An infrastructure service suggestion system for data communication network : Local area network

HAHV Halwatura[1#], RPS Kathriarachchi[2]

[1,2] *Department of IT, General Sir John Kotelawala Defence University Rathmalana , Sri Lanka*

[#]HAHV Halwatura <halwatura.vihanga@gmail.com>

Abstract— *Network Infrastructure development includes building of networks such as LANs, WANs, Intranets and Extranets. This is a responsibility of the Network Engineers or the network architects. They should have the knowledge as well as the skills to plan and design a data communication network, be conscious about the best place to have communication lines, be updated with the latest network equipment and be aware about the hardware and wiring needed for the buildings. These tasks are more complex for larger organizations which needs more accuracy, dedication and flexibility in their networks. Therefore the solution proposed in this paper to reduce these challenges of a network engineer is a Data Communication Network Infrastructure Recommendation System. This system will be able to get any floor plan and analyse it in order to provide recommendations on the installation of the main networking components such as selecting the server room and deployment of the backbone cable. It also allows the user to draft the plan with endpoints by the drag and drop function, keep a log fie of the saved data and also to send a System generated network layout of the plan to the customer. The software is being developed by making use of the Image processing technology with the help of the MATlab Software and C#. A series of algorithms will be used of achieve the objectives of the software. This software is non-identical to current software in the market.*

Keywords— **Network Infrastructure, Image Processing**

I. INTRODUCTION

Data communications is the transfer of computer information from one place to another by using electrical or optical transmission. Such systems are often called data communications networks. A variety of performance requirements and system constraints were considered in the design of the network. . Designing a network consists of tasks such as making decisions about the network type that best fits the needs of a particular organization. In larger sites this task is performed by a senior network architect: an experienced network engineer familiar with both network software and hardware.

According to a business perspective, the organizational commitment is an important characteristic when planning, implementing and controlling an effective network strategy. The organization must be committed to developing an infrastructure that facilitates communication of the business objectives to the network planning team. The organization must also develop internal standards, methods, and procedures to promote effective planning.

Often consultants and outside vendors are needed to help plan and implement the network. However, sometimes consultants are needed to help develop and specify the objectives and requirements. Although outside consultants offer benefits such as expertise and objectivity, they also present their own set of challenges. The design engineers work according to their own experience.(Tutschku et al., 1997)

These inefficiencies still remain and continue to exist when a network is being designed because once the requirements of the area is given, the network engineer has to use his knowledge to figure out the position of the cables and resources to be used. The ideal network design tool can mean different things to different people. But whether you're a network designer, network manager or engineer, sales or marketing manager, or member of the Research and Development staff, you probably want intuitive graphical interfaces that resemble computer-aided design tools. (Bragg, 2000) A Data Communication Network Infrastructure Recommendation Software is to be developed to eliminate the main inefficiencies of the Network engineer by giving them recommendation to perform the network design. The process of design involves the analysis of user requirements and their translation into a technical solution that is ultimately a compromise resulting from balancing technology against budget. (Linge and Parsons, 2006) It could decrease the complexity of the development of a network in a building or LAN area by giving recommendations to the network design. The importance of this project is not only to the Network engineer as mentioned above but also to the customer company who wants the network to be put up. This project can benefit both these parties, the system helps having a direct communication with the customer as well in forwarding the plan to them just by one click. The system can provide recommendations to set up the network so the engineer has another helping hand to confirm his/her decisions. Before he examine the place he can input the plan and check else he can double check the decisions he made against the system.

Rest of the paper is organized as follows. Section 2 provides a literature review on existing systems of image processing and automated architectural software's and

identify the research problem/gap and the possible technology to solve the problem. Section 3 is on the image processing technology used in this project. Section 4 presents the design and implementation and then Section 6 concludes the research findings.

