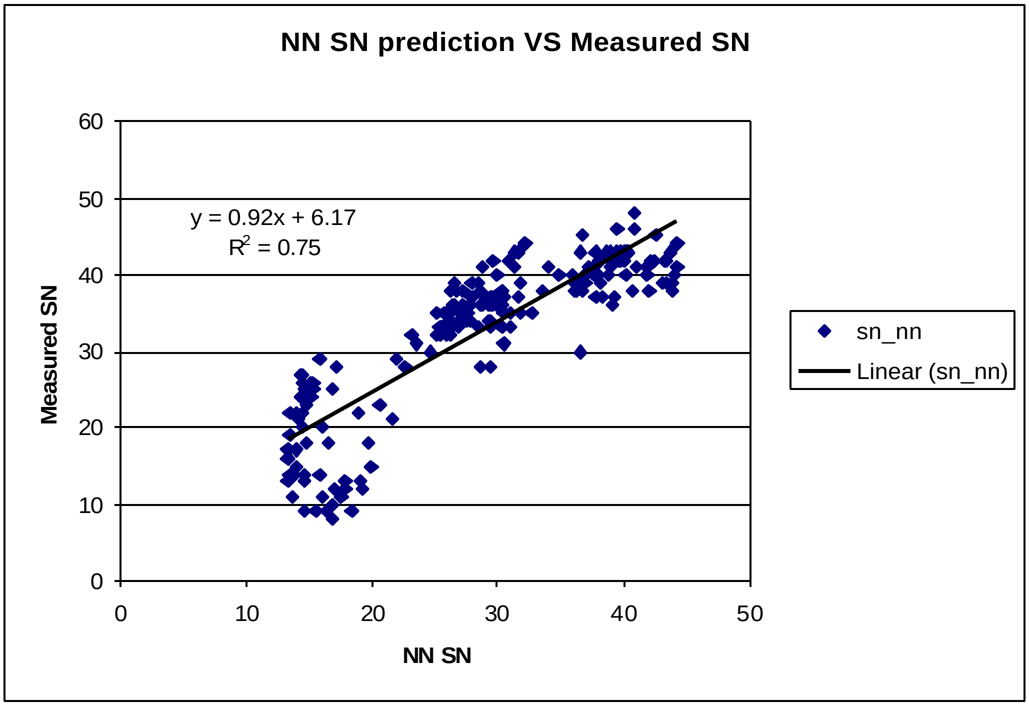


Figure 5.2: 02 test data results.

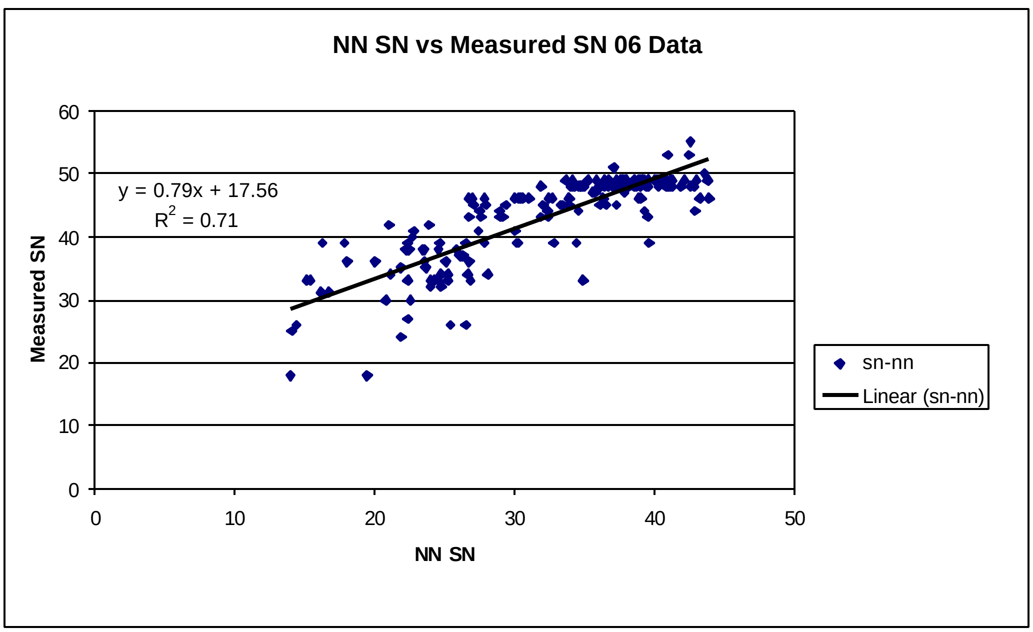


Figure 5.3: 06 test data results.

5.6 Further Neural Network Tests

In general a two layer, back-propagation neural network with log-sigmoid and linear functions can be used to simulate any function [17]. However, because of the highly non-linear nature of friction, a three layer network may produce better results. To test this hypothesis, a three layer back-propagation neural network was developed using pure-linear, log-sigmoid, and tangential-sigmoid layers. Results of this network were only marginally better than the two layer network presented above, and results are questionable, and will not be presented here. Further investigation of this and other matters will be discussed in Chapter 6.

CHAPTER 6

CONCLUSIONS AND FURTHER RESEARCH

6.1 Conclusions and Summary

This document presented results of data analysis for the prediction of the skid number between a rubber tire and pavement. The skid number is related to friction. Chapter 2 presented background information, including an overview of the hardware used to collect the data. Chapter 3 presented a linear regression model used in the preliminary analysis of the data which gave acceptable results. Chapter 4 presented DPS and power spectrum analysis of the data, and although this analysis did not result in good correlation, it did provide a method of checking for faulty data sets. These data sets were subsequently removed. Finally, Chapter 5 presented a neural network which was able to incorporate a number of inputs from the string filter of the pavement texture measurement. This network was able to predict the skid number and give a correlation of over 0.70, which is an improvement over conventional methods. Table 6.1 summarizes the results of the Linear Regression methods, DSP, and Neural-Network methods.

Table 6.1: Results Summary.

Method	Data Set	Best R^2	Comments
Logarithmic Best Fit	02	0.60	Used Overall STD vs SN
Linear Regression	02	0.64	Used Logarithmic Transform
DSP Power Spectrum	02	0.22	Used C++ NN routine
NN-Matlab	02	0.75	Used Matlab NN toolbox
NN-Matlab	06	0.71	Data was noisier than 02 data

6.2 Issues, Concerns, and Areas for Further Research

Although the neural network developed in Chapter 5 did produce good correlation of the data, and did incorporate a number of inputs, two additional pieces of information will probably lead to better results. First, it has been shown that the measured skid number varies with velocity [3, 4]. Although the ASTM specification defines the velocity range at which measurements are to be taken, there will be some variation which will affect the SN measurements [3]. The 06 data includes velocity measurements, however, the 02 data did not have velocity recorded available at the time of this research. Because of the lack of velocity data in the 02 data sets, velocity was not incorporated into the model. The 06 data shows a substantial shift in velocity in some of the measurements. This probably adversely affected the results. Because of this shift in velocity, more data should be collected, recording the velocity of each data set, and incorporating this data into the model.

Second, the 02 data was collected in February 2000, and the 06 data was collected in June of 2000. In all probability the temperature of the 06 data was significantly higher than that of the 02 data. In general, rubber durometer changes with temperature, and the durometer of the tire rubber, and other rubber characteristics, may change slightly because of these temperature changes. This change in durometer probably increases the friction coefficient. In neither data set was the temperature recorded, however, the 06 data had higher SN values than the 02 data. Thus, the tests should be repeated, recording the temperature, and incorporating this into the model.

Thus, it is recommended that further tests be conducted including incorporation of temperature and velocity.

Further, each data set should be examined by the power spectrum analysis, to check that the data set is good, and does not have an unusual pattern as discussed in Chapter IV. Data sets with an unusual patter can be rejected on the spot, and the data re-taken. Then immediately the data sets should be entered into a test set to see the effect of the specific data set. To run the power spectrum and neural network takes only a few minutes, so this data should be collectable and analyzed in near real-time, and the prototype system improved.

Eventually, if the system is proven to reliably predict the skid number, the power spectrum analysis and neural network could be incorporated into a near real-time system to quickly estimate the skid number of a section of pavement. This research has laid the foundation for such a system.

APPENDIX A

HARDWARE AND SOFTWARE SCHEMATICS

Illustration of the Measuring & Data Processing Procedure

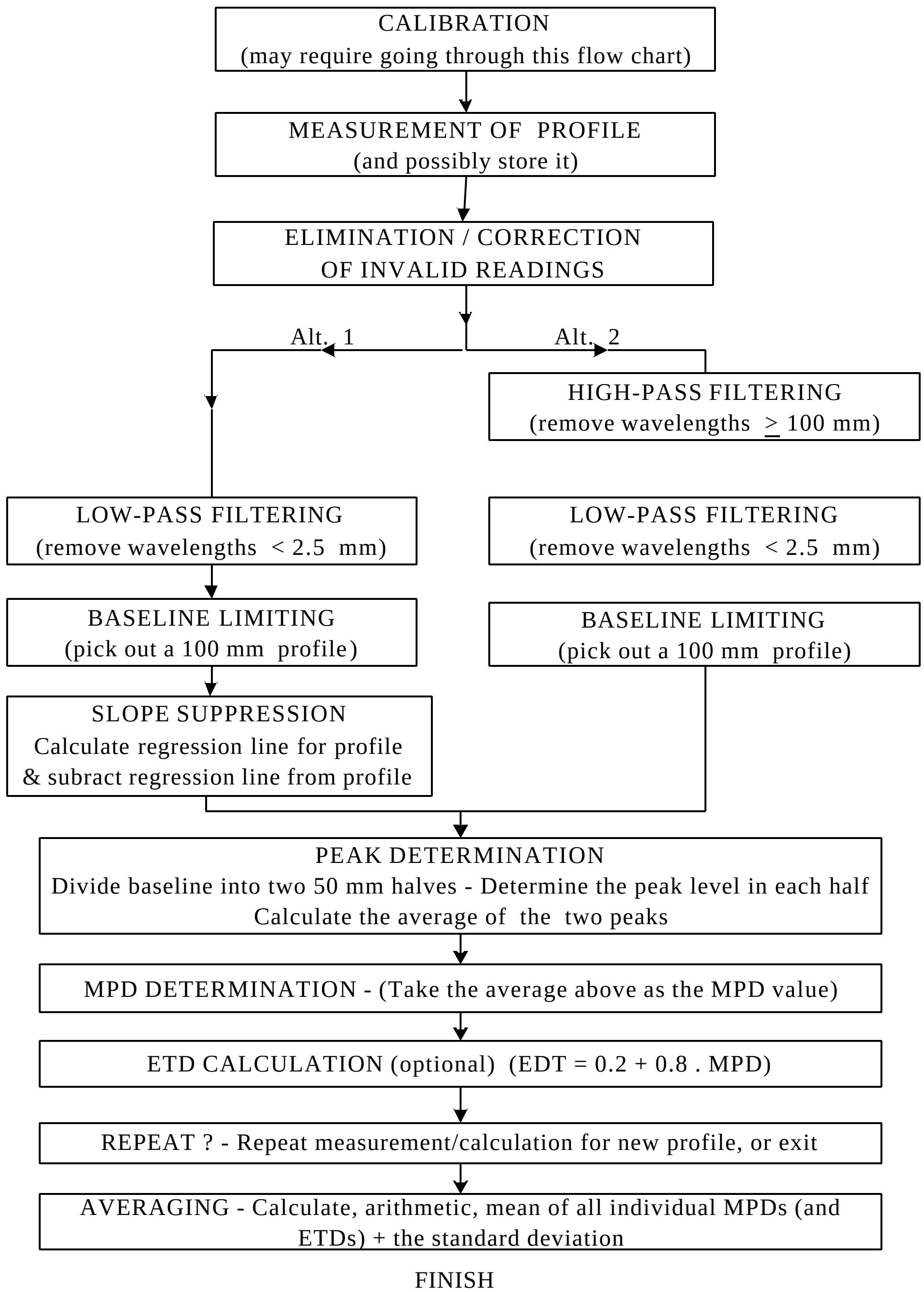


Figure A.1: Measuring & Data Processing Procedure.

PC Laser Interface Unit - Component Layout
Signal Flow

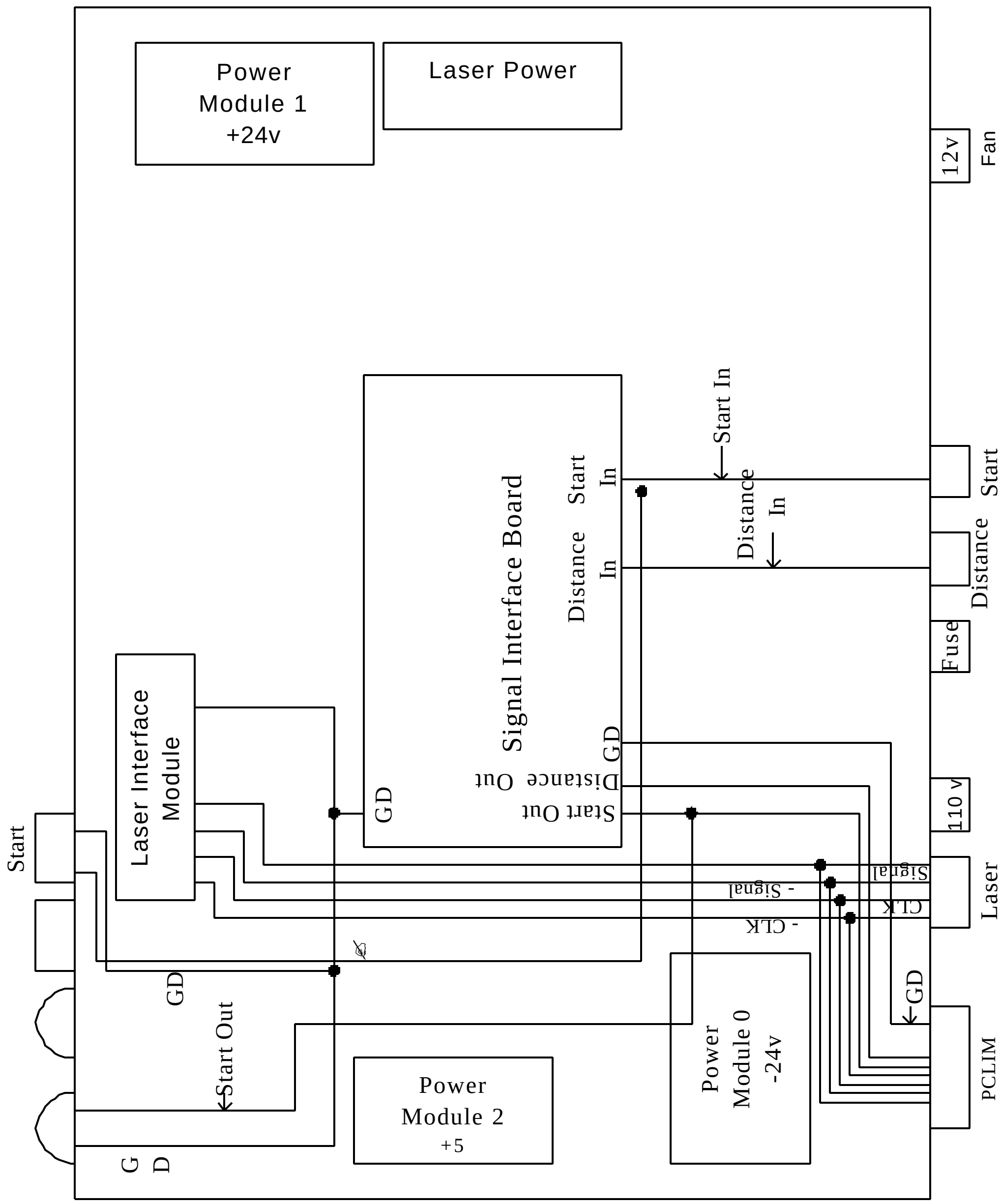


Figure A.2: Laser Power Unit Components.

