CHAPTER I

INTRODUCTION

1.0 Introduction

With the inundation of smart phones in today's world, the demand for Internet has skyrocketed. Almost everyone is consuming bandwidth incessantly, where individuals from assorted demographic background are fixated on socializing in the virtual world. In short, being constantly connected to the net is now part of the culture. The daily streaming of Youtube (Zink et al., 2009) and countless interaction with the social media such as Facebook (Bohn et al., 2014), Twitter (Chen, 2011), and Instagram (Thoumrungroje, 2014) puts further strain to this demand. Thus, it is not uncommon for service providers to struggle in supporting these undiminished needs. Worldwide Interoperability for Microwave Access (WiMAX) is an effective wireless technology that provides a fast and reliable Internet access to the public. It fulfills the requirement posed by mobile users by maintaining a high quality of service that handles most of the Internet demands in the most efficient manner. However, there is a limit to what it can offer. With the current usage of the Internet, even the high bandwidth supported by WiMAX would no longer be sufficient. To alleviate the impending quagmire of untenable network congestion, better planning and design is paramount. It is critical to optimize the resources available to maximize the quality of service while reducing the burden of cost (Sedoyeka & Hunaiti, 2011). In doing so, WiMAX network traffic forecasting is essential. This way, the performance of the network can be analyzed and reformed before it is too late.

1.1 Research Background

Network traffic prediction represents a simple function throughout characterizing the network performance which is of significant interest in various network applications, for example admission control or network management. Globally for a radio network and WiMAX network, predicting the future traffic level is usually mandatory in order to keep a reasonable quality connecting with services. Models that properly capture the characteristics of actual traffic are helpful for research and simulation, assisting in the understanding of network dynamics to be designed, as well as management and control of network (Daw et al., 2014) The key concept of traffic forecasting is to specifically predict traffic in the future, considering the tested and measured traffic history. The options from the prediction technique will be based upon the actual prediction phase and prediction malfunction along with computational cost. Through network traffic forecasting (Kim et al., 2011), the behavior of the network in various circumstances can be better understood.

For instance, it is possible to determine when a particular part of the network would encounter heavy traffic and bottleneck from the users. This allows a more rigorous design of contingencies to handle the situation at hand. Perhaps, to plan alternative routing strategies to evade a paralyzing congestion, which in turn enables the quality of service to be maintained without disruption, thus, maintaining the efficiency of the network.

Forecasting is normally done by analyzing the statistical properties of time series (Tsui et al., 2014; Wang et al., 2012). Patterns that occur repeatedly are taken as the frame of reference for future events. To illustrate, if a network persistently faces an influx of traffic after 10:00 PM, then it is reasonable to assume that around the same time in the future, the pattern would relive itself. This is the basis of statistical or stochastic forecasting.

Being rather effective at extracting repetitive trends that occur periodically, the statistical approach such as Autoregressive Integrated Moving Average (ARIMA) (Hasan, 2014) falls short when it comes to predicting sporadic events that transpires again and again at varied time. For instance, suppose that there exists a traffic pattern which builds itself every prime sequence days (2, 3, 5, and 7) only to collapse after the fourth one. It would be quite difficult for ARIMA to detect this form of pattern without being erroneous. This comes from the fact that the interval changes continuously.

The k-nearest neighbor simply imitates the humanistic process of reasoning. If a person decides by looking at the similar features between the new picture and the examples, so would the approach of intelligent platform. It compares the new instance with the set of examples and chooses the one with the highest likeliness of similarity. Now, although the actual algorithm is far more complex, the same principle is applied for the purpose of WiMAX network traffic forecasting where the forecast is derived by how close it is to an example learned before.

Contrary to learning from example, the artificial neural network develops reasoning by learning from mistakes (Audhkhasi, Osoba & Kosko, 2013). It performs a task and records the displacement between the result and the right answer. If the result is non satisfactory, it changes the way the task is done. Iteratively, this is attempted again and again until the result is approximately close to the right one. Again, it simulates the manner of which humans learn to execute a certain behavior through trial and error (Callander, 2011). This is the basis of the forecast. The method learns to predict traffic by doing it repeatedly until error is minimized.

1.2 Research Statement

Currently, the potential of artificial intelligence in WiMAX network traffic forecasting is unclear. Although it is capable of improving the accuracy of traffic prediction when compared to a statistical one (Yadav & Balakrishnan, 2014), the degree of enhancement is somewhat marginal. As such, it does not justify the extremely high computational cost that comes with implementation of intelligent approaches. In other words, the choice of using artificial intelligence in WiMAX network forecasting at the present juncture is not adequately cost effective to the extent of being reasonably compelling. Observe the comparison below (Table 1.0) between ARIMA (Statistical Approach) and ANFIS (Intelligent Approach). The performance is measured based on the amount of error (RMSE) incurred of which lower values are preferable over higher ones. It is quite apparent that ANFIS is superior from ARIMA in all the three cases but the difference is not entirely convincing.