II. LITERATURE REVIEW

There are many related research papers published related to the architectural plans. These research papers mainly focus on the wall detection of the architectural plans because it is a main component of a floor plan which can define the whole structure of the building. (Macé et al., 2010)Two different research papers which were focused on analysing the floor plans used the Hough Transform along with vectorization. These two methods were mainly used to detect the lines and room of the floor plan. How this algorithm was defines was according to a certain assumptions which were taken about the walls such as they are thick, they are double lines, longer hat the rest of the line and also rectangular. (de las Heras et al., 2013) According to the paper written by Sebastien Mace, there are there are some drawbacks in using the Hough Transformation such as it's complex nature especially when the images are large. Rooms can also be detected by using semantic analysis. Semantic analysis judges whether the syntax structure constructed in the source program derives any meaning or not. From this process the semantics can be separated in order to find the labels of the detected rooms so we could get the room functions through them. To detect the doors which are represented in an arc shape in the floor plan can be identified using a spotting technique to match the symbol of the door. The Function of the Optical Character Recognitions (OCR) is needed to identify the labels or text characters in the floor plan. OCR can also be programmed in such a way that it can split more than one label to identify the roles of a floor plan. (Ahmed et al., 2012) In order to increase the performance and gain accurate results an approach such as the removal of the components outside the outer walls are used so the functions can focus on analyzing the main components of the floor plan image. (Ahmed et al., 2011) Floor Plans could be analyzed and interpreted in terms of Geometry. According to the Architectural discipline, the building design stage can be categorized intro three main process which are the conceptual design process, design development, and construction design. Zimmermann, 2005) During the identification of the parts of a floor plan, identifying a curve can be very challenging. A preprocessing model based on dominant point detector which is associated with the maximum curvature point of an image could be used to segment the curve into straight lines or shorter curves. The dominant point detection process is based on the geometry theories. (Nguyen and Debled-Rennesson, 2011) During very early studies there were methods to segment the lines and arcs such as using the straight line segments as previously mentioned and then fitting those lines to ellipses. These two approaches are being performed with the help of a series of algorithms used to identify steeper curves. (Rosin and West, 1990) A paper has described an algorithm for detecting circular arcs in arbitrary space curves that result from edge detection in images. A fast algorithm for determining the minimum error match of a circular arc with the data is used. The computational burden is reduced over other curve fitting methods by the constraint that the curve must be bounded by two defined end points.

Although Geometry is an easier method, it might not be the most fast and accurate method. When compared with systems which uses further advancements, according to my opinion geometric is in the initial stages. Using an algorithm to identify the layout of the plan is the best. Two of the methods to input the image of the floor plan to be analyzed can be defined as an input and output method. In the input method, it can be done in real time while the architect is drawing the plan in a device such as a tablet by using structures already available in a drawing tool. If we use an output method, the image could be input as a hand-drawn plan, but if it is hand drawn, the drawing could be unclear and confusing. A digitized image produced by the output method requires high storage capacity, they are also slow in editing. So using an input method is much easier, reduces the time to process along with the storage space. It can also minimize complexities that could arise with the image type compatibility as the image drawn is already given as the needed image format but the architect must have the drawing skills and access to a required computing device such as a tablet which contains drawing tools. (Dosch et al., 2000) However, there are ways which could minimize the errors that could occur in digitized images and they are classified into three sections namely; First being the recognition of lines and shapes which falls under the geometric area, second is identifying the building elements which are walls, doors, etc and the last is about the spatial articulation which is concerned on the space and distribution the objects in the spaces.(Koutamaniss and Mitossi, 1992). Depending on the above analyzed facts, it is most suitable to use the output method as it is a flexible approach to an architect.

Although the above paragraph focuses on the digitized images, this doesn't mean that hand drawn images are not possible to interpret. There have been a number of previous studies on the interpretation of hand drawn floor plans. Hand drawn images tend to have more noise that the digitized images, these are categorized as pixel, vector and context noise. To address these noise in the images we can use Incremental Arc Segmentation Algorithm (Wenyin et al., 2001) Due to the possibility of unclear drawings being input, it is recommended to use various algorithms. During this process the image can be scanned and vectorized, during this process we can get a graph

structure with attributes which can later be used with a graph matching process to recognize the image. Many vector files containing only ASCII-format data can be modified with simple text editing tools. Individual elements may be added, removed, or changed without affecting other objects in the image. It is also easier to render and save the vector data. But still vector files cannot easily be used to store extremely complex images, such as some photographs, where colour information is paramount and may vary on a pixel-by-pixel basis.

Parts of the image such as the walls of the floor plan can be recognized by a filling algorithm. Where the darker, thick areas can be easily identified. This will be used along with a Hough Transformation this identifies the areas without a fixed pattern. (Lladós et al., 1997) These were relatively easier methods with respect to the traditional or manual methods but errors and challenges still remain. Even if these methods were used at some point a human intervention needed to recheck and cover the unidentified errors. (Ryall et al., 1993a) The Hough technique is particularly useful for computing a global description of a feature(s), given (possibly noisy) local measurements..