APPENDIX B

DSP TRAINING SET

Below is a sample training set using 62 power spectral frequencies. Test sets were similar except ignored the input skid number.

```
SNNS pattern definition file V3.2
generated at 20-Feb-2005 16:7


No. of patterns : 100
No. of input units : 62
No. of output units : 1


# Input patern 1:
66920187.897793 32941035.569412 23437597.363091 17102669.264975 12375282.247373
8706451.995003 6902257.775912 5908976.134060 5890983.809944 5646777.717170 4333716.456347
2292135.818704 2893704.064684 1774189.646392 1828983.203342 2807090.107007 1940404.912016
1380705.932342 1476759.050407 1368184.258929 1957798.622319 1087046.631661 1118246.402403
1289113.032590 1394383.808489 1245390.786830 1191570.296332 765733.030430 1030570.075107
906982.449463 899895.012009 735405.675547 774827.877264 781802.303863 474934.413461
1143384.548680 574815.551448 622722.848649 501121.132508 651019.557172 988438.234749
637251.202498 719121.992870 610071.409229 507990.605722 837105.327730 637186.687494
589613.044104 420922.006586 648077.185956 697637.865367 569259.932254 606596.329565
401638.377226 505787.123896 531308.547966 620212.512861 872843.745290 382565.283167
593640.297812 601466.106947 642702.435303
# Output patern 1:
0.530000
# Input patern 2:
72116228.322030 35256411.809467 23889382.793937 16442250.898121 12320555.427253
10408961.377553 7578640.876279 5572973.341398 5221509.381249 4548786.173249
3508466.764558 3090598.816205 2779208.940324 2493975.317202 2398684.705368 1700545.199604
573263.043070 603279.431756 1467085.560972 1501622.055320 980398.201004 959636.858664
1143522.039794 1063010.571967 1007726.029697 992352.903516 836693.010459 795727.465782
887503.341376 825020.502930 659459.092813 579530.717905 534115.534929 546794.903084
613020.192379 521118.059434 393424.289735 499288.687116 574094.592098 388323.955150
303738.986894 466817.258709 513273.959108 415969.933558 419150.592183 454869.938658
435298.477053 480587.674676 533313.620293 443575.062534 316125.523720 260245.427567
263350.950964 353625.041511 461828.704032 439928.217365 391535.618526 409787.899091
352972.754191 256129.069596 331115.567509 427806.744629
# Output patern 2:
0.500000
# Input patern 3:
60475628.032078 38630686.895999 22476452.448680 15581979.882860 11713849.632954
9412418.067209 6816016.470384 6659688.509732 4859393.415192 3449405.549713 4084114.920168
4673561.140919 1120946.134910 2576155.031441 1501074.446773 1416385.521160 1879945.435833
1362767.247748 1593565.049011 1508073.712519 1004977.300976 1152436.387032 1181396.614479
1426370.642061 392768.876775 1209332.600148 1044163.643738 916474.531049 909891.232913
750550.748779 603522.618433 690351.172314 403666.872300 626481.924636 823204.010805
525759.553767 418771.523209 602276.372721 754702.134233 352691.311116 584161.302744
486582.158788 589602.988099 534686.666258 559383.663111 521971.883110 694752.848575
247123.735443 338695.007599 557420.060625 470553.531428 337301.798729 389925.006875
531757.443546 371691.749142 440165.807813 365153.034302 439123.322110 511932.152318
252765.329124 519438.652659 625965.795654
# Output patern 3:
0.490000
# Input patern 4:
70174582.993319 39093821.283944 23669892.457786 15721680.711944 13632358.638952
9614617.278474 6821853.274720 6159218.964947 5098552.985648 4301955.543288 3262601.747185
2655236.487536 3131281.503928 2144645.513828 762119.532989 1313636.947285 1836758.105747
1657079.600178 1790310.473925 1491765.086250 1061679.369729 1221444.150466 1172459.657556
950911.442282 917336.539136 875613.669858 876439.748800 791528.312755 675555.040616
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783217.566406 717513.393156 576710.495809 754478.397933 689416.629007 430476.254925
513727.629084 557292.276118 470773.898003 547920.070089 526203.209793 451010.162337
518570.265225 508726.284731 464989.000964 468217.782982 476660.314297 515669.694483
447936.413783 405441.411382 580065.757302 544337.642222 265718.557141 207441.191743
254070.346885 328206.411508 495852.592845 461769.468945 341453.512917 426005.964743
476705.025023 416157.151656 394135.232422
Output patern 4:
0.510000
Input patern 5:
72286651.190605 35946173.957656 24324405.422707 18777694.801473 12281638.191813
9697670.754125 8822141.247413 6910371.560205 6185598.159410 4615314.488581 3987046.909205
3853311.683962 4054572.873900 3894614.313370 3570143.725923 3122631.373083 991955.814019
2161350.871417 1696322.093905 1879310.918911 1282944.597204 1063528.713185 1216759.788428
1270512.882696 1112921.555665 1332420.495343 953939.659496 894706.381836 945888.957852
873188.584229 893016.897892 1101883.888025 833508.018569 798674.122297 750951.824066
908611.885612 665516.395080 861441.454424 551588.678899 588099.447972 813404.614349
1037321.511149 720100.995449 896345.488004 884174.729567 798821.369735 640254.251905
799772.560517 457321.578840 709831.825095 561995.712685 653065.157061 607833.371683
645164.905414 689557.634803 395012.186588 717172.920725 597372.878852 338588.002651
478558.630814 475458.980748 312909.433838
Output patern 5:
0.490000
Input patern 6:
73575330.607193 36800742.236098 29179667.599438 17983378.379822 12111765.800753
9662383.528197 8026011.750764 6139903.181003 6019402.765863 4578244.222279 4753195.591671
3441463.275446 1664157.668126 2932030.080012 2687499.295878 3357458.923826 3196406.828512
2632067.378204 1892812.640939 1756890.995511 2099491.286171 1547008.371603 1723826.326627
1537122.076682 1485452.134315 1455893.324711 1285818.514811 834139.724006 889244.121630
1608450.956055 1549776.198713 1338267.056231 1308276.820918 1314976.240733 822886.647849
1059083.281794 1018364.456444 1223835.110771 1175719.132426 993370.618978 1079478.642971
967321.154935 907735.188993 700191.021566 804322.723116 937993.818425 884240.920762
766233.516270 851759.931001 538327.158112 784780.062287 681681.258483 979919.406418
933211.764819 859721.872300 738362.388026 1061473.711669 600012.991959 710669.848578
711643.384725 566986.791553 586186.097656
Output patern 6:
0.360000
Input patern 7:
59058897.446602 34211278.634336 23447771.349545 15363384.877910 12733639.680787
8958988.565974 7593632.998850 5835269.728988 5194587.327092 4119154.667313 4405012.842305
2917080.185443 3261574.376713 2664459.472813 1935757.304539 1815711.404272 1967808.435366
2898798.065620 1601641.895111 1463523.367628 1770352.505321 1258111.366206 1026221.026247
1219045.347791 823179.573526 816891.043352 912957.155854 976776.448723 686422.942128
903895.849609 626847.926915 854944.939096 504544.826981 657975.985935 863449.231498
725933.374974 557493.042656 544816.789082 562693.391254 556556.403601 382606.416499
566825.265366 454358.923669 497557.127216 618760.419877 581557.687344 405760.055933
495044.874148 546922.477038 285972.919818 455739.756096 391513.502226 407094.593944
417586.501394 274315.527159 280329.433400 348552.925833 273819.621385 328454.084820
273412.956356 423082.212910 345487.431152
Output patern 7:
0.500000
Input patern 8:
61701964.170475 35621656.807489 26759244.103088 17639210.838730 12393768.639601
9741485.119405 7223022.834401 6230177.139779 5572004.944787 4270632.548577 3659084.817829
3251123.454253 2560342.360649 2573593.675677 2796858.714876 2305314.029161 2039975.500124
1958068.650025 1336720.577377 1142585.220922 1639184.318829 1505857.651490 889639.617306
942426.126199 1279378.051670 1223827.970672 1047048.016498 900319.165835 786684.369021
771881.361328 685810.032537 576266.212662 667235.701183 736243.395606 642653.162421
633210.738152 597170.689660 416882.230768 426446.512471 610755.144647 636121.211822
661481.710269 746724.886929 597688.432279 426015.476227 541850.366316 618674.647752
490699.323284 391603.510770 402464.017906 411859.628446 379705.810168 294352.620067
298118.103805 454227.257295 503678.550880 413155.305439 405370.825238 394300.946241
289665.745725 306279.619905 377921.371094
Output patern 8:
0.500000
Input patern 9:
76045398.923043 34651941.200094 22292599.049120 16888646.314961 12455815.714520
9741009.532280 7668159.397767 5685351.277025 4800502.709310 4448064.597382 3577981.279034
2897172.280034 3021803.941784 2930823.604535 2255315.671242 1921740.786531 2063422.229817
1861834.322267 1430744.950322 1439387.982055 1613970.218256 1384633.596106 1097560.219461

1107876.056777 1084878.879995 850039.430503 745557.037145 837494.893740 824801.449215
723808.921143 669239.771995 625833.899540 529919.277493 480424.336657 485082.940352
508835.183025 665556.054361 879220.094389 807758.285787 462695.777859 327934.730939
513677.232388 608449.450388 454551.328237 318995.212007 341606.486773 397889.555726
441733.488827 488606.863729 480224.585250 427476.759551 409550.880614 383922.774890
307456.799687 293322.548352 366180.832780 369612.876529 299040.066943 301479.199521
332606.011234 263436.060111 197075.171631
Output patern 9:
0.510000
Input patern 10:
128416174.605180 58346299.646342 18264370.827780 5247879.145430 6522455.502578
10273386.637456 10797121.716041 8499330.739185 5716787.890131 3810138.787807
2948462.674554 2697198.856902 2698682.264001 2742929.749728 2602666.651444 2205307.621210
1787548.226037 1503085.723083 1379368.600460 1281512.192065 1135878.118707 1037789.101724
1083152.318816 1183509.418040 1146471.797264 876743.876533 598332.961090 490462.456565
643358.515490 873187.427002 949001.242249 811545.518493 567076.086699 395687.122928
389573.345602 549083.719657 730380.826182 801529.974600 669010.373334 432459.105635
284261.027303 351052.544600 569626.075778 717384.354003 643531.713988 430482.283963
281090.807354 318684.104679 463396.913635 542199.658258 489998.904106 391925.750319
343241.133740 360115.603603 375207.796277 360415.382936 349127.812559 372719.833808
399771.568077 379473.300733 313933.014696 280076.068604
Output patern 10:
0.500000
Input patern 11:
67329809.498721 38615193.579924 20721991.001940 16607370.571499 13335045.638532
10286529.754274 7596919.712312 6344488.729079 4918746.074927 4312054.285709
4194303.778610 3306445.486296 3240427.985571 2238466.517226 2795899.060185 1589723.646373
2144304.114958 1559030.813412 2237965.518336 875663.133546 1134844.466942 1266030.846795
1428721.127457 934300.366397 834220.055276 983664.991185 756787.898059 1031348.467115
924227.861137 738176.169434 810469.521959 753233.149329 913011.297099 640979.224708
1012359.794747 387630.987558 830509.827940 707451.036600 439386.839178 650323.196998
636898.328485 437626.900623 499954.210909 350921.623326 604845.112222 538156.360704
380390.127728 477110.675319 466380.441554 468184.587875 627872.212120 429194.538366
509285.812687 390007.667019 560572.561318 411210.116166 547092.795920 332099.538439
346086.391338 462416.790502 396073.829128 315095.447754
Output patern 11:
0.540000
Input patern 12:
45221809.760050 24517534.744528 13128791.215252 11054589.888040 8192819.047049
7501251.400669 4354463.956114 4272875.277555 2723378.218265 2884860.570653 4414928.969357
2477983.897144 1942076.202841 1743472.271682 1629269.265224 1224342.347589 1055321.228760
1097299.122304 964110.493983 1138388.656578 600746.100146 866977.268405 826090.999220
415477.504773 570577.482325 480458.551308 437735.279786 421406.866556 701490.293976
624924.058838 492395.455716 399728.670130 311117.491929 620157.014493 416984.918496
315653.258217 392058.877076 391482.422407 433648.989304 455410.359842 434043.867712
181801.292825 226220.155134 246968.137970 327359.709071 354465.876268 133140.446073
253150.005032 318591.865401 285522.107974 218290.018704 231973.377681 193366.695081
167348.839184 325953.585083 278153.361550 343073.483628 279716.644742 246665.195536
356473.770084 266006.578205 229422.517334
Output patern 12:
0.300000
Input patern 13:
45415857.589069 30735322.593551 20044314.279748 14290047.260846 14441262.570730
7676067.145054 6147261.062787 6555321.746088 4120172.043272 3654443.410852 3515354.244703
2883507.291982 2774476.913585 2241661.051937 1687594.868917 1715180.754420 1863589.139616
1595203.338714 1211255.240753 1213455.060719 1136682.092169 1048124.681063 1026808.740935
924907.928064 986894.228501 746557.384591 538725.854723 867214.588431 786552.855016
653706.169922 691667.229159 292623.473570 551183.122802 984850.352707 397032.022570
245184.893046 622562.149600 517546.469727 451937.457164 439504.526574 400030.708413
476706.177245 372173.267187 357967.946281 466274.199127 381683.295720 351562.407325
372757.715166 362756.695304 347626.192712 325592.758082 427100.916164 373236.661312
213755.452203 345479.347513 406347.379512 327004.779521 355840.237128 299230.179983
263573.142845 351652.469414 393740.571777
Output patern 13:
0.490000
Input patern 14:
1545336.167352 63955813.420345 28677119.406629 1503977.035851 22362227.574275
9466005.778681 1472474.844441 11538553.928334 4122941.570578 1449779.938566
7003171.193128 2060508.158108 1376304.796762 4650044.709524 1127280.274224 1322511.596465

3274320.545514 659539.319773 1254200.104432 2385435.495228 430253.842738 1161311.120912
1771368.244821 320498.124489 1086686.929839 1346070.495580 273749.399156 1008090.384309
1036719.914436 262003.578125 920518.358528 808809.994171 271402.815987 841596.062762
643310.847626 285037.164464 770763.509367 519467.100046 301626.780569 700939.332802
436031.267493 322905.514348 641690.266413 373533.133026 336677.567288 582372.178171
329541.860484 351364.601105 533883.840804 301320.585964 364538.128475 496544.829859
281707.414130 375240.312861 461972.092721 269878.188385 385896.018800 435733.842350
264326.217558 399276.137834 416053.238233 262683.598145
Output patern 14:
0.490000
Input patern 15:
120107459.166277 12259150.150531 37250853.264093 10108486.481924 15211712.745635
8661244.615607 7828581.797653 6205395.043847 4606141.004576 4979765.248912 3293827.266422
3361793.245567 2635308.994001 2770025.420504 2056277.642810 2033495.485475 1740199.263965
1862157.913344 1270650.987678 1576436.197377 1127910.132647 1426648.495730 882303.498479
1229350.064022 875204.583916 1014059.512211 802476.048687 872901.640601 785198.855306
755995.784912 719136.339275 700446.641458 619990.165942 717459.576056 527733.535296
678731.651563 448047.407902 716051.467437 396780.650929 610003.548778 429754.190871
604601.552454 405883.959582 465977.629854 513540.400289 447273.869047 440438.940048
377326.713355 540700.698812 371235.410651 399596.003277 415872.334534 467692.202414
390915.055015 320454.799694 499935.502921 368644.610807 417880.376074 284589.146100
551731.718043 303728.448741 424534.918701
Output patern 15:
0.490000
Input patern 16:
35680352.449468 29908071.568546 23397949.243172 18293773.979196 14304617.604592
10574930.266313 7904375.124527 6445739.456450 5239876.860557 4257831.274840
3558684.464229 2820561.350872 2411419.598674 2277580.748876 1909382.589308 1723968.790505
1897298.156681 1848940.350386 1596743.900304 1485383.109100 1335855.785062 1168074.694813
1122884.480631 1023402.823393 1014488.954702 1195203.658588 1200677.865202 1017710.992142
1000059.620731 958991.342285 770087.307655 680175.007464 667364.752652 662227.295095
746800.924372 759033.968564 663175.790202 704234.208353 730890.529595 567849.184960
499873.803464 550967.205392 516393.450314 473740.907360 469737.440871 423698.531398
447724.697903 495190.439657 424282.869218 449895.130796 599763.174726 600956.871853
534802.812643 557775.916458 519906.307309 420323.491964 359147.336756 267304.785887
227502.948166 292106.017286 249146.399796 168177.168457
Output patern 16:
0.490000
Input patern 17:
44981277.477409 33797709.786369 24296339.783666 15503083.527578 9605699.435426
6061269.891717 4213266.750669 3543481.085838 3526488.368360 3147297.577804 3267174.772488
2604099.775201 2632594.494093 2036928.020381 1949717.760701 1617435.555190 1383582.165546
1231944.375413 1086188.578083 1021891.624602 1106193.460242 1044544.922273 1161150.111650
991299.837454 917621.571994 769326.469241 586161.087850 669804.362082 542683.814322
737233.472412 651805.452503 687352.667270 563599.667863 459554.144618 377183.059124
373623.536686 344139.029991 512520.172135 438845.978813 612854.559194 475844.538600
548184.233521 471026.980861 478650.603417 507808.276519 473525.722295 479841.446462
422516.533556 331846.081493 319016.109607 235798.228023 288009.056256 307904.579748
317735.124227 407673.352383 303417.243431 392237.912019 255536.699910 318871.822147
258106.644747 281250.851939 277201.490479
Output patern 17:
0.480000
Input patern 18:
82481944.321428 39353919.659629 19875970.850121 20028700.568884 11705294.347673
9155570.105500 8539279.517924 5463563.569512 5297401.759360 4370378.695627 3585209.066541
3489652.145913 2893422.335483 2689645.284291 2327965.493503 2055416.721580 1858219.400263
1605922.113008 1584839.562788 1459302.586779 1329449.905827 1435057.157218 1106961.097745
1190604.525494 1084573.102820 768938.558855 1107969.952698 673347.275294 908308.902612
940050.230225 597457.444815 1020085.800212 527165.420432 733110.858324 680787.757427
424427.545926 822130.513944 333832.027463 886829.556167 293285.543089 893031.325779
213238.009448 765719.909138 278649.378424 533352.049915 500284.037487 381941.808119
608061.156485 405719.346671 504464.554350 460040.921001 373435.189394 440726.256502
363604.480327 442897.419507 402730.278963 481333.659817 421396.517557 434197.366464
432276.124048 331020.939635 443816.839111
Output patern 18:
0.490000
Input patern 19:
92056994.610428 36675331.723424 24850797.830839 20970322.616687 13420280.868459
8404275.503028 7904135.036329 7197745.483011 4844357.727511 3387433.176605 3574390.353770

3499082.149062 2681299.054740 2183606.657285 2252313.314894 2085441.397431 1674231.391991
1570590.649536 1684102.286293 1583673.540748 1311595.021333 1149482.521026 1161887.593671
1163751.369793 1080765.067582 975037.548645 888929.192846 821657.702511 756326.058903
703107.440186 716489.479012 756046.505917 683304.912390 479656.848751 428311.569661
634745.692870 785848.069125 668821.154111 559795.688984 681426.619430 765685.038723
537309.567549 241464.431363 235223.158030 426750.362454 528223.007265 514677.255084
494910.007929 451209.908611 390007.285874 422610.907500 515525.621314 514229.681685