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Table 1: ARIMA (Statistical Approach) vs ANFIS (Intelligent Approach)

((Yadav & Balakrishnan, 2014))

	Number of Parameters	RMSE
Case 1 (500 samples)		
ARIMA	2	0.085
ANFIS	104	0.080
Case 2 (1000 samples)		
ARIMA	2	0.089
ANFIS	496	0.087
Case 3 (1500 samples)		
ARIMA	7	0.083
ANFIS	1064	0.081

1.3 Research Questions

The research objectives define the goals of the study that can solve the mentioned problem. Having a clear set of objectives in mind, it is beneficial to itemize them into a series of exact questions. These questions will steer the direction of the study throughout the duration of the research and provide a much greater focus to the coordination of resources. Only activities that contribute to the resolution of the inquiry will be entertained while others ignored. To impart a definitive assertion, the research questions are:

1. What is the current prediction WiMAX traffic forecasting based on ANN, KNN and FTS?
2. How to develop an enhancement model for ANN, KNN and FTS traffic forecasting?
3. How to evaluate and compare the model based on ANN, KNN and FTS?

1.4 Research Objectives

Given the uncertainty of utilizing artificial intelligence in WiMAX network traffic forecasting, it is imperative to conduct a worthy study in uncovering its actual potential. Generally, three intelligent forecasting approaches will be proposed. They are selected based on their proven contribution in other areas such as economics (Sun et al., 2015), engineering (Fan et al., 2012), and medicine (Jovanovic, Salkic & Zerem,etc al, 2014) which increases the possibility of success. Now, although a particular approach is effective in a certain field, there is no guarantee that it would be successful for the purpose of WiMAX network. As such, the research will incorporate novelty in making the approaches effective for the problem at hand. Specifically, the research objectives are:

1. To predict WiMAX traffic forecasting based on ANN, KNN and FTS.
2. To develop an enhancement model for ANN, KNN and FTS traffic forecasting.
3. To evaluate and compare the model based on ANN, KNN and FTS.

1.5 Scope and Limitation of the Research

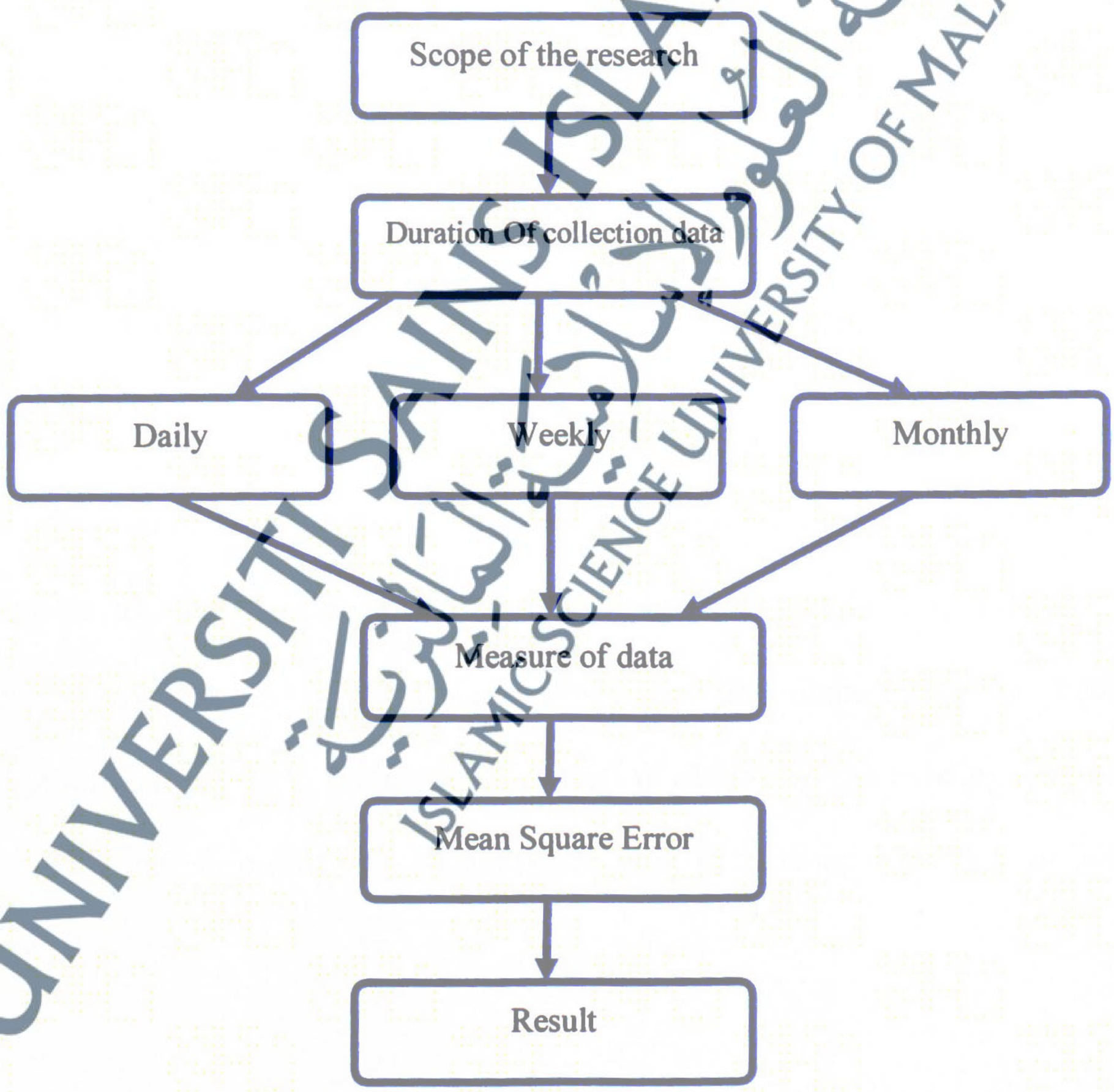
The scope of the research (Figure 1) is confined to two factors. It is known that forecasting can span from the daily to the quarterly as well as yearly duration. This impacts the overall intricacy and workload of the research. To ensure that the research is feasible within the stipulated time constraint, only three types of temporal entity will be emphasized upon. These data are available from Libya Telecom and Technology over a period of 180 days. The duration that is covered by the study is on the daily, weekly, and monthly basis.