A sketch based system was proposed to query a floor plan repository along with pre-processing methods such as differentiation between thick, medium, and thin lines and the removal of components outside the convex hull of the outer walls. According to this hypothesis, a line of polygon is selected as wall edge if it is short and is either convex or concave. (Ahmed et al., 2014) Another system is proposed that offers recognition of scanned floor plans (sketched by hand without use of rulers or other tools), and automatic conversion of walls, stairs, doors and other architectural elements. A recognition algorithm was the main solution taken for this problem. Floor plans are read through a scanner while architectural elements are recognized and interpreted automatically, which allows large-scale reduction of input cost. (Shio and Aoki, 2000)

According to the successfully completed review of the network infrastructure designing problems, solutions and the technologies, the system which is proposed by this thesis will be developed using Matlab, C# and MySql to address the common problems such as the inefficiencies of the system. Table 1 shows the summarized results. This was decided based on the results of previous research studies.

Table 1 Literature review summary

Project	Technique	Software
Scan Plan Project	**Hough Transform Vectorization**	**-**
Unsupervised wall detector	**Hough Transform Vectorization**	**CAD**
Automated Flow plan Analysis	**Segmentation Structural Analysis Semantic Analysis**	**CAD OCR**
Flow plan drafting to building Simulation Software	**Geometric**	**CAD**
System for performance evaluation of arc segments	**Arc segment algorithm Segmentation**	
Data Communication Network Infrastructure Recommendation System	**Noise removal Edge detection Filling algorithm**	**MATLAB C#**

III. IMAGE PROCESSING TECHNOLOGY

Image processing involves changing the nature of an image in order to either improve its pictorial information or human interpretation or render it more suitable for autonomous machine perception. We shall be concerned with digital image processing, which involves using a computer to change the nature of a digital image. It is necessary to realize that these two aspects represent two separate but equally important aspects of image processing (McAndrew, 2001).

A. MATLAB Software

One of the most advanced and sophisticated tools that is used to analyse and edit images today is MATLAB, it is user friendly with graphical interfaces and anyone without prior knowledge about it can learn about it easily. By using various functions, an image can be edited and analysed by using MATLAB. When it comes to floor plan detection, we can use colour detection, noise removal, converting to grayscale, edge detection and area filling functions. (Buksh et al., 2014) A software was developed by using the main functions of the MATLAB. It was an image editing software where the user can insert the image and perform a series of functions accordingly. A previously proposed image editor contains a variety of image editing functions used by MATLAB with the intention of bring all of them under a single platform so any level of user will understand it. In a modelling system, a user friendly GUI is developed and two alternative methods for image acquisition are executed. Many experimental examples are used in evaluating the performance of the adopted edge detectors.

The proposed system that this research paper will focus on developing the image processing components by using MATLAB based on the features identified by the already existing software.

B. Secondary Software

Apart from the main language MATLAB which is used for the image processing function, two other technical software will be used to successfully complete the development of the proposed system. They are;

• C# -- for functions which does not include image processing functions.

• MySql – For the implementation of the database.

IV. METHODOLOGY

This section will show how the above technologies are utilized for this ongoing project. Matlab will be used to do all the image processing functions. The image in this scenario is the Floor plan of the building and it will be enhanced, restored and morphological image processing will be done to make the image useful to the network engineer. The Mysql database is used to store mainly the login information and log details of the software so they can let authorized engineers to the customer plans and view log of the saved plans to preserve there integrity. C# is used to view, retrieve and login to the software, basically it is used to operate all other processes that are not related to image processing. Figure 1 shows a diagram of the methodology