419372.846248 390600.885885 432708.505606 414790.449428 381641.381255 428733.394430
463810.223780 381552.420643 309766.818604
Output patern 19:
0.480000
Input patern 20:
31261279.563817 48085527.439895 20232118.650773 14604730.055451 10893160.833726
10220375.482915 6226933.225208 5824490.616780 4711622.693154 4438932.939166
3211711.770327 2842525.328563 3128027.675115 2082851.936891 2006239.039189 2127833.209868
1594052.090266 1454946.045758 1552136.005613 1207954.992491 1206755.897855 1050633.602761
1078858.209873 854543.603257 971686.098281 726319.942422 806847.508112 818920.420967
487702.696105 851613.549072 554975.420785 541003.237793 642571.274915 562310.964442
444837.329100 588741.784471 493970.223717 433140.616623 537553.733204 409143.319091
487899.434012 412213.517162 466286.307301 354356.506067 520586.911460 297886.455198
400777.528505 524468.376486 165677.828957 530692.220665 330584.366710 319998.202966
385344.316663 341813.773288 383857.340032 246799.667120 409810.574833 362614.108225
219579.033246 396686.138351 387293.510881 195932.075439
Output patern 20:
0.500000
Input patern 21:
21870249.371449 20770007.014673 19215062.279486 17657571.679291 16068870.246773
14366783.956438 12580828.347671 10841952.499619 9036885.155093 7418844.678980
5931663.303245 4570555.151577 3411305.131490 2439164.977966 1665881.679917 1051758.681785
634002.797543 372895.598003 246676.960149 226809.161162 291550.781165 410589.727063
568293.562659 726412.536358 879396.884107 1013078.714790 1106828.240695 1162893.496985
1177444.250166 1146327.599609 1084784.712863 1001527.518911 880239.121688 767381.303270
647122.304860 528366.220352 427722.644735 340702.252273 280270.546106 241621.314772
229021.772798 232540.813342 256445.358937 296643.428892 340989.540918 390660.960510
437518.251109 479349.207184 511020.539753 534645.878809 540970.601925 535177.105664
513612.736125 484786.323992 447232.872489 406459.745176 360389.541928 318587.845789
283393.141285 254196.295531 235990.649181 230689.235352
Output patern 21:
0.500000
Input patern 22:
81851165.648374 8845395.117319 16113724.868485 26994749.961891 15931839.064770
6736061.685977 5942604.121547 7387018.998836 5272009.556752 4514532.907437 4230559.065192
3402307.662996 2096199.905196 2621880.667578 3160345.330203 2242681.743730 1333927.233319
1443334.084714 2142830.943168 1572182.847589 1274554.505488 1019646.116969 1340815.005579
1038350.273244 1167128.944240 1001949.153236 877479.271718 679144.103026 906115.034749
981905.679199 673260.152274 527942.752460 665768.115973 828824.096836 544229.804931
532241.871807 565537.057075 635752.472088 395871.799579 533622.475984 593706.214166
515316.571987 270313.108786 452223.405454 636776.658301 479702.972070 238653.064805
338610.831079 597909.899758 476386.643706 293784.563105 295870.289759 488366.753535
441653.400747 360005.715210 340872.730595 395957.989338 380577.952108 385593.399604
399072.417130 377650.378835 346576.684082
Output patern 22:
0.480000
Input patern 23:
5763927.535103 57169063.436888 26194789.745976 4787425.252732 20302446.988056
7941537.937356 4979229.966563 12146056.077965 4295779.606718 3386597.064836
6392315.877278 2514222.553764 2938009.735816 3941089.054390 1497643.686408 2114346.929743
2520514.541327 1293673.680201 2137383.614499 2048192.594743 936170.916896 1598913.340543
1464521.946146 978221.607865 1451491.515640 1157692.105723 1076862.755319 1278989.944284
949461.048144 1120003.336670 952848.625747 679837.962107 906608.780079 677814.869922
548469.423198 638679.875186 627040.911446 758458.401823 616556.893369 544819.651698
745216.093869 548800.178949 381373.371421 667215.039059 605777.805055 244501.849419
458830.678728 552106.694614 340993.951582 534058.754513 395212.942649 312241.164356
615403.215271 300357.161098 340480.191190 704159.174708 320967.350647 306911.848421
597518.943389 369047.939300 346654.834087 517232.682373
Output patern 23:
0.490000
Input patern 24:

71342801.752792 19523794.145752 24513040.197154 19486242.389785 12454107.783913
11685495.944854 9695345.073458 5626889.857572 4853314.210900 4985462.082717
4401660.750400 3771694.840034 3601607.249590 3098728.028704 2661166.121150 2337638.728795
1961618.432248 2096384.031404 1910476.864238 1808224.189630 1616234.584346 1658061.025596
1342799.795612 1374025.527361 1517326.975896 1296394.892296 1066797.458127 975635.722378
983316.728104 799316.872070 920008.571165 911692.760031 844878.953159 791084.282668
837501.664437 769664.046390 626741.933817 561038.258409 575071.886116 667021.936110
699330.888876 647468.311603 649359.125648 616360.001223 552632.238104 599335.336530
666591.244221 554486.466488 423020.051817 546172.973425 527041.891661 512233.583309
528894.067137 609639.294579 495555.524870 505544.754914 468081.921705 338795.506697
514683.210975 688810.871301 528265.941216 212337.154297
Output patern 24:
0.500000
Input patern 25:
107844826.510076 73382253.210985 45548281.853734 22625563.930538 8140118.367469
2159600.318738 1705396.073801 3876815.937193 6637253.732170 7145898.171160 7156375.399136
4633853.065122 3616072.497778 1660730.339637 1306786.875142 1474216.187212 1836178.409474
2442992.189783 2737408.465756 2027263.259247 1913277.446492 1198440.671179 1266608.823297
1043494.601086 1119396.162022 1205776.400693 1300602.798194 1543391.965444 1284067.872849
1080366.774658 1080290.178747 866406.152413 858905.704911 713303.525554 557870.285602
755342.208228 735484.792698 876567.635769 802442.712828 841721.552659 746772.295542
671114.596071 509603.904580 549621.224525 502129.899260 638281.612023 729852.322429
817417.061359 759822.290511 694777.977121 479089.051541 489279.802004 469655.633628
501801.482713 528057.858832 699145.526645 827399.834681 741875.629805 628903.574977
405477.659719 313308.253848 428100.053955
Output patern 25:
0.500000
Input patern 26:
69434366.695234 40061937.428863 23337480.870888 14283782.248930 11576759.105180
7914096.869289 8321910.656852 7380239.202397 4870356.674679 4410822.930195 3588796.721143
2961118.638923 2689127.507245 2184074.562289 2352151.779714 2227936.848859 1802927.513454
1722615.632797 1367600.334148 1184568.619887 1270365.334717 1195016.368907 1153342.507965
1075483.347491 947888.213895 840097.593803 877319.018364 851619.924983 518652.258246
721203.356201 1042125.873162 553034.598767 445279.739928 700976.020876 525164.705245
642983.631014 667267.313969 320390.810403 408514.660979 579810.862150 596829.259089
547040.843384 317906.503162 381366.573840 464789.331427 317637.126676 470980.806518
584922.264057 421034.209793 289562.561997 236804.254002 426008.394160 506980.733022
302496.456284 379245.977122 478679.414526 318014.336956 305018.345508 347656.603437
315230.319173 387688.919768 460478.989014
Output patern 26:
0.490000
Input patern 27:
4902640.269267 47094325.609103 38646677.113494 4535967.211999 13677994.030292
14661257.157788 3763009.973586 6509091.503508 7007651.989817 2856571.207996
3947197.752572 3668339.425147 2147763.863870 2687787.905177 2318198.392860 1727957.009679
1979531.280315 1878311.456938 1390373.957330 1464301.027675 1573988.667670 1070122.307866
1029287.406623 1211332.390326 935632.147894 726930.299715 955199.949003 995755.146154
565986.133521 835632.120850 1041060.582124 466965.679300 731846.106170 887246.651694
413372.179121 583458.603728 697106.461529 430533.489496 495004.610340 624994.908445
479669.546675 501294.407877 625307.459500 443369.283033 526306.993042 557772.376562
333814.689271 522322.328589 443578.766299 287805.063346 513319.254787 423678.417537
343171.933643 503653.907154 482159.016744 370322.249498 466643.947273 503809.910752
299903.159946 432046.523107 456919.039910 246320.418213
Output patern 27:
0.510000
Input patern 28:
1590971.808800 1641049.347590 1658285.337371 1617497.071217 1589090.602228 1572663.653667
1571109.171021 1559639.724581 1537289.783642 1503056.021566 1482543.952524 1457542.761012
1434756.994073 1413086.459327 1380438.641658 1349165.130453 1320571.338549 1287726.322996
1252857.320581 1223058.028380 1188180.370646 1153267.269076 1120288.350454 1081922.551203
1044808.481257 1004383.708665 967674.164903 927031.493817 893735.267481 856504.495850
818090.731291 778514.975466 735331.233929 701227.620585 660723.988970 625264.683522
587865.723952 552073.418935 518881.944983 483403.468384 447157.168985 416156.327545
384375.810414 352507.999213 322923.033165 297888.437646 268453.920237 243817.583481
220074.760534 197832.751726 177433.746436 157976.577116 140673.798972 125585.055783
111545.141758 99607.073426 89560.505292 80937.565342 74333.555472 69313.807710
66657.487758 65865.435791
Output patern 28:
0.500000

Input patern 29:
95466344.895484 46664786.499546 24482219.460659 18162860.500075 15138047.265266
10769862.427187 6953003.679816 5616377.857418 5752700.945355 5266459.004586
3891406.304759 2780159.753415 2537082.896677 2622132.609990 2299975.707936 1722108.473182
1430853.458685 1475980.335689 1490306.658076 1279341.711781 1063070.171350 1085753.566863
1212839.926387 1185736.444580 1006084.535435 861150.888457 864651.144061 885910.432730
828590.837821 716468.261719 662515.518648 641951.925300 594919.689423 550975.409781
576608.490531 651690.484728 644687.591095 519846.598396 409653.231614 444719.493027
559620.032814 563252.241837 409104.306162 252989.801387 260214.196535 397066.011104
483244.987177 439134.830554 356027.794989 353850.493290 438037.023720 516930.058698
531040.731403 487995.641929 428584.834732 357733.822264 281394.587975 226913.392439
239662.834095 320507.796239 417505.474226 456929.131836
Output patern 29:
0.500000
Input patern 30:
40640399.081410 26739518.229281 29079694.578517 16432963.169742 13388956.119184
9537542.611696 6118981.644137 6691266.842871 5479593.445494 3804487.698690 3838604.300087
3370133.427849 2488010.950330 2299236.545567 2486224.083648 2092604.203688 1501901.299276
1610474.421367 1623404.533854 1280219.176071 1291308.399779 1233642.065029 1004576.454790
975513.341070 967245.718259 999662.411710 873211.644786 615799.595972 790335.192856
846743.187744 614546.410333 696276.674128 595044.016002 455390.045423 779441.713861
633946.536233 296223.763128 586353.945134 619790.147762 366613.883413 536993.173190
529436.888928 312956.131778 434516.910883 546563.338901 448243.979336 316813.333098
324786.526468 508087.069612 487088.112903 281103.445755 311766.282012 438663.648147
439968.750211 350191.516722 290588.157718 393813.324057 422427.025682 313957.494314
360030.458827 386040.169943 328397.405518
Output patern 30:
0.490000
Input patern 31:
90095811.143481 36357333.702579 25133590.913130 16599317.498158 10646376.898309
8948982.107070 6737410.238878 5162603.323313 5703410.920240 5341408.419297 3701531.760233
3071954.036118 2961716.012708 2239948.769697 1884291.881950 2073384.067935 1818737.521786
1472804.652269 1603106.459012 1554487.940519 1189817.318625 1120548.940128 1178892.924368
983239.329718 839307.601592 946646.525070 918580.521551 716244.913806 665045.494532
790999.553955 842205.534058 700721.522588 548167.757759 551966.764090 566363.981322
484912.372032 518299.002438 679132.108396 610066.134515 363664.011279 364566.865391
540528.482472 525208.648250 432662.526106 431885.751637 383050.025713 311522.636112
377163.353898 483303.169574 510889.700320 485548.187238 338476.556614 182606.472817
301068.409835 496425.627395 390824.676004 265362.896653 430530.552731 537386.568037
372731.546576 255686.166412 261379.268311
Output patern 31:
0.500000
Input patern 32:
108753795.846869 22275788.960872 29535856.578366 14883797.017175 12906483.997533
8977843.632233 8281030.629394 5186121.485295 5916612.138993 3606839.040989 4064141.443672
3093135.951706 2638882.600573 2761037.100300 1898410.481519 2182012.285737 1702665.543460
1566169.175817 1650519.263887 1136486.032992 1494027.301308 962614.550149 1237111.112001
897666.585440 1063581.103868 773714.466863 1007360.959086 590978.685351 1012307.248166
458710.909668 939570.866145 444749.031182 788280.006200 502474.986841 628560.825840
542774.993407 542474.943089 517364.696424 522498.619690 472538.987623 495093.323042
457793.241689 430890.325530 491317.099556 347860.091242 528096.640911 300955.450331
510715.004057 322347.365576 437470.364532 382227.061881 359717.238004 422514.132486
328564.046976 408847.347343 351455.408146 358304.660904 401404.879585 301058.858913
442520.381464 266476.261543 459237.710449
Output patern 32:
0.500000
Input patern 33:
58807558.503916 40185396.596139 19478962.613905 15908269.641382 13180487.428941
6056208.519614 9733990.576554 7614214.082082 5165319.452595 4024718.031825 4723443.322005
4015723.223745 3027737.503536 2970685.767263 2722682.045770 2363282.791601 3029954.034506
2127530.277299 2246226.629019 1755327.135460 2130667.185285 2019062.677454 1402315.513649
1432286.429929 1386149.673625 1480720.053840 808148.689730 1162857.062932 1222441.755818
1162176.864746 894125.412786 1037936.260796 882756.902001 1132080.895068 707765.289823
894668.948179 1120219.569111 930800.691272 854169.924178 970193.922082 743323.854267
749932.476021 555454.888123 814062.423541 698766.734933 757465.917307 882504.342948
757812.995620 735939.373895 714391.647468 658482.889996 549632.246528 681095.172091
516629.115567 606566.689790 564316.049311 523340.644113 729253.049683 387468.806283
705026.467713 732075.713476 536389.610352
Output patern 33:

0.460000
Input patern 34:
68949144.284723 29285320.278595 19206360.575513 12499130.480441 11798509.863182
9445401.213103 7050943.094257 6118079.051012 4358389.871411 3530138.433074 3446968.950845
2843484.417610 2597151.410827 2349377.060331 1902464.812637 1909632.724444 1754032.100852
1419293.544801 1248642.849495 1114927.878086 1282240.437705 1305610.731200 896560.296072
888137.908148 943804.456489 698824.170910 811733.225446 843286.598699 598676.674266
804602.790771 777183.814203 336390.497429 504519.650009 757972.622126 531879.025569
523725.706378 605920.349966 417616.453179 348717.297826 469277.826835 558298.315611
492880.231674 350945.464603 414655.823701 481999.715539 307984.198946 276376.566333
482097.888125 544106.019607 381859.135580 202511.398737 265466.214425 462047.627390
443101.290995 360360.334160 341186.890719 252393.872673 335351.495349 461821.446888
313347.914437 293050.149364 411064.770264
Output patern 34:
0.500000
Input patern 35:
53187876.415728 25270281.057211 18461795.969128 11066157.050314 8778908.108721
6444432.137086 5197059.613983 4611638.893283 3524511.367546 3603268.026991 1998254.163978
4001180.305847 2714335.984686 1628806.027537 1508728.280297 1441971.382928 1276230.539884
1372666.027042 1181400.158107 1192795.762427 950495.966425 900790.621759 729492.611937
665718.379520 756796.324489 562460.606255 147740.229453 698537.843876 540532.550586
587595.005615 468844.225446 408502.421221 363662.166111 316690.924505 376806.394304
357425.530815 449914.156127 383980.547441 417882.781716 223374.531713 622735.443545
307603.947296 323102.697878 261938.025796 341196.838406 333626.762014 394538.302550
373649.825240 356705.172767 318045.888846 253912.298600 268243.422284 211362.268487
406750.737659 176988.788119 202948.562954 303495.033523 298810.867558 260138.890868
241695.027102 177945.585896 197177.512939
Output patern 35:
0.420000
Input patern 36:
63364635.191112 39131024.567879 24164214.835757 15285450.892739 15391232.682623
9372685.905421 7994348.593778 6263341.572593 4813693.098132 4622021.648423 4085068.089069
2873146.616472 5354484.458549 2448628.427297 2457864.809119 2397286.885549 1693304.919773
1595212.653895 2313971.716067 1399954.846806 1035904.075238 1355391.915535 1565963.722838
1092618.041844 1251188.187475 784040.395898 631084.170705 861866.661256 1126696.060819
636364.785645 703687.790318 757117.447507 640113.133631 644120.303605 605709.331185
801431.010121 561532.282351 515185.696175 526386.778053 519847.938139 628961.540981
763484.847413 464116.227339 713870.292874 501161.534968 519422.792429 412816.191455
739273.277743 389437.709766 570745.660339 456327.211759 534889.567194 590577.222359
490100.246540 459063.600910 367230.197825 274146.735364 417674.891297 359234.927385
456945.352700 377844.848033 443005.605957
Output patern 36:
0.510000
Input patern 37:
64362618.975609 32111958.940379 22750917.470780 15462569.033354 10792952.582079
9486206.552043 5728799.596624 5780341.039060 1917250.741215 4765599.688167 4120513.849372
3022285.441811 2350422.146168 2499149.134883 2338373.416747 1762031.760400 2355937.423258
1648282.084469 1902328.145082 1512092.517755 1399527.193692 1129288.195738 1040743.002921
1168283.958492 973952.722799 991418.851077 1226992.507617 1144664.390832 983445.823218
1274175.712402 769668.670180 488338.671258 635952.311136 717127.724978 695699.585661
595775.061059 737513.766874 724168.585136 802284.831907 745997.872420 613199.630062
558476.948765 270779.792195 466913.321461 604119.261912 457882.532109 414153.184958
485349.994747 600772.081762 508323.198301 487701.920269 486338.414971 370029.433145
312450.754973 457920.828980 377974.112673 382507.925355 351346.618552 399907.299157
459908.024167 368712.618160 492436.529785
Output patern 37:
0.460000
Input patern 38:
65958562.104817 34379896.042089 22037648.410946 14630389.961120 10057276.265804
8252434.256959 7288812.839707 6297774.544556 4465046.965938 3014924.407860 5562139.255912
2851122.184643 1989805.181643 2611931.046948 2110984.703546 1658356.443939 1491212.822232
2066466.073875 1582100.038659 1275407.526504 1111433.757209 937393.698052 779901.842203
1504629.596304 1040796.028231 1041105.886062 900149.249305 701739.191587 951684.665719
895863.122803 661673.632283 759568.388554 409753.287973 824572.533596 697083.413664
715130.365962 393095.377519 400859.152633 508513.049911 623698.445151 623692.675429
475269.550095 633021.431542 488588.802154 409387.093453 627652.088306 415049.128620
475266.713978 444356.152914 455072.118828 546362.578913 331572.919756 342885.836722
384493.840598 498951.445089 230452.569877 439425.886855 543024.713768 397303.820081
434992.005449 493429.437118 281107.958740

