TEXTURE RECOGNITION BY USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT

This thesis describes the texture recognition by using the Artificial Neural Network (ANN). There are hard to understand on how to perform the texture recognition on any new set of image data. Therefore, to ease up the process on texture recognition, ANN has been chosen as the classifier to enhance the process of the texture recognition. There are thirteen types of Brodatz textures are considered as the dataset for this research and five sets for each type texture with different level of histogram equalized, noise for the training dataset. Back-propagation algorithm is one of the methods for the ANN. After the feature is obtained from the dataset, the feature will be trained and classifier by using the Back-propagation algorithm. All in all, this project will tell us how the Back-propagation classifier help in texture recognition and how to increases the success rate in texture recognition.

ABSTRAK

Tesis ini menerangkan pengiktirafan tekstur dengan menggunakan Rangkaian Neural yang tiruan (ANN). Terdapat sukar untuk memahami bagaimana untuk melakukan pengiktirafan tekstur pada mana-mana set data imej. Oleh itu, untuk memudahkan proses pada pengiktirafan tekstur, ANN telah dipilih sebagai pengelas untuk meningkatkan proses pengiktirafan tekstur. Terdapat tiga belas jenis Brodatz tekstur dianggap sebagai dataset untuk penyelidikan ini dan lima set bagi setiap jenis tekstur dengan tahap yang berbeza histogram menyamakan kedudukan, bunyi untuk dataset latihan. Algoritma Back-pembiakan adalah salah satu kaedah untuk ANN. Selepas ciri yang diperolehi daripada dataset, ciri akan terlatih dan pengelas dengan menggunakan algoritma Back-pembiakan. Semua dalam semua, projek ini akan memberitahu kita bagaimana Back-pembiakan pengelas bantuan dalam pengiktirafan tekstur dan bagaimana untuk meningkatkan kadar kejayaan dalam pengiktirafan tekstur.

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LIST OF ABBREVIATIONS

AI : Artificial Intelligence

ANFIS : Adaptive Neuro Fuzzy Inference System

ANN : Artificial Neural Network

SOM : Self Organizing Map

SVM : Support Vector Machines

CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Texture is exist most of the natural surfaces, and the image of the surface maybe is not uniform but it contains variations of intensities which from certain repeated patterns. In machine vision, texture analysis is an important and useful area of study. Most natural surfaces exhibit texture and a successful vision system must be able to deal with the textured world surrounding it.

Artificial Neural Network is composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the connections between elements largely determine the network function. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Typically, neural networks are adjusted, or trained, so that a particular input leads to a specific target output. The Artificial Neural Network in machine learning is used for applications where formal analysis would be difficult or impossible such as pattern recognition and nonlinear identification and control. Neural networks can also be trained to solve problems that are difficult for conventional computers or human beings. The toolbox emphasizes the use of neural network paradigms that build up to or are themselves used in engineering, financial, and other practical applications.

By enhance the texture analysis, the Artificial Neural Network has been chosen. With the help of the ANN, the results for the texture recognition can obtained easily. This paper is

start by describing the basic techniques used, and the most important how the ANN uses to perform the texture recognition.

1.2 STATEMENT OF PROBLEM

There are much work has been done in the area of texture recognition. However, it is hard to understand how to perform texture recognition on any new set of image data. Therefore, ANN will used to classify textures. Neural networks have the advantage over other classifiers that although training times can be long, but the amount of storage and the time required to test on a particular texture are small. The outputs can be treated as giving the probability of a feature vector belonging to a particular class. However, a significant number of parameters need to be preset into neural networks, or adjustments made by human operators, so that one could end up little better off than if conventional pattern recognition tools were used.

1.3 OBJECTIVE OF THE STUDY

i. To recognize different textures in an image.
ii. To enhance the texture recognition rate of complex image.
iii. To test and validate the proposed method for image texture recognition.