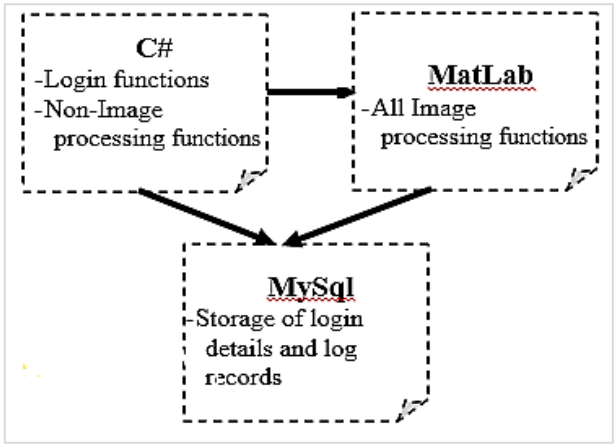

Figure 1 Methodology illustration

IV. DESIGN AND IMPLEMNTATION

A. *Description of the proposed system*

Data Communication Infrastructure Recommendation System is to be developed to minimize the difficulties of a Network engineer during the design of a network. Considering the problem, it is important to develop a system to facilitate the services needed by a Network engineer in designing a Network in a better manner and overcoming those identified problems in the current manual system. System would be a Data Communication Infrastructure Recommendation System. The system would be built with MAT lab and the main user of the system would be the Network engineer who is responsible for Network design but it can also be used for training of the network engineers. This system will be designed to cover some of the main functions such as the ability for the network engineer to import the plan, selecting the server room where the backbone cable will be auto drawn. An input form could be used input the bandwidth, topology, etc. Furthermore, when the engineer wants to know the number of routers or switches needed for a particular area, he/she will be able to input the number of endpoints in one floor so the system will generate the number of switches needed accordingly.

B. *Features of the proposed system*

Aim of the project is to develop a Data Communication Network Infrastructure Recommendation System to eliminate the above mentioned problems which can make the job of a Network engineer more efficient, fast and easier.

Network Engineer should be able to;

- Import the plan of the building.
- Input the bandwidth, topology, Number of endpoints etc.
- Manually select server room in the plan.
- Send a system generated network layout of a particular area to the customer via mail
- Drag and drop the end points
- Calculate cable distances
- View/Print a report

System should be able to;

- Auto-draw the backbone cable.

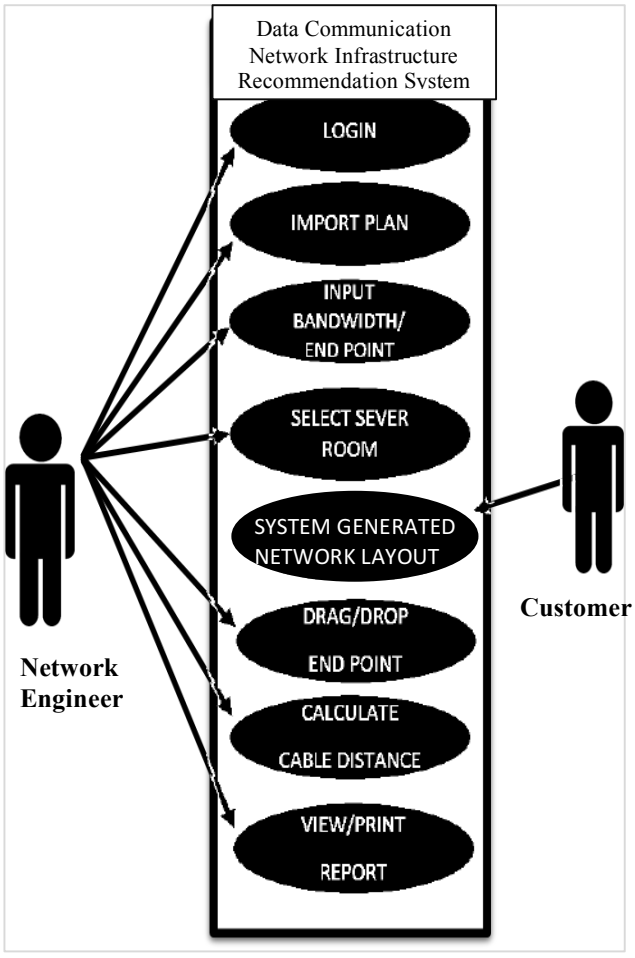

Figure 2 Usecase diagram of the proposed system

After the engineer enter the username and the password, they will be able to successfully access the features of the system. Next the main input being the floor plan of the building will be input by the Network engineers to perform the floor analysis. An input form will ask to fill the bandwidth and the number of end points. The backbone cable will also be auto-drawn according to an input request given by the main user. Via a mouse click command the user is able to select the server room from the floor plan. The outputs of the system is very simple. After the process is being done the engineer can print or view the finished work. If the user wants to clarify the diagram of the structure with a customer feedback, he/she can send a system generated network layout of the finished work with just one click.