In effect, the quarterly and yearly traffic are beyond the scope of this research. The second factor is the unified measure of performance. Many measures are available for

evaluating prediction such as root mean square error, mean square error, etc. Furthermore, different approaches may highlight a variety of performance measure such as regression, speed, etc.

For the purpose of this research however, only the mean square error (MSE) measure has been used and included across all approaches. Therefore, other measures of performance such as the speed of computation are not included within the scope. Finally the limitation the dataset has a life span usage which is limited in period of time.

Figure 1: Scope of Research



1.6 Significance of the Research

Artificial intelligence (AI) is a form of technology that emulates the human mind in solving problems. It is exploited across many fields such as engineering, medicine, agriculture, and social science. Being able to imitate thinking makes its potential almost limitless in the future. However, the utility of artificial intelligence pertaining to WiMAX network traffic forecasting is still vague. Thus, the study is critical in establishing the importance of the technology in traffic prediction (Ahmadzadeh et al., 2012) within the domain of WiMAX network.

Gaining confidence on the promising ability of artificial intelligence is merely the first step of the venture. The next step is to determine the precise method within the technology that can enhance the process of forecasting. A multitude of approaches is presently available, ranging from the modeling of the human brain to the complexity of genetics (Hong et al., 2013).

Nevertheless, it is also important to be realistic in such research. Each particular innovation does come with a setback. For example, in the case of artificial intelligence (Hernández et al., 2014), the accuracy offered by the technique is fettered by its consumption in resources. It takes more processing as compared to the traditional statistical approach. As such, the research is vital in clarifying the existing limitation of artificial intelligence in performing WiMAX network forecasting such that an informed decision can take place.

1.7 Contributions of the Research

The contributions for this research are:

1. Development a new model for WiMAX traffic forecasting using ANN and KNN models.
2. An improvement forecasting predictions models.
3. Comparison all methods, ANN, KNN and FTS.

1.8 Organization of the Thesis

The thesis is organized into a total of six chapters, First chapter poses the introduction of the research. Literature review is the second chapter which covers the literature on WiMAX, network traffic, statistical forecasting, and intelligent forecasting. The research methodology makes up chapter Three which explains the process of data collection and the mechanism of intelligent forecasting in terms of the processes. Chapter Four present the models designs this chapter states the description AI models of the research. Chapter Five is results and discussions which analyze the performance results for all the intelligent forecasting approaches from the perspective of daily, weekly, and monthly traffic, and also discusses the comparison of the approaches and the rationale of certain phenomenon. The final chapter is the conclusion and future work, which presents the conclusion and prospective work to be done in the near future with respect to the current advancement in research followed by the bibliography.