1.4 SCOPE OF STUDY

i. A set of image data will be collect to perform the texture recognition.
ii. The images data will proceed with apply the neural network classifier to judge the images by using MATLAB.
iii. The results of the training data will be study and analysis in detail.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Although there is no strict definition of the image texture, it is easily perceived by humans and is believed to be a rich source of visual information – about the nature and three-dimensional shape of physical objects. Generally speaking, textures are complex visual patterns composed of entities, or subpatterns, which have characteristic brightness, color, slope, size, etc (A. Materka & M. Strzelecki ,1998). In addition to M. Tuceryan and Anil K. Jain (1998), the images that are not uniform but contain variations of intensities which form certain repeated patterns called visual texture. There are most of the natural surfaces in the world exhibit texture, therefore, the texture analysis is an important and useful area of study in machine vision (M. Tuceryan & Anil K. Jain,1998). In texture analysis, there are four major issues, feature extraction, texture discrimination, texture classification, and shape from texture (A. Materka & M. Strzelecki ,1998). But in this thesis, we only focus on the texture recognition area.

To enhance the texture recognition, an artificial intelligence technique - Artificial Neural Network will be used in the project. Among artificial intelligence techniques, why artificial neural network has been choose to enhance texture analysis? According to Martinez, Juan, Tomas and Luis (1999), "the employment of a neural network improves the classification results rather than any other classic methods". Besides that, Isabelle, Renaud, Philippe, and Jean-Charles (2002) contend that neural networks can acquire prior knowledge through a learning process, with a suitable learning database; they can be independent of

lightening conditions. By modifying number and nature of inputs, new parameters can be taken into account.

For instances, there are many image processing bases research done with the assist of Artificial Neural Network. For example, Per, Beata, and Laris (1999)'s research "Artificial Neural Network-Aided Image Analysis System for Cell Counting", Yang, Prasher, Landry, Ramaswamy and Ditommaso (1999)'s research "Application of artificial neural networks in image recognition and classification of crop and weeds", Paulraj, Hema, R.Pranesh and Siti Sofiah(2009)'s research "Color Recognition Algorithm using a Neural Network Model in Determining the Ripeness of a Banana", Park, Lee and Kim(2003)'s research "Content-based image classification using a neural network", Isabelle, Renaud, Philippe and Jean-Charles(2002)'s research "Contour Features For Colposcopic Image Classification By Artificial Neural Networks" and Martinez, Juan, Tomas and Luis (1999)'s research "Marble Slabs Quality Classification System using Texture Recognition and Neural Networks Methodology". All of them are showed significant positive impact to their project by the assist of Artificial Neural Networks.

2.2 SUPPORT VECTOR MACHINES

Support Vector Machine (SVM) investigated by Vapnik has recently been proposed as new machine learning system based on statistical learning theory (Chen, C.-M. & Chen, C.-C., 2006). It is a learning algorithm that performs binary classification (pattern recognition) and real value function approximation (regression estimation) tasks. The idea is to non-linearly map the n-dimensional input space into a high-dimensional feature space. This high-dimensional feature space is classified by constructing a linear classifier. The basic SVM creates a maximum-margin hyperplane that lies in this transformed input space. Consider a training set consisting of labelled instances: A maximum-margin hyperplane splits the training instances in such a way that the distance from the closest instances to the hyperplane is maximized (Berger, H., & Merkl, D., 2005).

2.3 SELF-ORGANIZING MAP

The Self-Organizing Map was developed by Kohonen in the early 1980s (Chen, C.-M. & Chen, C.-C., 2006). It is a general unsupervised tool for ordering of high- dimensional data in such a way that similar instances are grouped spatially close to one another (Berger, H., & Merkl, D., 2005). Based on the artificial neural networks, the weights of the neurons in the SOM are adjusted to fit the various input classes of patterns in the training data. In practice, the SOM will construct a topology map, preserving mapping from the high dimensional space onto map units with one or two dimensions. It is a useful tool for visualizing high dimensional data in one or two dimensional space. Moreover, the topology map can be easily adjusted to fit the particular patterns according to many external parameters of the SOM (Chen, C.-M. & Chen, C.-C., 2006).

2.4 STATISTICAL MODELS

Statistical models provide understanding or context to the problem by incorporating information derived from a training set, usually consisting of instances of the problem along with the solution. While the model framework is general and devised by the developer, the model itself can be quite rich and specific to the problem being addressed (Leventon, M., 2000).

2.5 ARTIFICIAL NEURAL NETWORK

Artificial Neural Network, is a mathematical or computational model based on biological neural networks. There is no precise definition of Artificial Neural Network that are agreed upon among researchers. Overall, it is accepted as a network of simple processing nodes (artificial neurons), which is capable of complex global behaviour, dependent on the connections between neurons (Ha, V., 2008).