```
# Output patern 38:
0.550000
# Input patern 39:
57598206.473175 36062178.656572 22767976.669100 16343724.925311 12415176.761460
8855133.175034 7191049.088562 5132515.243464 3826706.615307 3794855.032939 1183306.426217
2655926.154082 3069277.330743 2399771.429282 2483374.701303 2037803.529683 1544538.059803
1584953.953149 1516609.430933 1268734.017304 890840.182447 1230045.757179 686741.170712
829222.032771 544875.018310 997166.656224 1054013.032130 924121.985945 721204.294871
800319.350586 648742.398523 681539.210610 640852.879629 304152.996528 740841.347082
500788.100927 555980.749814 423038.175799 645691.061893 683826.551496 411197.965394
400288.104962 545532.340249 377861.781696 533600.903664 455511.324624 258259.381714
468182.568442 404271.902902 227747.443540 464798.805098 454514.252137 479145.083187
351766.821676 345515.066209 364575.799372 329577.870784 443888.648273 357258.888540
432527.931394 311528.871060 411232.536621
# Output patern 39:
0.490000
# Input patern 40:
56020951.422488 37910037.574439 21396547.338582 14355776.950724 12506911.328189
8417229.395708 8397070.472861 5980576.021779 4231801.462678 4094010.749830 3612279.032389
2874280.633687 3177928.156325 2808258.118164 2536341.743754 3586508.580645 1347587.495008
1517176.884669 1663695.680266 1437486.736003 1488907.322008 1456069.443246 1102069.489724
1044782.746969 652120.943108 1104327.496284 1069140.461256 932303.494211 838336.816414
844383.673828 616262.146649 564543.003056 579710.523348 403083.830455 909445.092356
796134.455440 663801.782540 681176.048118 603077.843541 556058.497223 680139.119974
689812.778097 790206.048674 436296.102160 533538.182891 522336.255860 515620.385227
453421.630277 547411.615948 575679.498762 534251.776725 554411.983310 377035.910480
355645.310193 402806.793057 385603.031229 442395.762302 514580.691370 441487.589424
424674.534042 383805.196565 611771.202637
# Output patern 40:
0.390000
# Input patern 41:
58717006.437423 33685267.699877 23926124.768115 14883239.568135 11828306.179475
11398330.468698 6085481.884472 8421727.526390 4685370.864728 4563744.066995
3884760.231822 3003173.930576 2362915.487617 2808712.481460 1841597.083940 1470894.511456
3272037.867483 1826973.140558 1589444.449314 1284767.668546 1396184.254038 1258728.363274
1310392.418137 989240.023692 827082.475711 1170090.227615 483524.918729 898773.609497
875396.679412 904836.736328 984794.787658 893231.419610 871624.326150 921037.944947
905672.059636 606730.102291 567536.590070 608923.657286 825183.641330 663310.880977
432145.653652 551824.693352 685975.483765 417045.887830 535558.963851 685730.605454
516745.792587 516687.450538 387564.845707 431695.560156 417153.054266 492501.659356
400668.127192 344498.198242 533686.166435 543017.566554 493827.411911 325787.889156
449761.920150 541220.286159 469089.301449 511840.937500
# Output patern 41:
0.440000
# Input patern 42:
63044877.893785 34959219.029924 21589132.803250 13630024.350492 12332743.762753
10643219.558662 10566893.950538 4008891.189209 5742497.457391 5760929.450164
2846294.197539 2975694.128874 2231875.325508 3197734.881219 2492440.839347 2016334.011908
2216991.711134 1629994.020327 1511823.309331 1572198.307511 1600759.131410 1373938.775639
1186695.042843 986223.559784 849797.815991 918565.654673 655165.521996 1119932.741114
1017815.598683 855010.712402 766090.093767 1045833.219184 704930.713908 943314.985373
997999.487338 796857.829453 415118.819842 463498.823033 1031428.264853 658167.359896
677413.394496 458861.457060 593386.011901 598885.843143 414133.900077 661132.276008
334069.050509 421272.848962 764043.840276 550274.895655 521140.003414 370469.517151
413512.126595 375303.784072 523989.551795 425646.652920 479188.137314 386917.729481
510723.768553 537121.271860 562926.058681 493009.123535
# Output patern 42:
0.480000
# Input patern 43:
50214363.692506 23379898.511493 28724110.262607 10838673.265262 8609916.712919
4957464.136281 4603417.976052 1569886.015132 2947422.586914 2605359.296978 2572591.994169
2227054.330611 2143985.008678 1722509.621452 1425177.713555 1205311.804221 951046.776511
1165133.208012 878110.187594 794670.683637 791212.782796 864165.829855 454131.336752
624903.719211 712729.456764 576267.037687 463580.814373 703698.676231 552883.434954
325147.085938 441128.951826 450083.447017 280986.921866 298959.246574 487086.657607
333869.146448 325003.541238 368917.299474 379230.282013 238965.753666 329325.492797
316025.743279 302097.312839 271807.999956 280561.188465 240798.617805 219933.202208
215439.925600 199240.313575 310612.651636 271821.783200 312885.855646 289017.600103
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346818.275406 120239.807517 206401.442211 142835.571098 188811.890279 87443.207542
374101.296557 261965.665795 325880.627930
Output patern 43:
0.110000
Input patern 44:
71145868.348737 36100400.247162 29890720.478248 20512944.740277 12632853.896841
14001836.430461 8159318.629043 10389314.203172 6691692.091124 4950405.810375
4724289.389859 3450850.704896 4729645.161058 4140448.870907 4015315.511189 4009575.363039
2696852.138817 3040491.144289 2272801.731609 2090126.587019 2405067.729916 1845033.901011
2672536.708180 1890266.314964 1569721.743068 1755063.239070 1681149.083329 1734961.010721
1851748.136068 1565340.687256 1548127.197089 1678544.906192 1399335.860438 1000011.956679
792128.016131 1251588.956966 1238267.842590 1085954.088643 1121706.140095 1010715.164646
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761035.962113 724659.419914 881024.562788 779370.710153 577418.569039 693216.761351
964610.238048 698481.170706 565533.290485 694809.794872 735202.544420 701579.551997
742310.681521 700120.568672 694693.132545 734837.075439
Output patern 44:
0.460000
Input patern 45:
72114778.606438 35310527.718029 20917158.218496 16558203.694006 10976034.295114
9311031.993450 6967435.719522 4610491.627521 4871542.405572 4045683.652674 3269473.379342
2014120.893642 2256150.858404 2314394.414022 1335929.645325 413809.262250 1024478.400221
1600104.942050 1743764.484714 1812338.296683 1187615.937102 1282874.581789 910638.587310
1069211.459287 904827.083894 475341.942559 740927.857438 797661.412850 721592.352014
450332.571533 452080.443621 482464.440626 545655.275267 396165.229248 578329.992698
596276.414495 535151.360502 702889.514917 506328.896274 522439.805715 409180.595158
441358.309235 367217.404045 191476.523064 287379.477814 409817.327677 391715.924489
295720.037815 296317.864425 257961.488708 340676.640549 390656.465319 486150.859208
424081.486992 306167.465657 353587.709251 338003.066118 325648.789762 328192.184241
324522.925155 225981.397786 147923.244385
Output patern 45:
0.550000
Input patern 46:
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8274963.040963 8447852.199703 7138792.568666 5205049.518264 4150109.958571 3422284.319888
2835525.145804 2635337.526905 2417719.438207 2135193.161557 2028042.299973 1884984.890199
1559894.097204 1389323.816555 1390101.225147 1242140.253581 1146205.586248 1294385.925275
1317383.771942 1055955.407702 890547.634384 888410.198291 799974.238772 673929.137337
603527.461914 497950.601706 459221.391892 694955.189921 889438.257868 711218.842950
482684.528138 552595.042821 661860.276646 569973.067825 484314.475603 469242.337014
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227564.301221 351524.697545 504065.944220 480747.484531 428509.261866 425789.147576
381072.261629 271650.888090 212585.924316
Output patern 46:
0.490000
Input patern 47:
60611537.109395 36333245.674523 24130789.756295 17540247.179897 12057524.320631
8949277.634226 8169735.779228 5658662.444383 5393686.517799 5598350.879967 4110555.190313
2601626.552966 877195.068500 1534420.505143 2909859.497979 1861018.327891 1522241.298567
2030433.130382 1659012.265254 1382932.671592 1278416.101635 1205290.504350 1091527.754051
1160393.930078 1582428.057979 1264174.406642 756307.983334 701740.443959 693763.835351
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476248.469810 542724.159576 665448.661903 573138.123000 616223.146713 567382.623787
591103.114514 765856.545389 658372.144577 525444.418986 457652.922677 386781.904719
451862.110084 485158.163443 481246.930566 440355.549491 480586.487342 680267.749508
622170.882399 529193.759230 587481.166748
Output patern 47:
0.490000
Input patern 48:
68447793.569524 38832276.113989 24388562.160095 15636185.597057 12972651.299860
8738781.726794 7529242.090601 5955336.688613 5404806.878426 3797345.781338 3755891.296770
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991150.450592 1271467.359365 843936.050508 938399.459791 916000.276417 701910.452562
658780.793945 827681.213282 652883.006957 650622.020161 611676.959337 536950.921660
417258.486228 327517.341783 604345.990376 404863.773266 426338.291888 330252.504844
577342.629276 560903.162994 433314.557868 429354.958579 252982.632478 347241.540636