According to the successfully completed review of the network infrastructure designing problems, solutions and the technologies, the system which is proposed by this thesis will be developed using Matlab, C# and MySql to address the common problems such as the inefficiencies of the system This was decided based on the results of previous research studies. Figure 2 shows the list of main functions to be performed by the proposed system and the actors or the users of the system along with their relationship with the actions.

C. *Presentation of the application Interfaces*

a) Welcome Screen and Login screen

The welcome page for the software which gives an attractiveness works along with Login screen which will be loaded after the progress bar is loaded. Figure 3 shows the developed welcome screen. Figure 4 shows the login screen.

Figure 3 Welcome Screen

b) Image processing form

This form will contain the import button and other buttons related to the process of the plan of the building. This acts as the main interface of the system.

Figure 5 shows the image processing form with a plan already loaded. The original image of the plan before being

Figure 4 Login screen

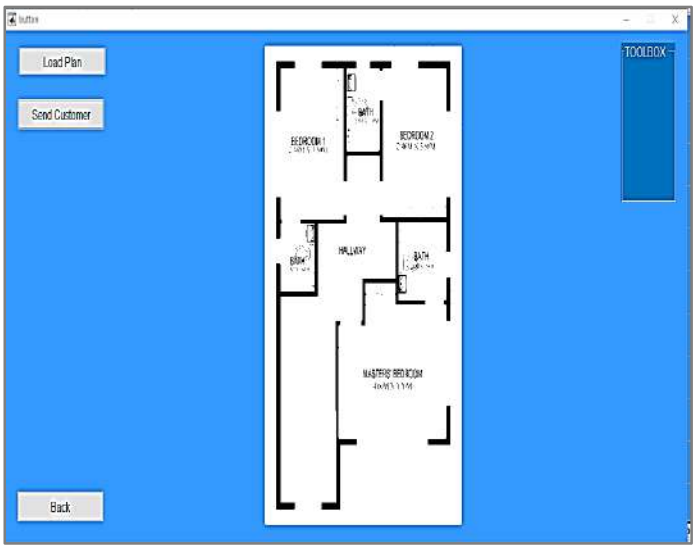

Figure 5 Image Processing screen

loaded is processed into a grayscale image then removed noise by using sail and pepper technique and then the image is turned into binary so that it is easier to identify the walls from the black colour and the room from the w white colour.

c) Log form

This form captures all details about saved data which contains the time, date, who changed it as well as what was changed.

d) Input details form

This is a form which will take the inputs of no. of end points, bandwidth, topology, etc for further processing of the image.

e) Send system generated network layout form

Once the network engineer press screen shott button this form will appear where he/she will have to enter the

customer name so he email will be taken directly from the database.

V. CONCLUSION

This paper presents a research to address the main inefficiencies of a Network Engineer when planning, designing and implementing a network infrastructure for an organization because depending on the complexity of the organization structure, a design can be more advanced. This paper proposed a Data communication network infrastructure recommendation system to give best possible options a network engineer could consider the design. The system is being developed by using MATlab, MySql and C#. The design and implementation is also presented in this paper.

REFERENCES

Ahmed, S., Liwicki, M., Weber, M., Dengel, A., 2012. Automatic Room Detection and Room Labeling from Architectural Floor Plans. IEEE, pp. 339–343. doi:10.1109/DAS.2012.22

Ahmed, S., Liwicki, M., Weber, M., Dengel, A., 2011. Improved Automatic Analysis of Architectural Floor Plans. IEEE, pp. 864–869. doi:10.1109/ICDAR.2011.177

Ahmed, S., Weber, M., Liwicki, M., Langenhan, C., Dengel, A., Petzold, F., 2014. Automatic analysis and sketch-based retrieval of architectural floor plans. Pattern Recognit. Lett. 35, 91–100. doi:10.1016/j.patrec.2013.04.005

Bragg, A.W., 2000. Which network design tool is right for you? IT Prof. 2, 23–32.