There are many types of artificial neural networks. There are feed-forward neural network, one of the most used and simplest types of neural network, where the information moves only forward. The recurrent neural networks, in which information are propagated in both directions, forward and backward. Other famous neural networks include Kohonen self-organising networks, Hopfield networks, Boltzmann machines, spiking neural networks, etc. In this thesis, we focus on the back-propagation neural network.

2.6 BACK-PROPAGATION NETWORK

Back-propagation algorithm is one of the methods for the Artificial Neural Network. It is the most important algorithm for the supervised training of multilayer feed-forward ANNs. It derives its name from the fact that error signals are propagated backward through the network on a layer-by-layer basis. Back-propagation algorithm is based on the selection of a suitable error function or cost function, whose values are determined by the actual and desired outputs of the network. The algorithm is also dependent on the network parameters such as the weights and the thresholds.

2.7 FUZZY LOGIC

Fuzzy Logic is a branch of Computational Intelligence whose basis lies in uncertainty, allowing the handling of vague or difficult to specify information, in case it has to be objectively used with a specific purpose. Fuzzy Logic is a methodology that enables modeling knowledge. Fuzzy Logic enables to implement a system by means of predicates and rules, which generally refer to indefinite or uncertain quantities. These predicates and rules are sometimes formulated via algorithms that “learn” when “processing” real data. But they can also be created by a human expert or, even better, by the mutual consent of a group of them. The flexibility of Fuzzy Logic is a convenient quality to decision-making support systems. Its power to elaborate linguistic models renders it very useful to solve real problems,

providing proper schemes for a better communication with Decision Makers and Experts (Meschino, G., 2008).

2.8 ADAPTIVE NEURO FUZZY INFERENCE SYSTEM

ANN learns by adjusting the interconnections or synaptic weights between layers (Chandankhede, P. H. ,2012). An adaptive network is a multilayer feed forward network in which each node performs a particular function (node function) on incoming signals as well as asset of parameters pertaining to this node (Hemanth, D., Vijila, C., & Anitha, J., 2009). Fuzzy inference systems are the fuzzy rule based systems which consists of a rule base, database, decision making unit, fuzzification interface and a defuzzification interface, if-then rules and reasoning. For solving complex problems, Neuro Fuzzy (NF) computing is a popular framework (Chandankhede, P. H. ,2012). By embedding the fuzzy inference system into the framework of adaptive networks, a new architecture namely Adaptive neuro fuzzy inference system (ANFIS) is formed which combines the advantages of neural networks and fuzzy theoretic approaches.

2.9 EXISTING SYSTEM

In order to better understand about how the Artificial Neural Networks can be apply in texture recognition, there are an existing system calls MaZda Texture Recognition Software. MaZda is a tool for computation of textural image features in 2D and 3D images. This software's program code has been written in C++ and compiled for a graphical user interface of Windows operating system. MaZdawas originally developed in 1996 at the Institute of Electronics, Technical University of Lodz, Poland, by Michal Strzelecki and Piotr Szczypinski, for texture analysis of mammograms. MaZda is very powerful image analysis software; it able generates almost 300 texture parameters. With such a large number of features, it is very difficult to predict, which parameters will be most useful for texture

classification. To perform the nonlinear discriminant analysis, a fee forward artificial neural network (ANN) with two hidden layers of sigmoid-type neurons (Figure 2.1) is implemented.

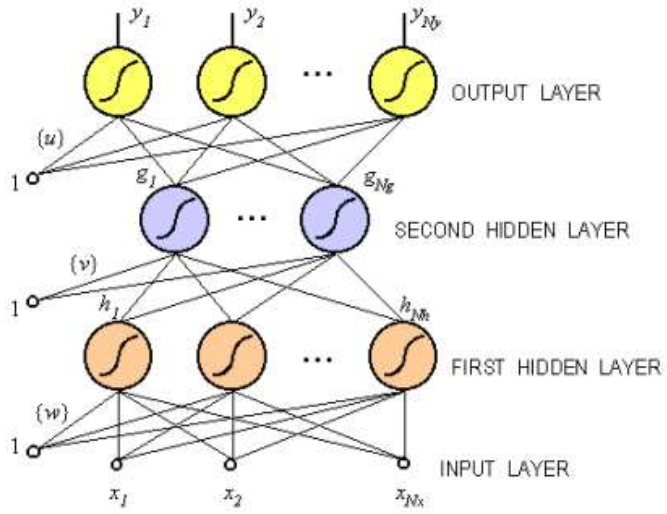

Figure 2.1: Artificial neural network architecture for nonlinear discriminant analysis.