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472808.562269 289739.527248 498763.544499 433873.104556 504210.849198 328656.544840
313175.298067 380342.339069 395021.701172
Output patern 48:
0.500000
Input patern 49:
67733168.951024 39183411.439953 25627889.320168 16588762.166982 11626705.390083
9864051.378093 8993955.484840 6912186.441606 2776767.846212 4739136.354603 3156122.047982
4284597.123117 3245127.595625 2754593.269620 2389265.609185 1909731.552146 2052354.694754
1563252.917710 2081706.045577 1814680.514433 1357522.689575 1578841.499780 1220783.117133
1051466.925058 931697.818090 1132630.439621 1077092.507471 863376.123367 755937.810944
1114864.465088 850891.396256 581018.659971 1498576.762370 932846.512278 860918.302049
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477173.339909 394775.523019 727765.835824 398485.331431 662249.255282 489515.389585
405950.665417 445053.499809 479925.885894 658610.438778 614989.282513 469691.286587
330988.588925 388014.289174 353108.855576 424375.141299 408670.299486 484647.036644
474330.281321 399254.239939 358596.241943
Output patern 49:
0.510000
Input patern 50:
68432805.765208 36840426.669870 20862165.445033 14308944.608419 11802236.354019
7924328.688971 7239145.643820 5655729.826673 5261984.095674 3928897.528484 4056981.921989
2358529.056748 3112327.032278 2041283.617969 615897.971853 2477783.102473 1758236.539856
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488291.182253 494054.142303 430385.839253 420671.372441 417003.745313 426439.928940
403253.722556 313957.759448 425754.803527 507954.990150 297563.043750 301873.474953
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Output patern 50:
0.510000
Input patern 51:
70116022.141591 36815031.645346 24803642.300474 16418771.569163 13025749.595489
9330721.444005 6836602.539025 6586755.649739 5565634.557836 4604016.168530 3527481.666383
3135516.946274 2466088.822823 2843378.302963 1676016.786883 854835.693667 945003.935464
1736674.486395 1364377.486613 1101064.444720 1325978.574946 1442404.356188 1280807.902123
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767222.515396 524036.354855 312784.207071 491317.930953 562785.079686 618659.032671
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397456.541981 623222.839041 524639.947510
Output patern 51:
0.510000
Input patern 52:
57035545.804706 40224559.739244 24672667.111221 19138374.065172 12976674.823986
9375694.133247 7422051.053324 5486898.989141 5198638.873710 4362132.829521 4402575.419101
3003883.054653 3182049.589736 2430838.426159 1859706.483436 2093475.880397 752093.769118
561041.116618 1213967.016364 1087796.304732 1565849.798602 1229359.229650 1415587.579332
1222398.878678 1278594.779428 898627.575427 773742.636870 850966.667801 928492.107539
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629401.921921 624234.074929 540517.967284 329999.573068 585481.910399 376214.030056
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427305.710235 455891.912062 441160.231934
Output patern 52:
0.500000
Input patern 53:
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8427270.589177 6692779.076059 5701840.062029 4783565.893188 3879165.858511 969219.958180
3956835.229234 2525559.471848 2554976.753454 2082096.768048 2207086.909093 1346674.593244
1471525.403539 1427559.917930 1141589.710773 1150592.677259 931903.912444 968284.452609
742146.187502 926603.008616 817681.775326 1099806.511953 711465.245535 796033.426822
393317.638672 666733.438180 667370.435184 449658.370511 547636.591039 454196.947693
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424799.568649 278678.028373 432555.338814 395984.166263 330211.084437 395661.652324
347384.672478 438323.634204 358243.260445 264076.530455 496174.408306 446101.269736
209061.051954 322271.550083 294088.599644 276707.202234 331690.925166 398217.795784
320670.302655 315216.894915 394908.131348
Output patern 53:
0.500000
Input patern 54:
62287172.303694 38018808.127737 24387032.568689 17095254.803880 12015052.619103
10179543.210210 7172327.501048 5987100.782297 5337228.217332 3369807.288959
5118990.934826 5486528.451448 3401121.924389 2315162.581334 1918172.251332 2004352.652162
2122069.453283 1469926.276468 1725084.140434 1615572.851346 1374123.728566 1473026.041172
1623061.762971 1237479.812783 878987.947185 971992.243353 793301.259129 984491.601956
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584815.881864 425382.065493 437783.079607 664605.515769 700278.649380 351380.031860
479483.736156 440830.698627 546920.905033 483112.441455 605347.787565 514776.110717
433938.818056 385182.313023 504182.165908 457809.371094
Output patern 54:
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Input patern 55:
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8811189.528721 7873676.472002 6420714.830983 5474844.905960 4664963.171353 3771416.869511
2927286.490563 2951992.298629 2406647.214193 2745466.709363 1933914.917852 1766702.011727
2436920.839742 1956906.018679 1210781.341589 1303468.802729 1381229.534782 1399939.467972
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770522.598877 852506.266183 993549.815192 725576.495753 876356.300267 318432.005262
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528249.669063 654981.737471 385950.021788 388560.628686 440606.777383 444684.837852
452664.281226 406950.982572 411867.614990
Output patern 55:
0.480000
Input patern 56:
67991870.161968 33104156.255071 37539987.894943 17911712.799367 11647760.203343
10879719.862480 6527064.125315 6512218.132118 4761319.531959 5777804.873597
3414205.030685 3888576.143505 2408806.376634 2748620.210383 2672739.874738 2466686.610657
1756242.330698 2580416.475227 2121399.728331 1727356.562776 1317942.476822 1611979.999304
1214459.517939 1124939.886883 1087419.500156 1076097.043230 995920.644322 1211261.375975
1041806.670375 1031796.719727 859777.498544 925385.239064 768819.010657 602311.136673
669377.295789 795257.042901 830424.429204 754501.565844 812257.082106 730565.443228
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881919.930852 495901.887148 609592.243733 569667.975886 647802.617757 428649.901191
484829.115882 532438.832137 701441.801850 420721.686307 337954.351087 559895.580370
570771.924033 440028.310592 483018.496606 835600.145508
Output patern 56:
0.430000
Input patern 57:
78592194.229833 44763322.847697 23518919.534880 14122080.645473 11284102.091657
11807543.134259 9892150.273577 7435467.583302 5210157.188830 4136864.555182
4726051.957935 4767757.775103 4383366.131145 3683765.642825 2536339.829228 2356605.112037
2015827.427244 2216127.055852 2545216.240248 2355373.552909 2162526.447079 1375867.341591
853537.338026 756178.891381 764228.592983 945478.924653 788930.847342 574169.840742
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384413.485794 289447.421519 289661.978868 420361.083960 583277.955408 683284.076862
701673.386543 613904.034251 515385.040018 474586.631348
Output patern 57:
0.490000
Input patern 58:
79409935.206013 37891564.178089 24699724.581558 16184895.120254 12374368.153320
10797274.925656 6793876.561326 6935361.917679 6430372.009333 4521607.512548
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905614.680979 616995.167913 813685.478450 791471.348023 614280.911929 623490.895831
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618515.128289 569013.720682 551937.138738 606133.072065 369218.786142 429708.229314
398846.775101 565227.184562 505926.851515 557015.088135
Output patern 58:
0.510000
Input patern 59:
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10318668.677526 7805022.914663 5958570.606291 5145826.896977 4368899.208773
3839595.356696 3709712.232143 1211915.633951 2301823.439652 2367551.782913 2148933.880888
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1060512.922998 1072870.742272 1095468.734252 1407707.752684 1163298.519255 1042372.099990
638218.863265 1065535.058838 703056.926464 659577.255617 829175.350956 558026.171728
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379057.892263 478515.441527 306721.100141 375354.628129 313935.756830 428723.585969
318189.369582 308537.850784 324054.369480 407410.126481 447039.143162 416408.572969
288129.063948 389009.436422 347873.529870 280235.445557
Output patern 59:
0.530000
Input patern 60:
65794973.436593 26060119.199860 19633477.969916 13339403.433946 10435400.860397
8975535.779430 6110944.488577 5428086.549886 6568876.380446 4527931.697007 3082376.015931
2005228.591719 2909708.716435 2014019.189903 1701180.200352 1445786.031595 987420.263509
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702527.720192 771042.472683 938292.540375 804970.540779 676356.100297 561710.493356
522627.650879 330550.150684 683307.063669 509529.969404 642114.868131 439310.531027
516342.327587 274193.435737 402742.308077 540688.464548 466064.448078 424086.697172
418369.611308 441609.725681 385015.673674 351538.649034 345270.143105 239516.680644
364721.762819 318316.311045 221677.006355 229086.220370 311085.298094 363592.380409
140457.103966 242417.704965 190728.471794 393511.017838 393504.031114 409047.030582
265243.708389 320163.368014 393182.448242
Output patern 60:
0.380000
Input patern 61:
95848423.060863 34029799.293654 23511725.170532 18820714.121524 10717686.046608
7044164.403822 7275709.323203 6495063.333820 5047032.225040 4601194.720808 4189400.120456
3268275.302286 2658973.569431 2463609.641678 2028333.327179 1659591.033308 1743968.888275
1844920.393136 1600285.213403 1357465.818331 1241259.286295 1124313.860927 1060500.566100
1100010.207267 1022583.304477 798330.793773 715658.295535 791856.790609 831128.244412
788640.740967 744117.485023 666334.953214 566968.209738 553196.299311 586253.569300
545698.281812 501614.581394 554914.640395 574243.984994 503920.759486 447652.189512
442396.266837 433638.795906 454918.386207 494870.475733 423368.755295 296553.277627
321028.106576 469027.529938 531724.478441 480781.527875 384502.454082 246599.103304
190793.681771 360398.367039 539499.445245 438471.356697 279886.814589 390528.116602
511184.806287 313059.705211 131778.119873
Output patern 61:
0.490000
Input patern 62:
62838299.129691 41388126.246349 26084725.809186 17230908.597608 13233942.912214
9015189.359337 7746907.879549 6694802.179942 5350640.148958 4625701.872197 3411136.440523
3280943.366460 3220577.815690 2405617.709760 2574677.686886 2008669.064659 865973.097624
1446585.017651 1885970.824770 1354247.312043 1248033.271299 1293449.774680 1424410.066976
1459804.830430 1095919.495156 900774.065889 885820.080358 900901.703984 956536.382058
802704.156982 831604.614266 880698.843242 634461.437279 682035.111742 747436.601223
557877.539199 761362.794598 924240.255655 654265.468618 443335.482350 389621.951337
509288.065551 645687.259862 553538.365159 483627.640405 511605.820026 570298.686859
634066.193281 532942.467464 549639.956103 661072.394479 537271.245744 532942.217418
606460.421851 496710.625215 590689.677112 743177.460334 631602.170378 483519.544460
395274.094855 431388.663459 511101.047119
Output patern 62:
0.480000
Input patern 63:
48566257.810164 33436519.786571 22034176.653144 14614796.945459 12088045.436981
8424465.431009 6892204.231838 5558889.475254 4126815.776749 3787769.612324 2966180.065509
2646033.909501 2579691.443999 2151064.841484 2336257.375909 2109377.092897 1991567.714684
2484964.553114 1577634.185519 676425.217089 1211266.074409 1270120.184207 981227.327679
1032621.246283 865249.700044 785043.195811 781221.026302 664929.288582 693992.636145

657072.281250 617805.716674 652963.570620 577152.969182 590388.272702 561620.976733
494803.919670 549360.198115 447086.162638 508815.292057 731109.841722 448215.430138
224982.833051 406835.174342 419338.989455 409254.162163 475278.200508 435203.763362
452669.078057 440049.994386 390143.036317 395741.214874 335090.438313 311481.989381
297158.061990 243482.089014 266765.950389 234202.031244 228391.241359 276291.221810
190760.252565 320124.865776 523225.156250
Output patern 63:
0.510000
Input patern 64:
58573689.252819 28527892.853067 20078533.406339 16154623.550497 11379233.586589
8335784.194983 7241902.127819 6018514.867782 4572989.792768 3839865.017830 3446291.103177
2785355.261980 2308823.371100 2299730.906126 2267145.803441 2022983.619240 1953005.754146
1970493.480287 1634280.636423 1223087.096277 1236132.155743 1320995.301516 916134.624101
357094.578614 337535.683060 724652.161708 886989.810310 751727.300538 671603.921705
687081.992432 623034.228981 553827.733721 590535.536383 638694.427665 598871.342918
550642.019821 534547.006521 468811.207524 385291.281036 388858.310330 440878.195786
447274.173836 465758.366369 523009.733614 497652.461382 369212.979128 346548.820532
466076.210029 493047.197055 340245.179831 252131.625666 362585.858336 484643.362616
476567.533281 432084.075313 434503.291276 423659.270577 390009.438198 413605.281157
478006.145477 499856.364639 493650.859619
Output patern 64:
0.480000
Input patern 65:
61816401.050498 33801278.036787 22329587.557253 15531206.837796 9759646.628159
8579751.170526 8390803.136678 6590507.879233 3898242.937385 3690594.192044 2977509.585424
3018020.842386 2602415.749418 4066048.663655 2092974.996926 1221497.241800 1910004.265432
1641338.679557 1613093.794956 1282899.397684 1389215.090281 1289746.427958 938541.906544
740273.979195 1182240.904675 949971.717339 828109.515589 579440.607822 619463.901387
377463.727051 571424.377281 833438.955835 446008.917753 573982.382317 498883.607570
546606.510354 492216.798691 434624.670181 503793.550693 621244.331094 361314.692334
440002.764414 554727.027918 594512.743087 571265.372160 492335.284588 492143.185574
304349.496957 456323.434906 286003.649604 288726.241702 330366.934588 312261.504621
363716.862194 376106.933975 312208.329222 454095.826411 424908.011532 278924.255253
325927.993879 252550.904217 345214.507813
Output patern 65:
0.340000
Input patern 66:
61240343.681357 35091962.654996 23725626.461779 16714462.338837 11287160.575175
8218231.375399 6633983.586312 5580557.888678 5200385.073914 2630914.876100 1743697.679183
5024188.035673 2370871.518749 2254309.920075 2373268.334442 1762854.900204 1619288.422124
1255439.081680 1352065.526994 1283654.465211 1177781.277691 1130665.951566 559500.307986
1303591.577677 1258271.873822 666988.169489 806688.713547 886603.185444 459268.319135
692717.889648 579455.927546 720198.807012 609067.815145 607699.162534 531610.168493
462104.329375 838235.148977 398949.242330 434841.981663 464856.545798 453379.955835
271805.907450 572226.670359 431570.241987 494612.674253 415843.454925 426887.125714
346997.044091 436798.006720 483784.917103 224339.914728 393908.015275 355166.851043
321623.766642 377966.129451 513275.370839 345353.294184 372802.132991 381882.055396
296756.745806 322718.578165 426108.281250
Output patern 66:
0.490000
Input patern 67:
59194667.209964 38736376.600719 23423495.845793 16318409.687411 12067233.656062
9658501.415336 6822507.182231 6028283.989557 3781547.487923 5295083.581512 4306009.088719
3161070.385939 2961292.078325 2305326.661973 2380835.396662 1733098.657135 1910982.639357
1518613.410356 1552322.034511 1288258.343439 779059.629483 936953.715424 1440781.770806
1226042.880022 908899.432335 1321560.732023 854261.055472 934531.318440 955163.462989
724846.626953 677441.289601 544515.066520 838185.541625 981222.137853 684948.448314
442073.330886 671105.196954 434782.690098 432868.053202 518273.875191 378370.558098
450145.027223 414116.350707 497726.203957 405570.552829 451631.767715 420054.193425
407717.169918 446959.056312 417330.262089 388414.472018 386769.102419 418958.801733
229951.296330 346951.826937 378746.080143 483987.375166 409287.697444 178024.427422
335677.998459 290608.494935 195777.704590
Output patern 67:
0.450000
Input patern 68:
66322203.596843 32047755.405378 23201159.417283 15047267.947267 12072319.069971
8358359.151632 7026360.435240 5635555.856743 4784100.827916 4484943.479977 3407131.798119
3553776.396293 3055982.760714 3134174.195213 2085464.141390 3303619.278193 936056.160908
1160621.091013 1279880.580851 1363835.899756 1150647.761091 1022036.069197 793939.531551