Buksh, R., Routh, S., Mitra, P., Banik, S., Mallik, A., Gupta, S.D., 2014. MATLAB based image editing and color detection. Int. J. Sci. Res. Publ. 4, 1–6.

de las Heras, L.-P., Fernández, D., Valveny, E., Lladós, J., Sánchez, G., 2013. Unsupervised wall detector in architectural floor plans, in: Document Analysis and Recognition (ICDAR), 2013 12th International Conference on. IEEE, pp. 1245–1249.

Dosch, P., Tombre, K., Ah-soon, C., Masini, G., 2000. A complete system for the analysis of architectural drawings. Int. J. Doc. Anal. Recognit. Manuscr. 3, 102–116.

Koutamaniss, A., Mitossi, V., 1992. Automated recognition of architectural drawings. Presented at the International Conference on Pattern Recognition, pp. 660–663.

Kumari, P., Gupta, S.K., 2015. Image Enhancement GUI using MATLAB. Int. J. Innov. Res. Comput. Commun. Eng. 3.

Linge, N., Parsons, D., 2006. Problem-Based Learning as an Effective Tool for Teaching Computer Network Design. IEEE Trans. Educ. 49, 5–10. doi:10.1109/TE.2005.852600

Lladós, J., López-Krahe, J., Martí, E., 1997. A system to understand hand-drawn floor plans using subgraph isomorphism and Hough transform. Mach. Vis. Appl. 10, 150–158.

Macé, S., Locteau, H., Valveny, E., Tabbone, S., 2010. A system to detect rooms in architectural floor plan images, in: Proceedings of the 9th IAPR International Workshop on Document Analysis Systems. ACM, pp. 167–174.

M. Kudˇelka Jr., 2012. Image Quality Assessment, in: Šafránková, J. (Ed.), . Matfyzpress, Praha.

McAndrew, A., 2001. An-Introduction-to-Digital-Image-Processing-with-Matlab-Notes-for-SCM2511-Image-Processing.pdf.

Nguyen, T.P., Debled-Rennesson, I., 2011. Decomposition of a curve into arcs and line segments based on dominant point detection, in: Scandinavian Conference on Image Analysis. Springer, pp. 794–805.

Rajesh Parihar, V., 2015. IMAGE MODIFICATION DEVELOPMENT AND IMPLEMENTATION: A SOFTWARE MODELING USING MATLAB. Int. J. Comput. Sci. Mob. Comput. 4, pg.72 – 79.

Rosin, P.L., West, G.A.W., 1990. Segmenting Curves into Elliptic Arcs and Straight Lines. Presented at the IEEE, pp. 75–78.

Ryall, K., Marks, J., Mazer, M., Shieber, S.M., 1993a. Semi-Automatic Delineation of Regions in Floor Plans.

Ryall, K., Marks, J., Mazer, M., Shieber, S.M., 1993b. Annotating floor plans using deformable polygons.

Shio, A., Aoki, Y., 2000. Sketch plan: a prototype system for interpreting hand-sketched floor plans. Syst. Comput. Jpn. 31, 10–18.

Shrivakshan, G.T., Chandrasekar, C., others, 2012. A comparison of various edge detection techniques used in image processing. IJCSI Int. J. Comput. Sci. Issues 9, 272–276.

Solomon, C., Breckon, T., 2011. Fundamentals of digital image processing: a practical approach with examples in Matlab. Wiley-Blackwell, Chichester, West Sussex ; Hoboken, NJ.

Tutschku, K., Leibnitz, K., Tran-Gia, P., 1997. ICEPT-An integrated cellular network planning tool, in: Vehicular Technology Conference, 1997, IEEE 47th. IEEE, pp. 765–769.

Wang, Z., Sheikh, H.R., Bovik, A.C., 2004. NO-REFERENCE PERCEPTUAL QUALITY ASSESSMENT OF JPEG COMPRESSED IMAGES.

Wenyin, L., Zhai, J., Dori, D., Long, T., 2001. A system for performance evaluation of arc segmentation algorithms, in: Proc. CVPR Workshop Empirical Evaluation in Computer Vision.

Zimmermann, G., 2005. FROM FLOOR PLAN DRAFTING TO BUILDING SIMULATION-AN EFFICIENT SOFTWARE SUPPORTED PROCESS, in: International IBPSA Conference Building Simulation. pp. 1441–1448.

ACKNOWLEDGMENT

I would like to express my gratitude to my supervisor Mr. RPS Kathriarachchi for the knowledge, support and words of encouragement he has given me at all times during this project.