Besides that, MaZda also is a useful tool for carrying out quantitative analysis of magnetic resonance image texture, feature reduction by converting input data into another space of lower dimension, allows for feature classification and visualization and etc. Although MaZda is a powerful image analysis software, but it still have some deficiency in the software, for example, MaZda only support some medical file format images, for example Dicom and Picker, but it doesn't support the general image file format, like jpeg and png. It mean that, we cannot use MaZda to analysis general texture image.

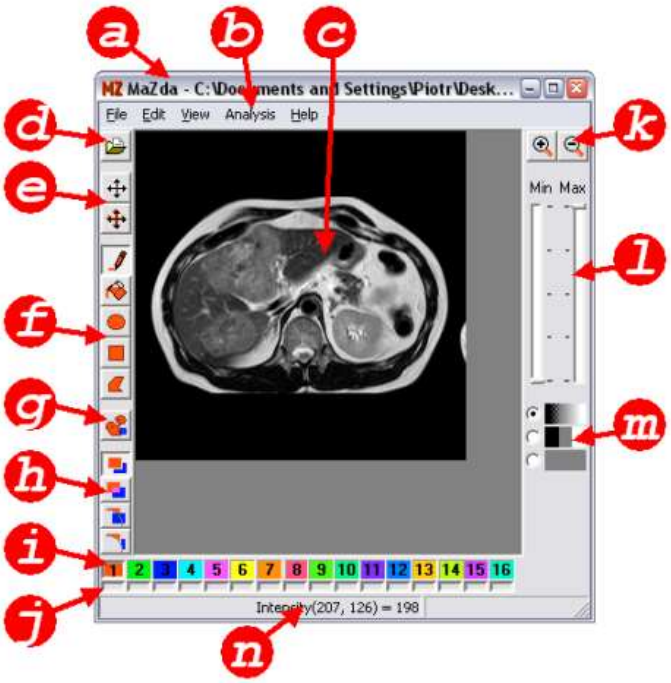

Figure 2.2: Elements of MaZda main window: a) window title bar, b) menu bar, c) image panel, d) load file button, e) copy and move buttons, f) graphics toolbar for ROI edition, g) morphological tools for ROI edition, h) drawing mode selection buttons, i) ROI color selector, j) ROI on/off switches, k) zoom in/out buttons, l) sliders for adjustment of grey-scale palette, m) image view mode selector, n) status bar.

As stated before, MaZda is purposely design for medical file format images, as we know, many of the medical types image are complex image. In order to recognize the complex image, the effective feature extraction of an image is needed. Therefore, in this thesis, the Brodatz Textures dataset is selected. All the textures in Brodatz dataset is complex, and it is the best sample set use for testing the recognition system.

2.3 BRODATZ TEXTURES

Brodatz texture database is widely used by researchers for texture-related research. The images in Brodatz database are photographs taken by Phil Brodatz, a professional photographer. In the beginning, the photographed textures were published in the book

‘Textures: A Photographic Album for Artists and Designers'. The book was published in 1966. Since then, the 112 textures have been used very widely in scientific texture recognition. The entire electronic Brodatz pictures can be obtained from the website. (Brodatz, P. 1966).

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss on flow process for the Texture recognition by using ANN system. In order to develop this system, the Agile Models System Development has been choosing as a methodology. The reason for choosing the agile development method as a methodology is because it is based on iterative and incremental development. In software development, the agile model does not build an entire system at once, but rather develops incrementally. Less time is invested upfront for documenting requirements when development is done incrementally. Figure 3.1 show the flow and phase of the agile development method.