965289.910056 735401.405780 716734.287322 744848.320021 722833.020889 832367.430023
713162.534180 600404.504189 545551.701099 843597.597812 444447.092230 980062.617362
842509.745407 553216.125866 565385.873705 555630.559664 497481.002867 500499.669699
330292.663870 427222.330660 470452.002157 435006.091970 402867.152443 383459.006656
359074.958019 402827.831024 349958.586402 143081.705336 436819.480009 307055.348205
333890.872262 582296.382019 411297.091157 333247.326884 358707.803964 338199.450233
438087.321880 401063.844046 360305.576172
Output patern 68:
0.480000
Input patern 69:
58068604.987055 43340534.559687 22606300.503019 14607010.391029 11412700.328448
13808935.931791 6512132.097428 6220921.363443 5012283.394072 2145714.620843
3128435.378972 3450125.277602 3028925.052301 2140265.885230 2298343.523406 1873464.491620
2204166.276458 1693941.221485 1846692.454199 1379511.951852 1159003.219884 1327486.580289
787889.824347 1474862.853999 959366.797037 1229364.557443 722283.384295 1362785.977094
954523.137777 739135.250732 998945.247891 861834.845435 613316.653277 729221.255226
643303.856645 598796.497543 585511.230929 728109.360160 572785.724577 763597.880106
569341.230931 577204.811484 587989.201911 695210.504649 538206.416510 518375.647485
466626.040787 389054.751669 542901.546112 367844.105909 593065.140729 415841.990456
343328.395347 419342.915846 451616.484788 524656.736603 409151.743231 464048.233158
320076.067626 357570.336367 516862.401649 377609.222900
Output patern 69:
0.390000
Input patern 70:
74671915.870258 42089692.908119 25555834.148352 16610144.281130 11918853.622085
10010790.545253 8769378.557976 7193858.052962 5794028.241994 4891681.793009
4156764.803067 3476652.116962 3246082.002670 3051271.145751 2524316.199584 1972787.012207
1813740.396507 1839802.215750 1744001.772161 1564009.910996 1312965.290296 881529.307885
515443.710212 553108.666017 886921.050289 1128876.892926 1250573.760291 1334770.240381
1224293.718061 915538.598389 687911.942183 732785.050628 793431.266078 700893.362697
645208.327737 722707.668148 712967.259940 512770.697575 375073.869286 470408.778325
602747.662860 577039.316662 478045.520400 496913.788190 610984.641236 629482.625245
492916.528093 347093.209884 327822.481299 384646.881281 419178.351131 477909.826279
611031.346975 689483.608467 602497.750720 494987.688958 529881.850786 580066.467446
479609.575800 368413.027950 399147.379377 459197.131104
Output patern 70:
0.490000
Input patern 71:
63692396.664871 43309072.254934 23443090.441770 19009145.226667 15770769.427405
10242959.841485 8403847.966564 6265677.978919 6540833.414058 4908800.710652
4427884.254212 3997304.242276 3203664.217021 3415176.068355 2812612.762347 1682290.035773
1731968.281614 1977301.920939 2096238.267143 1732071.116608 1640498.117652 1710177.576358
1910460.023440 1863020.838257 1318945.142445 1369327.845854 1245018.560581 1580259.891604
913348.730383 791707.444336 1253255.118543 1077211.932030 1318502.000363 1017280.122429
866196.674338 761044.339247 733551.104782 696529.562875 670388.445130 818291.065996
574240.153941 502299.866607 660385.526010 794745.485209 887117.230140 722418.836919
750403.051767 761120.277870 707848.373301 682511.854989 558420.463391 603164.755974
570148.102315 594011.876704 390832.454456 449783.408934 526426.838284 491703.271251
655379.356981 501534.269352 401875.454741 395339.070313
Output patern 71:
0.480000
Input patern 72:
62669877.340354 44474092.001794 24800285.324089 16731844.810182 12580790.996987
8788471.386803 7714596.653681 5812310.154834 5231142.619763 4487567.003527 3389667.766337
3080798.699946 2902185.535912 2913978.097963 1691232.317209 1219538.850763 2051076.296969
1447923.313709 1305852.465766 1675509.539176 1268218.035808 1368694.890650 1221384.503249
838515.228150 872094.521713 803065.605252 951197.111615 956168.676405 756847.462153
885349.290771 943661.786939 800741.005777 613895.108123 745701.361257 882798.768594
640607.504924 634551.806932 493767.948502 263413.547690 470832.906694 496954.970380
480141.679001 575331.966546 470088.679712 477176.962463 420929.978697 417939.254837
625928.272316 550724.311594 376997.080213 386290.165367 483242.519805 535858.134109
496874.140255 465548.027227 276474.076101 231040.802436 409444.414232 350491.458554
381924.682725 475355.183288 429272.528564
Output patern 72:
0.510000
Input patern 73:
69534452.075139 34133243.013086 22738520.885075 20080513.360508 13022864.620950
10271230.431808 7639908.555664 6800443.111554 6889156.676983 4780816.181906
4391679.910147 3561491.165822 3548010.627702 3179522.067391 2512426.064303 2309052.839998

2358527.181851 1570451.639258 2244869.708752 1784514.398104 1572542.814276 1477758.856548
1351421.614874 1977593.263236 743862.753869 1236255.028327 1229032.180867 879534.738811
1206885.369536 633055.313477 898011.934076 832152.853407 937304.983360 714041.551992
731344.532624 765649.023715 733923.204736 691638.379423 607808.160759 825164.164281
691593.595724 537319.713068 665613.582137 717475.361686 594719.028237 728828.634758
458211.524327 597154.443801 485657.552584 588505.285163 717238.106520 487229.322875
573859.492525 639857.379096 562559.522955 852818.080145 526931.605275 600934.845013
481534.284024 614587.086182 562684.134711 411698.135254
Output patern 73:
0.500000
Input patern 74:
78678117.583068 35890152.074322 29132377.054143 21067654.611252 12016052.303750
8929766.319309 7887708.030930 6081186.353191 5012053.495096 4541391.606046 3866554.054408
3370136.431392 3044745.116451 2382433.755738 1954456.496081 2008034.347374 1843147.064247
1420925.451595 1332484.999026 1407220.898674 1216582.607280 994001.957432 959003.377132
996665.840922 983394.965155 860984.243369 651150.811591 705872.075115 1039683.084489
1113794.119873 811511.782959 607471.761797 605916.988316 556829.899565 568670.210073
654947.831801 521901.727700 303069.694887 385323.402028 524219.841694 399150.870927
360251.923376 582482.422976 617510.599387 405570.952269 356340.808226 444141.875123
354850.868714 250245.291663 360990.337214 489875.067277 479411.481613 456496.548430
468877.361380 431025.572551 347193.505407 276973.390169 285954.411780 392434.838569
439852.813514 307384.045676 195725.041748
Output patern 74:
0.500000
Input patern 75:
74399985.316759 16516080.000941 17182210.373654 16926960.286639 11856396.950313
10298751.087757 8006540.402303 3865854.080638 3151284.343665 4779992.187208
4483404.428784 2701678.802548 1959208.863607 2049795.557925 2087341.549751 2067384.452631
1786213.831411 1271562.351014 1125191.316095 1333267.741668 1323430.206105 1050981.028581
892926.948549 897134.338720 907059.003420 858210.279055 758523.429030 698088.338403
689065.177940 660933.289307 626708.577194 642241.483438 580869.752151 450808.309453
505703.457281 643645.864952 540612.995824 346134.717548 388473.272609 517965.904650
506510.778876 446529.629106 369646.820587 279679.646766 371809.639715 569370.899594
463085.639465 176372.605641 240113.531117 509190.986590 465378.361909 264062.639253
288543.825947 373776.010841 320541.876635 323527.154272 404338.338568 358634.731244
256323.595003 274822.453017 359278.731003 394431.619873
Output patern 75:
0.500000
Input patern 76:
60935492.599559 31669395.538493 12629695.277492 15425559.361118 11832290.239790
7870159.475761 6151840.543078 6380828.450026 4352603.123251 3896870.849577 3602416.263766
2731268.100513 2174830.738657 2240830.022747 1678774.825630 2839992.440117 1498910.584103
748081.670472 1113382.674422 963565.541202 1464136.923547 989452.399669 582279.584386
647614.871368 798083.672881 421779.333004 913155.357381 660492.347011 738431.334763
644206.483887 402732.888137 675078.172226 616171.431910 641264.270554 420871.617686
638826.628252 387383.940233 517059.272366 452484.116243 319171.085849 561533.743553
312981.196504 386479.408744 453335.498430 276155.228866 323109.517292 216535.782686
303696.523214 421238.321213 330238.165553 248366.688550 148514.946797 368384.097359
276268.992829 462278.963230 290119.798649 246809.671094 388856.362562 237130.800913
394273.264849 323451.217043 327638.318848
Output patern 76:
0.390000
Input patern 77:
63244056.142569 39874563.867822 24298693.114155 15647723.775862 12751970.716802
9873635.998471 6471997.402169 7599176.277093 3404926.720732 5483447.080821 3213768.430041
3115719.094316 2958550.568653 2252618.676472 2426105.775532 2002146.730207 1427280.230278
1783809.848276 2796990.265359 1285073.723612 1589536.650804 1129945.106358 989106.595313
1019316.679345 977174.044785 953757.261722 769627.197111 822560.723614 686128.633170
921369.735352 466473.365248 783502.310214 564032.641485 647282.068785 624560.471307
417521.082269 604045.583669 632528.051058 434722.142509 159910.480728 462139.984979
261758.917248 479707.669189 468751.976403 476544.346161 380926.389934 360128.523569
488863.568467 372468.131419 413560.265850 310839.945167 471876.851752 327546.496741
427755.949581 293877.647568 389755.955150 447774.497962 295420.138694 325968.919423
376712.063835 549657.736967 392516.443848
Output patern 77:
0.510000
Input patern 78:
72468143.400817 40557224.016506 22076767.005924 17544971.025761 13389095.077696
9057377.197634 7843976.290902 8050714.462196 6290007.671616 5039329.680207 1626244.360082

5226700.282020 2358489.330961 2453314.608384 2374788.697499 2510027.173361 2175409.723317
2219433.798829 2022118.249774 1807058.176735 1412368.916589 1561162.586035 1705590.169003
1085519.049281 1859261.968788 1209558.672244 1156177.357516 794941.511348 1023626.923032
757789.986328 1126689.917718 1006420.673213 704682.786026 889248.659176 898619.373499
586125.998600 585559.493894 1014619.788166 780789.178922 729845.895918 496848.182799
700851.401833 590329.390896 823544.323924 404895.112919 636698.541030 787642.502979
666530.826449 701517.928406 619033.305562 559467.835837 610941.375876 439373.764880
558494.185977 712558.109387 619147.060800 842044.865003 440190.215642 684609.089764
665890.736453 617590.087815 526018.615234
Output patern 78:
0.520000
Input patern 79:
79087326.851000 39528132.900498 29863513.670900 17570600.814092 10816464.281837
9645155.575985 7376230.099903 5688321.435045 5172184.063528 4193654.126607 3526200.794421
3433391.491659 2820065.717644 2233590.738825 2171145.800250 2061760.384496 1922138.338999
1900698.581266 1659923.360594 1445627.131155 1428701.833501 1221617.047898 939801.250728
876438.166984 849574.380462 871672.773148 974090.251066 901308.602500 796278.017416
882434.945801 851495.367764 678756.963914 599745.626753 527312.666314 543831.375656
745423.196578 615382.457597 211493.655250 341122.537969 746481.847181 652538.986175
457686.622206 569558.111160 490299.284042 241731.696685 326767.652777 524767.875763
495077.814677 417346.452625 372690.659442 322992.352780 360467.546046 391821.452574
333204.711101 349555.264523 444432.627215 464042.651750 435004.799424 377466.124353
294828.275484 293920.576957 326944.896484
Output patern 79:
0.510000
Input patern 80:
60368034.416790 38953443.266763 23621493.611183 15149186.884041 11541430.307213
10055264.837158 8583276.430360 6640060.874208 4736564.607826 3516636.900043
3062863.239936 3011867.072138 2924677.521809 2626449.260745 2240255.565649 1961550.818254
1842535.493627 1748552.465355 1582118.427946 1345061.454119 1145002.957584 1054338.429945
1071513.715763 1103678.051751 1055870.623285 947144.138604 840646.093084 801210.435772
822701.398474 850801.625977 833892.181261 744599.942400 610198.606496 447615.661372
304193.196175 197816.643861 162378.993428 208451.185159 314985.763422 419111.404017
465067.176439 439464.020210 382813.381327 353869.081478 370300.102016 396210.255857
378276.836569 304526.045522 225697.134353 210035.464399 282194.747043 400365.215893
481027.527654 475108.860238 411966.288269 353048.233836 347970.026966 381957.805912
405901.006102 389939.233897 349158.852212 327160.960938
Output patern 80:
0.500000
Input patern 81:
80254121.014754 37747082.798227 25204023.962756 16154096.041604 12202641.843441
8790657.013791 7562601.999345 5372960.799063 5255714.471269 4512242.688378 3853143.673886
3208154.930244 2978750.805451 2386800.450870 2292632.373325 2032095.096838 1606577.506252
1379881.295392 1480910.381046 1539545.599383 1334608.835156 1163407.186838 1762442.275276
570986.907230 771560.008017 635066.562228 1023981.503414 1124158.581079 645187.406245
731679.099365 771199.139733 647861.473005 604354.630623 707022.476547 428087.757968
567446.131237 634013.286234 574489.868668 444227.634725 611980.124048 433632.696026
522104.904924 526958.626270 433112.532678 210506.423129 530912.904110 502421.188362
346170.228781 584829.176726 417011.368984 403549.445210 294299.794277 238567.236240
534511.904336 409687.951153 405622.752070 338775.707646 440522.325242 323708.112621
466976.641406 319596.530043 345212.175049
Output patern 81:
0.470000
Input patern 82:
54670824.610140 34040285.908463 25141264.994959 18710151.389849 11577558.173126
9740114.396361 6667470.566039 6493605.506866 5276955.046830 4508363.657872 3084652.006010
3246785.305475 3100677.266677 2473890.240715 1881007.472231 2224869.026578 1624423.158626
1753656.449729 1499069.887346 1257878.703027 1256576.671553 1303325.012029 972390.399358
1068693.412254 940999.179761 889660.735880 748387.600138 994816.733648 711353.559234
527580.756592 828972.385731 779072.499644 462646.300134 649093.463305 484259.123114
741864.316031 559356.495613 208332.085638 795125.315181 416466.815855 509864.660975
348759.222416 558610.132244 376741.810975 490286.433634 422310.846687 322485.917267
473488.716297 408535.832298 440565.874110 261358.223511 404926.888244 515878.956557
276029.979605 305749.272390 494468.936261 299935.334105 372943.119865 376230.007458
348891.930061 347878.919699 392513.068604
Output patern 82:
0.500000
Input patern 83:

65357969.458653 39858509.954108 26376872.988788 18034971.187234 11206979.573608
9142649.129602 7505630.599668 6313296.019936 4457624.643512 3651903.219312 3824517.502481
3451733.615441 2715777.292908 3890355.925540 1452697.676369 1522377.607203 1984792.340572
1456505.841457 1399374.656487 1333225.691918 1452208.267664 1263636.506773 952508.966737
1083034.457911 1010322.077765 1089866.943211 625629.019567 688689.125135 601217.505190
853645.571289 725313.489963 727820.970908 684750.847683 616239.158058 585277.047562
419498.650576 586257.367894 475755.979949 582590.215762 362255.142303 515295.990567
464374.551350 544553.745722 481186.555894 520253.220166 178139.327390 478278.112731
424914.639078 256918.514705 489481.697767 427407.230227 475066.831132 264410.255312
386909.971567 416598.417886 407955.138048 306290.358718 256617.990207 432361.050688
330361.488649 295412.793883 589279.011230
Output patern 83:
0.550000
Input patern 84:
61789138.500788 30269320.113888 25112276.003052 15115311.939135 9910870.316835
9527967.383837 6182257.887198 6285758.014314 4073435.551784 3899968.209344 3542026.349091
2827852.323501 2562426.380046 2016827.660904 2247344.050270 1756073.686476 1562015.129109
1340309.684965 1628828.042943 1102153.385825 1102102.018464 1045380.770309 1141218.712391
859792.335840 725392.481779 904276.376049 1034370.994557 169614.365884 1188864.974748
392309.165771 736169.140904 494986.463646 680316.852200 480306.579236 544883.196548
556123.988999 359845.404609 641157.239639 362183.452952 433682.866065 477225.350578
407573.915476 439732.174546 303952.777830 500501.090904 346438.809311 375081.935419
309296.882863 491934.339231 258501.630651 379161.882475 330466.539029 394590.759524
325162.736097 251464.225614 457481.393538 300712.827165 241565.699374 462121.346024
223602.841580 401816.447572 264074.569092
Output patern 84:
0.480000
Input patern 85:
65988433.737284 37914793.566238 23321630.454952 16868911.880672 11979161.839838
9316346.304170 7383662.840136 5858422.561932 5050697.854674 4054758.115199 3602055.656378
3089209.963717 2597746.069282 2462126.112179 1941315.673961 1942272.938299 1528170.570995
1199906.650414 1332117.125555 2559513.448949 1239825.815028 1389772.234245 1179311.424549
1035606.300268 1068861.146093 882003.533090 928037.679881 817623.166862 777910.075025
785365.822754 675600.519755 731059.483105 628845.949010 638683.716530 639654.637424
542148.178721 662045.571558 491317.639525 654773.227196 745368.211167 597744.830358
191453.990168 505884.175073 355940.744462 415908.750515 422917.630008 363611.412613
433182.079040 355913.246198 399193.966824 380372.084855 354160.958331 404222.713864
331470.845497 392658.357712 352046.628130 344386.670655 404316.891225 279813.448541
457756.167923 235669.230499 131660.692383
Output patern 85:
0.510000
Input patern 86:
62798708.816951 37353553.043481 22423562.860099 16784589.261902 13558809.483441
9790653.166388 6881850.786381 6222389.006241 5049548.591365 4355549.017573 3841718.142868
3345482.232864 2524298.079722 2315392.240707 2501749.169910 1906581.202274 2038369.475724
1469469.002703 853511.040042 2501877.205985 759649.863575 1095063.106975 1203041.841555
1018985.283130 1046042.052056 891955.240978 867026.280843 717156.831153 864269.936596
736992.963867 712181.380483 671238.532329 615157.881352 604868.257879 598198.313322
699739.270278 435275.525922 583966.332832 402921.700840 675261.549658 539066.932127
293869.719418 499861.258836 571483.218381 380715.449114 466307.980973 386634.967817
445216.494486 395059.329821 465625.300487 381796.798562 374147.135632 410371.795709
377668.858648 421994.417649 370429.738309 428790.668595 265474.155762 446976.727111
395283.968648 445197.370273 211777.578613
Output patern 86:
0.480000
Input patern 87:
39549882.489566 27812278.758118 14935720.811152 14257813.396588 6606688.022369
7931388.627997 7721843.326979 4297802.476952 4421652.968057 2984406.221045 1703454.121202
1468598.700287 1057131.923069 1686303.473057 1109942.193329 850061.863063 1617936.861464
458078.828969 1359380.570351 853234.137242 1383355.233223 891712.169498 790500.173707
815289.068620 438142.562238 436093.831552 602026.898810 529470.768513 505604.323082
488804.998047 458954.036444 511998.309989 308797.925461 650423.216545 408558.466673
381664.676173 328169.445070 238593.131118 254295.331459 182105.222794 368521.540436
348847.449571 270142.752997 380529.948130 307977.785387 343539.586514 302702.430465
411909.851475 294555.524776 253253.321176 163567.963252 229453.694213 74685.790073
214821.956152 207514.746660 231450.375470 181883.087827 213569.560523 275780.883521
209673.610404 335460.698123 324643.816895
Output patern 87:
0.410000

```
# Input patern 88:
64424846.733161 34922951.650682 22712194.096095 17672696.823327 12885488.428203
8757046.180862 6997111.120434 5947392.254181 5687386.222610 4433827.990850 4154690.560592
3220610.252665 2955653.963149 2267043.123821 2398958.722692 2434507.313311 2464959.252129
2279192.788864 2030256.276336 1875053.146731 1224309.223308 784681.486326 502425.184542
954043.304589 1150061.477638 1103273.327161 847614.301173 951145.759094 1130666.609407
1103642.493408 920652.307936 841372.563544 779556.521146 679072.455825 565378.153668
716849.145151 746257.849786 683795.987942 476687.437026 566661.196902 646026.936685
651023.406738 638424.773380 752679.808401 839530.011447 618826.171590 462536.999253
503173.345006 768827.187871 735678.576848 573171.457691 450327.830802 535771.385504
566079.297019 496672.562314 457805.880693 497558.314566 507043.773735 419269.636250
374214.547440 430543.753632 482325.032471
# Output patern 88:
0.470000
# Input patern 89:
75701384.805786 36521659.564531 25004522.319198 18332473.484283 17797462.083000
9216327.758089 4802032.478215 4780670.859831 5487311.664204 3793434.205970 6582259.310946
4579964.801309 3239693.408418 3662644.135698 2171399.031323 2582515.337524 1160898.774170
2171653.572520 2266235.624976 2187792.498179 1865884.565011 1586530.322949 1103875.850448
1631025.087963 1690695.625942 832234.474095 861661.213723 1227728.460185 1122868.166303
1292903.649658 1130369.520668 898978.012133 883634.933203 966494.013323 788020.397595
745864.155753 773839.257057 815016.790912 733998.910930 819296.168724 775317.809825
845340.473011 847965.955148 1015094.100100 627424.073725 608837.044478 556971.957775
563530.856041 633875.388834 705701.487750 562632.934291 665209.062124 851003.019545
514693.736448 635260.449332 436829.259098 506719.240644 568740.851378 545455.245695
428935.870179 634583.695139 671820.517334
# Output patern 89:
0.460000
# Input patern 90:
56873823.678541 36460705.272242 22441657.923858 15213109.448931 10818100.887090
7659692.497592 5984621.987306 5680170.168866 5583782.474689 5569999.825846 3529408.194899
2525390.915147 2561166.824167 2226423.870216 1580626.262988 1638523.424652 1882967.654598
1563875.336668 1478992.508070 1727540.812269 596359.739696 1424164.460473 1066720.134445
1152399.001768 959096.397628 865749.370049 988560.728762 856189.859745 627771.746078
652934.710938 637347.928381 442711.917911 652645.351336 373606.668399 337734.091026
451919.254756 533586.277968 409174.735585 371133.298754 460862.274593 397526.844366
341641.630656 452635.352028 267994.736313 532853.032862 383616.799706 478870.953774
326154.204863 218295.058064 340885.303422 333841.038098 234931.248441 354335.270250
445450.900100 300397.835817 434255.133171 243553.016298 293213.506780 320830.884963
433756.374152 443642.237632 393031.202148
# Output patern 90:
0.460000
# Input patern 91:
68036734.530020 37491469.625629 26521955.031326 17196037.109250 11286388.918006
8875403.226225 7554276.732708 5801510.112327 4964007.947189 4203238.835549 3726297.102849
4003173.554609 3356835.765694 1194233.900412 2335622.377632 1820325.611984 1825463.686462
1731385.602132 1786525.145481 1194996.398993 1251120.890219 1240190.296245 1073986.500907
830000.312899 1027627.263487 764102.596827 928626.812794 813264.878626 891744.612619
915293.184570 332390.720513 648726.022382 580428.367155 731702.671659 573574.752545
501063.253072 642707.008234 551068.613284 426511.176938 485607.441879 516857.381521
356013.739823 499215.681800 334303.448199 554202.379276 639487.387674 182292.263406
429754.803525 339861.637395 467307.766418 283222.636269 449422.415477 436191.673379
350393.418934 334287.526710 466893.474936 304115.503126 338626.298682 346022.479741
311223.322383 350779.376736 524598.623535
# Output patern 91:
0.490000
# Input patern 92:
63104664.799809 38026927.060520 26036433.676659 15315728.646144 11446596.019950
9880581.835451 7481459.482564 6528397.015786 5641748.851612 4278482.015120 3607670.558269
3086039.217830 2744858.085367 2848820.517432 2260128.811718 1607584.528952 1937931.857414
1812396.887090 840565.113669 705881.476174 1147682.199247 1092872.941226 1002160.385920
973127.035050 683178.290304 614303.321812 826535.289623 852230.306080 801318.686268
849530.553711 843752.869016 823093.829244 774364.407950 673170.007867 691843.048613
600512.948842 318634.075020 351168.517995 619221.763838 605964.137768 512462.935575
544621.410255 466386.105168 403821.942369 484078.597704 429630.182763 325305.091520
389014.701831 436373.145007 378584.624895 365550.875346 397408.745657 459364.662510
502699.945562 446669.523591 441205.157670 476997.346425 338432.738847 229544.746624
370302.751891 473318.750524 457939.869141
# Output patern 92:
```

0.510000
Input patern 93:
50778649.493572 31800159.718605 19540575.577791 15224908.240709 10519520.177881
8764149.292025 6575378.211495 6220961.522424 4437552.241863 4247846.021867 3198954.066623
3276431.341555 2425558.260648 1859964.107490 1961364.906050 536712.731817 1619054.496426
1967589.912959 1356190.116425 1076206.443286 1105844.627269 1033400.723746 882784.991061
811292.963135 709681.205516 870270.672329 612257.871380 702091.781131 585686.190426
720287.711182 604053.622767 399136.388552 644807.998843 428470.862544 661346.322858
841934.884782 633744.725387 447894.342647 560990.221017 534858.103891 463935.976195
435048.817538 378495.551117 493027.604719 326687.406845 373054.467217 320674.330500
390658.105114 351269.996085 192085.564539 393814.239375 383265.116718 421450.452777
498754.832013 420105.159502 251115.904394 393882.091734 403748.818291 356941.249518
372716.090885 330883.200460 459426.382080
Output patern 93:
0.490000
Input patern 94:
59314651.879962 32386800.816927 20383380.511271 15540654.615261 12509634.441732
8149197.279485 6531019.050334 5547556.285143 4486671.194196 4115127.556008 3485153.868143
2752358.908843 2173632.076118 2677935.185519 1633242.154204 2268735.012906 1559443.262453
585824.104545 2446407.200412 834172.448296 1142341.711315 923806.754860 1115362.397033
990291.975145 830609.877688 750195.278287 773835.221874 739266.601648 717424.893527
653322.546875 604189.134586 569472.771226 549046.479375 681782.805776 358376.820870
696206.737441 268068.030903 533047.257658 652655.635616 265364.430549 419559.680398
444278.951196 481752.844625 390151.185102 294220.451068 459511.336942 341219.168281
411779.471955 352794.730500 330294.132934 358459.411452 347039.061069 367249.845278
357533.721669 258558.023222 425514.874169 208280.186582 476614.940264 293485.431551
247023.431382 345747.192829 392301.601563
Output patern 94:
0.490000
Input patern 95:
79545648.139703 41700863.869828 24719483.515273 18338410.233836 12223081.894069
9383578.808253 7514350.722357 5415573.209590 4864313.391783 4191429.080455 3450356.521160
3330209.934151 2629781.898554 2395502.322576 2953561.992774 955536.855699 2311039.784768
2036221.411554 1763793.301983 1058461.617326 925062.031767 960442.177227 983153.147799
1137317.779881 1062052.175316 951959.247309 949002.066450 831500.076783 793694.886926
719883.368164 533794.717509 620494.806018 662970.163338 552651.299760 448463.546581
778221.111290 571056.558276 413961.631988 477797.126498 508215.625114 571976.043266
564939.626762 421222.974108 357930.580986 336816.190237 356220.685237 447940.492510
428173.439423 405474.998520 456275.395735 414626.143860 541858.847918 136567.262151
522648.952844 297848.189249 288142.324390 329029.450559 366927.095940 448131.306573
408075.377814 331014.293805 328237.996582
Output patern 95:
0.480000
Input patern 96:
59287048.012957 37985727.409748 23781618.703728 15504905.870205 11930131.013989
9749846.633046 7123726.896567 5603133.774041 4989094.654182 3229194.379991 2976299.577330
2445595.437762 4411964.537876 1866112.151249 2664247.572213 1811619.477586 2043411.340546
1791241.511378 1485155.474838 1472446.956496 1226113.345714 1183871.498052 971516.999716
987486.342200 1360707.256761 929940.022715 1245122.843748 695161.535649 815295.081837
869497.177734 928828.710590 450923.100491 776188.829059 640496.197104 490895.820657
646938.002614 632284.641536 673244.080865 645121.852229 458664.740686 593480.527587
304780.886949 635294.838055 482220.445440 301779.481902 390373.218868 532234.098804
279133.205954 491375.661567 472974.930996 423221.132501 399813.424477 348376.669796
285049.969678 403496.490937 339751.014729 385878.063447 221382.454087 358455.465377
359286.814724 411431.833220 345087.184082
Output patern 96:
0.490000
Input patern 97:
62921958.492717 33358238.919052 24043743.303205 15301487.967960 12556004.425264
9309002.460529 7921387.486309 6044017.256219 5601494.050303 4359522.082533 3792743.423222
3287593.057404 2914462.245827 2082156.188472 2038949.184896 1331518.340947 3005242.187056
1835488.204302 1433482.580109 1466050.605644 1263652.547883 1071685.971272 1043741.909897
1030771.776094 840798.150682 889951.328271 848069.092602 787876.266593 716812.014947
856019.295898 675526.027809 688417.298657 838218.651154 818207.235527 963759.633441
495007.582600 493872.408213 670835.838650 474656.516027 526032.546984 488684.284314
519685.217492 375262.389730 504854.545145 385191.163949 411189.594731 360861.570092
465241.915696 280641.224824 429249.473312 447474.233724 331257.681193 281666.772128
167113.282284 312525.900097 436886.216337 257857.055317 410818.449668 354701.132914
397292.121404 312764.107254 456233.678711

```
# Output patern 97:
0.470000
# Input patern 98:
63033740.112103 39365472.378977 21548407.244453 16420247.022219 11973420.652289
8600504.328098 7534092.131372 5607118.829085 4675471.706626 3707011.281557 3931666.857081
2351529.005349 1837091.248358 1285886.094135 2725021.943056 1766010.317771 1819593.209754
1703824.969523 1422221.552814 1116163.959357 1335915.505637 1059165.803021 1002386.258824
901407.284235 800313.993620 850886.037512 806240.877044 460535.971371 422169.917776
918566.564941 593262.975597 722637.618439 733834.024591 445361.203983 633895.077175
378691.511328 602173.738023 474377.764549 338214.041844 516580.022086 342399.410232
510141.968142 268959.802212 314804.868424 407470.121374 547405.324810 325245.781654
525493.989377 382599.081602 241965.774535 405514.205129 326055.738318 343310.607547
340830.784020 234106.409259 404006.351315 297115.652415 330275.702177 205934.361608
401993.775530 377169.216762 392375.640137
# Output patern 98:
0.490000
# Input patern 99:
68792713.861441 36716213.804654 26906229.956675 16243926.149319 13558615.719212
9164483.420224 8013581.934469 6198855.920759 5082612.546581 4292872.768058 4233519.201594
3006213.408948 3321602.142513 2592407.216251 2706440.920518 1726794.884370 2343304.408584
1349509.026734 2415772.035833 1889033.009711 1067524.724312 793394.087925 1086902.817354
952067.976739 817221.431843 875114.090642 1009155.609761 758160.248916 850519.301468
786055.243408 767081.393679 610852.837221 683746.118986 523451.948760 752305.319095
338985.820699 782860.885784 629907.667456 561607.852789 599045.142457 421109.138831
518390.593226 841949.970608 575138.660948 536349.359171 554435.744198 499660.431544
431680.769288 418675.777721 396496.258244 513650.668674 296316.914806 532366.343550
392001.092950 478671.400233 331596.312920 430861.370998 373163.503823 211411.381661
261455.814710 401363.501907 327118.600342
# Output patern 99:
0.480000
# Input patern 100:
64373935.571038 36203648.606389 22045415.461697 15965280.310038 11208352.182805
8874774.668761 7380684.049138 6331903.018380 4261484.190872 4999343.364022 4456189.449805
2280136.396013 2639689.795858 2721403.399874 2551870.731824 1682026.602919 1696704.224759
1703871.534163 1452413.408416 1754219.082781 1981818.573859 1476761.813219 1219910.399920
1042461.298815 1285941.138642 801057.997120 807021.532588 959864.171875 1107551.871191
571019.359619 1000241.851318 524842.329864 690533.178228 567274.456751 827144.734136
777111.326534 418226.787921 689714.417472 660944.232680 609669.087008 545902.110563
532882.526650 422029.690787 383224.037310 337598.562069 454667.357450 375555.439289
330483.501268 584309.081538 459310.752330 272657.742648 405186.464758 306050.322706
452863.695275 464086.361225 385130.933573 503709.050633 254781.432497 427644.951635
335191.588227 400818.675347 210670.287354
# Output patern 100:
0.550000
```

APPENDIX C

NEURAL NETWORK SAMPLE TRAINING AND TEST SETS

Table C.1: Neural Network Training Set.

filename	mpd	etd	avg-std	overall-std
6091403.11	8.007	6.605	2.611	2.676
6081442.35	9.740	7.992	2.254	3.059
6100953.29	8.341	6.873	2.178	2.995
6091401.54	7.871	6.497	2.530	2.614
6091137.25	10.792	8.834	2.316	2.698
6211311.25	6.274	5.219	2.232	2.353
2091102.16	9.728	7.982	2.791	2.945
6211142.06	7.886	6.509	2.867	2.963
6211351.05	7.162	5.929	2.191	2.269
6091628.14	6.609	5.487	2.053	2.113
6091128.55	8.277	6.822	2.575	2.638
6091632.41	8.895	7.316	2.899	2.971
2091056.08	5.917	4.934	1.773	1.886
6211248.04	5.104	4.283	1.847	1.891
6091303.00	8.020	6.616	2.040	2.227
2091245.59	6.501	5.401	1.981	2.054
2091244.16	7.287	6.03	2.308	2.38
6091355.42	7.322	6.058	2.334	2.421
2091102.31	5.636	4.709	1.643	1.824
6211349.47	6.278	5.222	1.866	1.900
6091406.26	7.431	6.145	2.489	2.545
2091103.59	9.01	7.408	2.58	2.757
6101104.03	6.915	5.732	1.939	2.018
2091103.52	9.464	7.771	2.675	2.827
2091240.51	5.198	4.358	1.58	1.687
2091245.37	6.404	5.323	2.05	2.129
2091104.06	8.442	6.954	2.394	2.575
2091055.45	8.790	7.232	2.498	2.731
2091054.56	7.085	5.868	2.053	2.221
2091241.50	6.748	5.598	2.191	2.26
6101513.34	5.857	4.886	1.608	1.672
2091245.44	4.855	4.084	1.521	1.716
2091241.06	6.101	5.08	1.933	1.997
6091633.56	8.813	7.251	2.874	2.942
6091405.04	6.716	5.573	2.087	2.146
2091104.21	8.384	6.907	2.405	2.544
2091103.00	7.075	5.860	2.021	2.193
6091358.11	7.140	5.912	2.385	2.470
2091240.58	5.881	4.905	1.827	1.905
2091243.18	5.527	4.621	1.763	1.819