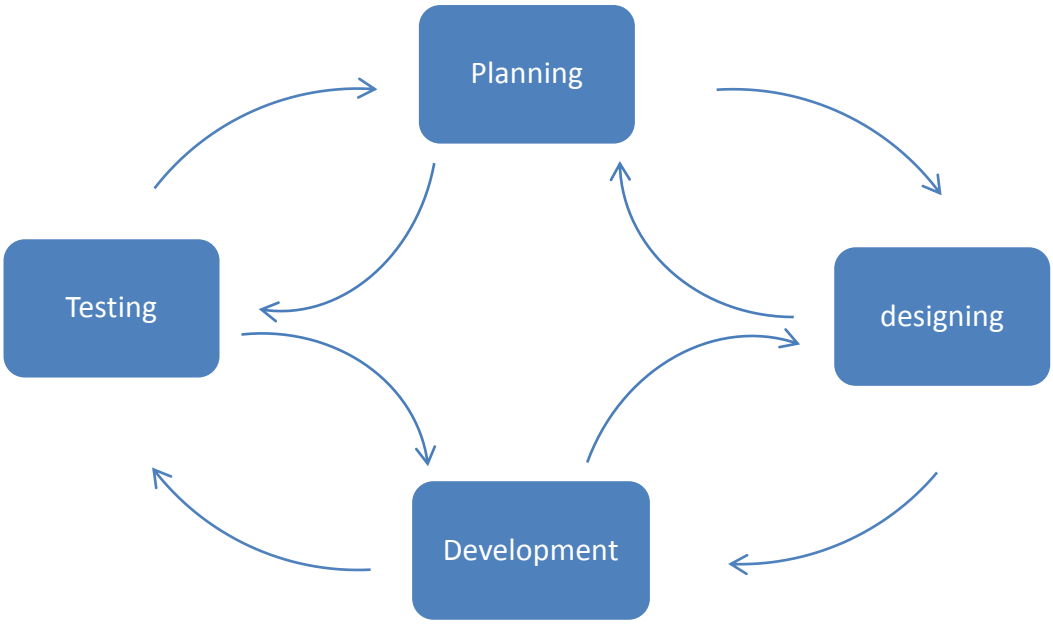

Figure 3.1 Agile Development Method

Each phases will be discuss in the next section for details. It is important to define all the phases because when the phases is proper arrange, there will be no unnecessary work to carry out. This will help to develop the system in the project scope.

3.2 METHODOLOGY

3.2.1 Planning Phase

The Planning phase is the first phase in developing the system. To avoid unnecessary work, planning phase is important, because it discusses the flow of the whole project process. After obtain the title of the system from lecture, in order to know about the details for the field of study, we must does some research first. Based on the research, an analysis process must be carrying out to determine the requirement, problem statements, objectives, and also the technique used for the system. Table 3.1 shows the technique that will be used in this system.

Technique	Description
ANN (Artificial Neural Network) • Back Propagation (section 2.5)	• Used to train and classify the dataset.

Table 3.1 Technique used in this system

3.2.2 Designing Phase

In designing phase, this system will be design based on the information and requirement gather from the previous phase. The main task in this phase is to design the application interface of the system. Figure 3.2 show the simple main interface of the system.