2091242.42	5.42	4.536	1.747	1.824
2091106.05	5.036	4.229	1.505	1.682
2091105.48	7.068	5.855	2.005	2.147
6081126.05	10.302	8.442	2.095	2.693
6211206.52	6.985	5.788	1.365	1.492
2091211.07	5.226	4.381	1.572	1.64
2091053.29	6.095	5.076	1.776	1.903
6091400.36	7.893	6.515	2.565	2.636
2091209.02	4.145	3.516	1.28	1.327
2091230.12	4.187	3.55	1.292	1.341
6211340.37	6.684	5.547	2.023	2.085
6211041.17	7.691	6.353	1.656	1.704
2091107.18	5.65	4.72	1.638	1.8
2091232.31	4.492	3.793	1.394	1.449
2091232.39	4.467	3.774	1.414	1.47
2091055.31	4.069	3.455	1.219	1.316
2091232.16	4.327	3.661	1.345	1.409
2091053.01	4.979	4.183	1.503	1.638
6081446.50	8.374	6.899	2.155	2.323
2091230.43	4.42	3.736	1.362	1.412
2091210.30	4.585	3.868	1.369	1.439
2091057.20	4.985	4.188	1.487	1.741
6081355.03	5.953	4.962	1.859	1.917
2091323.07	3.37	2.896	1.066	1.103
6101427.44	6.227	5.182	1.640	1.702
6091133.44	7.455	6.164	1.820	1.940
2091056.38	3.661	3.129	1.107	1.191
6100934.54	4.625	3.900	1.225	1.272
2091321.21	2.983	2.587	0.946	0.968
6101322.18	3.360	2.888	0.801	0.835
2091324.29	2.783	2.427	0.866	0.891
2091322.59	3.474	2.979	1.082	1.105
2091155.10	2.15	1.92	0.687	0.719
2091323.22	3.065	2.652	0.947	0.966
2091154.48	2.195	1.956	0.694	0.717
6101037.24	2.875	2.500	0.760	0.769
2091322.52	3.059	2.647	0.945	0.962
6101134.22	5.640	4.712	1.479	1.599
2091323.51	2.594	2.275	0.777	0.796
6101533.53	4.761	4.009	1.377	1.414
2091131.04	1.687	1.549	0.547	0.554
6091339.28	5.385	4.508	1.523	1.572
2091158.25	2.056	1.845	0.622	0.641
2091155.38	1.835	1.668	0.593	0.619
6211318.11	3.682	3.146	1.301	1.513
2091322.31	2.296	2.037	0.707	0.729
2091129.30	1.745	1.596	0.541	0.564

6100948.37	3.788	3.231	1.016	1.045
2091155.03	1.825	1.66	0.577	0.595
2091324.38	2.47	2.176	0.759	0.771
2091325.00	3.147	2.718	0.967	1.042
2091156.50	1.542	1.434	0.49	0.498
6091356.22	5.598	4.678	1.763	1.908
2091134.00	1.594	1.475	0.506	0.518
6091623.01	5.090	4.272	1.443	1.477
2091323.29	2.361	2.089	0.726	0.737
2091326.11	2.547	2.237	0.796	0.805
2091322.21	1.922	1.737	0.601	0.608
2091324.14	2.607	2.286	0.846	0.913
2091134.07	1.381	1.304	0.444	0.45

Table C.2: Neural Network Test Set.

filename	mpd	etd	avg-std	overall-std
2091242.05	7.327	6.062	2.348	2.411
2091056.30	8.065	6.652	2.352	2.515
2091244.01	6.776	5.621	2.175	2.254
2091056.01	8.657	7.125	2.549	2.741
2091245.59	6.501	5.401	1.981	2.054
2091103.44	11.2	9.16	3.196	3.405
2091102.31	5.636	4.709	1.643	1.824
2091209.21	4.261	3.609	1.27	1.312
2091056.44	9.852	8.081	2.822	3.056
2091056.57	9.051	7.441	2.658	3.052
2091057.06	7.331	6.064	2.202	2.396
2091243.11	6.945	5.756	2.258	2.335
2091244.54	7.029	5.823	2.246	2.31
2091245.31	6.963	5.771	2.222	2.29
2091245.24	7.048	5.838	2.2	2.272
2091104.55	7.033	5.826	2.103	2.253
2091243.48	6.88	5.704	2.162	2.226
2091245.02	6.344	5.275	1.993	2.146
2091102.38	6.869	5.695	1.972	2.107
2091055.38	5.405	4.524	1.625	1.758
2091055.19	5.215	4.372	1.588	1.756
2091055.54	9.445	7.756	2.744	2.936
2091104.49	8.428	6.943	2.539	2.853
2091103.13	9.065	7.452	2.597	2.762
2091055.45	8.790	7.232	2.498	2.731
2091053.15	7.839	6.471	2.261	2.405
2091105.26	7.454	6.163	2.157	2.316

2091244.09	6.928	5.742	2.22	2.29
2091243.04	6.58	5.464	2.142	2.278
2091245.16	6.724	5.579	2.169	2.24
2091245.08	6.67	5.536	2.159	2.235
2091244.47	6.69	5.552	2.139	2.204
2091241.43	6.392	5.314	2.058	2.135
2091245.37	6.404	5.323	2.05	2.129
2091240.51	5.198	4.358	1.58	1.687
2091243.25	4.849	4.079	1.486	1.613
2091056.51	10.348	8.479	3.032	3.256
2091104.28	8.768	7.214	2.516	2.673
2091242.28	7.156	5.925	2.342	2.405
2091241.57	6.765	5.612	2.149	2.215
2091241.13	6.35	5.28	2.023	2.103
2091244.39	6.401	5.321	2.016	2.078
2091057.13	6.028	5.023	1.787	1.919
2091105.03	5.242	4.394	1.537	1.789
2091242.13	4.762	4.01	1.461	1.523
2091103.06	10.264	8.411	2.979	3.224
2091103.35	8.349	6.879	2.453	2.640
2091105.34	7.863	6.491	2.267	2.441
2091056.23	7.103	5.882	2.048	2.198
2091242.21	6.602	5.482	2.12	2.197
2091103.28	7.000	5.800	1.989	2.135
2091243.41	6.379	5.303	2.031	2.13
2091243.54	6.197	5.158	1.998	2.115
2091053.23	6.573	5.458	1.909	2.053
2091054.12	6.135	5.108	1.781	2.021
2091105.18	4.965	4.172	1.468	1.668
2091106.25	9.829	8.063	2.857	3.12
2091053.51	9.720	7.976	2.738	3.003
2091053.37	9.099	7.479	2.642	2.849
2091241.28	6.378	5.303	2.061	2.127
2091241.35	6.144	5.115	1.976	2.035
2091241.20	6.077	5.062	1.942	2.015
2091102.23	6.009	5.007	1.919	1.996
2091102.45	5.556	4.645	1.631	1.773
2091229.52	4.606	3.885	1.44	1.485
2091231.42	4.539	3.831	1.403	1.44
2091231.22	4.262	3.61	1.303	1.356
2091054.20	9.596	7.877	2.774	3.115
2091104.35	8.99	7.392	2.539	2.715
2091055.04	7.847	6.478	2.317	2.473
2091054.27	6.223	5.178	1.849	2.156
2091107.25	6.696	5.557	1.904	2.102
2091055.10	6.531	5.425	1.922	2.042
2091105.41	5.221	4.376	1.827	2.024

2091242.49	5.549	4.639	1.771	1.819
2091056.15	5.084	4.268	1.542	1.646
2091105.10	5.275	4.42	1.557	1.64
2091230.29	4.667	3.934	1.439	1.506
2091231.01	4.46	3.768	1.322	1.389
2091212.49	4.234	3.587	1.32	1.359
2091212.05	4.131	3.505	1.285	1.319
2091053.44	7.301	6.041	2.136	2.347
2091054.50	7.360	6.088	2.076	2.262
2091053.08	6.704	5.563	1.978	2.202
2091106.33	5.601	4.681	1.611	1.776
2091210.53	5.132	4.306	1.577	1.641
2091211.36	4.952	4.161	1.52	1.57
2091211.00	4.963	4.171	1.516	1.565
2091208.33	4.837	4.069	1.48	1.538
2091211.14	4.83	4.064	1.471	1.521
2091230.51	4.634	3.907	1.386	1.433
2091242.34	6.518	5.414	2.143	2.215
2091105.56	5.129	4.303	1.548	1.641
2091211.43	5.001	4.201	1.553	1.6
2091054.42	5.041	4.232	1.462	1.589
2091208.19	5.011	4.209	1.525	1.574
2091208.26	4.913	4.13	1.49	1.556
2091208.41	4.825	4.06	1.459	1.513
2091230.36	4.761	4.009	1.454	1.505
2091102.52	4.226	3.581	1.309	1.478
2091210.39	4.456	3.765	1.381	1.444
2091231.31	4.552	3.841	1.37	1.438
2091229.00	4.151	3.521	1.321	1.372
2091209.41	4.218	3.574	1.288	1.344
2091052.47	5.407	4.525	1.612	1.889
2091106.18	5.614	4.692	1.65	1.765
2091211.21	5.403	4.523	1.612	1.677
2091054.06	5.201	4.361	1.549	1.673
2091208.55	4.4	3.72	1.38	1.451
2091229.30	4.419	3.735	1.371	1.421
2091212.12	4.323	3.658	1.34	1.39
2091106.11	3.964	3.371	1.248	1.387
2091228.31	4.181	3.545	1.275	1.326
2091229.36	4.016	3.413	1.255	1.294
2091229.08	3.949	3.359	1.214	1.252
2091211.28	4.903	4.122	1.508	1.566
2091210.46	4.724	3.979	1.49	1.562
2091230.05	4.473	3.779	1.399	1.444
2091103.20	4.544	3.835	1.332	1.427
2091232.02	4.279	3.623	1.342	1.393
2091229.58	4.355	3.684	1.327	1.378

2091228.24	4.188	3.55	1.283	1.32
2091211.57	4.132	3.506	1.281	1.313
2091210.23	5.347	4.478	1.603	1.693
2091054.35	5.318	4.455	1.526	1.660
2091232.09	4.89	4.112	1.506	1.565
2091232.25	4.604	3.883	1.441	1.494
2091208.48	4.266	3.612	1.329	1.374
2091230.20	4.152	3.522	1.295	1.344
2091231.53	3.976	3.381	1.222	1.279
2091228.10	3.918	3.334	1.23	1.277
2091228.40	3.951	3.361	1.229	1.272
2091210.16	4.007	3.406	1.224	1.27
2091106.57	4.27	3.616	1.244	1.314
2091210.09	4.121	3.496	1.244	1.291
2091243.34	3.494	2.995	1.052	1.277
2091227.56	3.959	3.367	1.219	1.26
2091231.11	3.988	3.39	1.19	1.237
2091104.41	5.361	4.489	1.555	1.667
2091211.51	3.566	3.052	1.136	1.177
2091156.27	2.441	2.153	0.797	0.811
2091053.58	6.283	5.227	1.893	2.106
2091228.17	3.821	3.256	1.166	1.221
2091322.44	3.315	2.852	1.03	1.06
2091156.06	2.203	1.962	0.699	0.717
2091130.13	2.129	1.903	0.675	0.696
2091104.13	4.861	4.089	1.395	1.68
2091106.40	4.588	3.87	1.379	1.573
2091052.55	3.445	2.956	1.038	1.122
2091321.43	2.473	2.178	0.773	0.792
2091133.38	1.882	1.706	0.609	0.621
2091133.17	1.852	1.682	0.601	0.618
2091154.10	2.115	1.892	0.657	0.684
2091132.26	2.057	1.846	0.652	0.667
2091157.49	1.902	1.721	0.62	0.636
2091154.03	2.414	2.131	0.75	0.769
2091155.45	2.105	1.884	0.661	0.68
2091133.09	1.922	1.738	0.626	0.641
2091132.18	1.917	1.734	0.614	0.628
2091156.12	2.054	1.843	0.64	0.652
2091131.18	1.825	1.66	0.591	0.606
2091321.00	3.056	2.645	0.968	0.987
2091155.31	1.987	1.79	0.639	0.652
2091321.14	2.778	2.423	0.861	0.878
2091155.52	1.873	1.698	0.607	0.617
2091132.56	1.735	1.588	0.556	0.566
2091130.41	1.56	1.448	0.501	0.509
2091323.44	3.296	2.837	0.966	1.01

2091131.25	1.8	1.64	0.595	0.608
2091324.08	2.25	2	0.726	0.75
2091132.11	1.906	1.724	0.613	0.63
2091132.04	1.598	1.478	0.521	0.531
2091323.36	2.949	2.559	0.894	0.909
2091133.52	2.365	2.092	0.67	0.735
2091157.56	1.99	1.792	0.656	0.678
2091132.34	1.749	1.599	0.572	0.59
2091130.04	1.75	1.6	0.556	0.574
2091131.11	1.498	1.398	0.494	0.502
2091157.27	1.539	1.431	0.506	0.51
2091325.58	2.963	2.57	0.903	0.919
2091131.33	1.758	1.607	0.58	0.593
2091157.42	2.233	1.986	0.703	0.724
2091157.35	1.933	1.746	0.623	0.636
2091131.39	1.673	1.538	0.535	0.547
2091129.37	1.578	1.463	0.513	0.523
2091130.57	1.559	1.447	0.505	0.512
2091325.43	2.828	2.463	0.843	0.854
2091325.29	2.591	2.273	0.803	0.815
2091321.29	1.93	1.744	0.606	0.62
2091134.13	1.524	1.419	0.493	0.5
2091325.50	2.85	2.48	0.897	0.911
2091321.08	2.478	2.182	0.743	0.871
2091325.23	2.596	2.277	0.796	0.809
2091326.05	2.535	2.228	0.779	0.792
2091324.00	2.264	2.011	0.695	0.71
2091158.18	1.643	1.515	0.54	0.551
2091324.53	2.425	2.14	0.74	0.761
2091325.36	2.435	2.148	0.747	0.759
2091325.07	2.701	2.361	0.82	0.831
2091324.45	2.333	2.067	0.702	0.721
2091321.59	2.121	1.897	0.667	0.673
2091321.36	1.916	1.733	0.615	0.624
2091325.14	2.434	2.147	0.73	0.741

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BIOGRAPHICAL INFORMATION

John Michael Kebrle was born in Dallas, Texas in 1966. He received his BA in Physics from Washington University and then worked two full-time technical jobs before resuming his college studies and received his BS in Mechanical Engineering from the University of Texas at Austin. He then began work at Bird Life Design and began his graduate studies at The University of Texas at Arlington. He has also worked at the Automation and Robotics Research Institute, Bell Helicopter, Vought Aircraft, and Raytheon Aircraft Corporation (now Hawker BeechCraft). Simultaneously, he instructed industry targeted Computer Aided Design classes and later taught sophomore, junior, and senior level design classes at night in Mechanical Engineering. He also worked at his father's stained glass studio painting and etching glass. While working full-time in the medical, robotics, and aerospace industries, and teaching, he took classes at night and on-line at the University of Texas at Arlington, and received his MS in Mechanical Engineering, his PhD in Mechanical Engineering, and is now completing his MS in Computer Science and Engineering. He currently works as a consultant in the aerospace industry, primarily in Tulsa, and travels to Dallas, Wichita, and Seattle, performing contractual structural analysis of aircraft components and systems. He has performed structural static and dynamic analysis and testing, acoustic design and testing, acoustic fatigue analysis, defective part analysis, implemented modern manufacturing systems, and performed manufacturing and quality analysis on aircraft and tooling including the Boeing

737, 777, 787, the GulfStream G-IV, and G-V, the Bell Helicopter Models 206, 407, 222, 230, 430, 412, 427, 429, AH1, UH1, the 609 and V-22 Tilt-Rotor aircraft, the experimental MAPL tail fan and prototype aircraft, and the Raytheon AirForce/Navy JPATS, T-6 family of aircraft. He has been active in music starting at 3; performed his first violin solo at 6 at SMU, and also played guitar in numerous St. Louis, Austin, and Dallas area bands. He has also, published sixteen technical conference and journal papers.