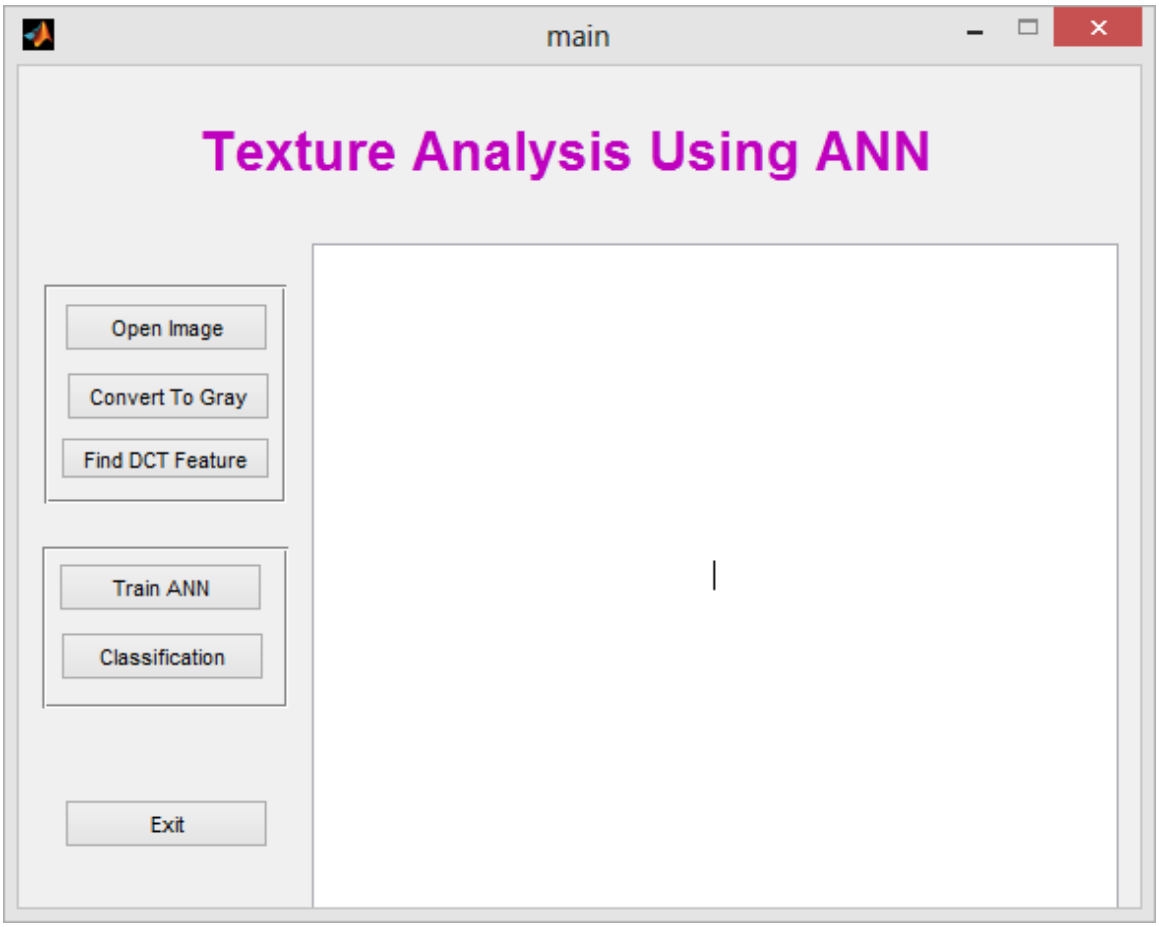

Figure 3.2 the proposed main interface of the system

3.2.3 Development Phase

Development phase is the most important phase of the overall and yet is the most time consuming phase. This process is about the converting a design into an executable system. In this phase, all the interfaces that create in the designing phase will combine and link with the coding. After the system is done, the Brodatz texture database must train first. All the trained dataset must be confirm correct, it is ensure that the recognition function for the future uses can minimize the error.

3.2.4 Testing Phase

After done the development phase, the system will start the testing phase. In this phase, once the error found, it will be fixing to ensure no error will occur again. This process will repeat until the developer and user satisfied with the changes.

3.3 SOFTWARE AND HARDWARE USED

The table 3.2 and 3.3 concludes hardware and software which will be used in the deployment of Texture Recognition Using ANN.

Software	**Justification**
Microsoft Word 2010	Project documentation
Microsoft PowerPoint 2010	Project presentation
Microsoft Project 2010	Project planning (Gantt Chart)
MATLAB-based GUI tools	System interface
MATLAB-based Neural Network Toolbox	Train and classify the dataset
MATLAB Compiler	Combining the system become stand-alone external application

Table 3.2 Requirements Software

Hardware	Justification
Notebook	Workspace and testing
USB data storage	Backup data
Printer	Document printing

Table 3.3: Requirements Hardware

CHAPTER 4

DESIGN AND IMPLEMENTATION

This chapter gives a detailed explanation of the design technique used for the implementation of this project. This chapter explains how I managed to devise a technique for the design and implementation of a texture recognition system in MATLAB and the work done in the design phase.

4.1 INTRODUCTION

The programming language used to design and implement the texture recognition system is MATLAB. The reason for using MATLAB in this project is due to its Neural Network and Image Processing toolbox that helped to obtain an efficient code.

4.2 DATASET GATHERING

The dataset use in the texture recognition system is brodatz textures. There are 13 type of textures in the dataset. The texture includes grass, bark, straw, herringbone weave, woolen cloth, pressed calf leather, beach sand, water, wood grain, raffia, pigskin, brick wall, and plastic bubbles. Figure 4.1 shows all the original texture type in the dataset.