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Software Model of an Adaptive Wireless Message Filtering System using Feed-Forward Neural Networks with a Modified Hyperbolic Tangent Activation

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ABSTRACT

This paper presents a software model of a wireless message system with an adaptive message filter implemented in the MATLAB/SIMULINK Language. The system is implemented using the UDP/TCP protocol and allows the simulation of the control dynamics of message transfer and prevention of valid messages and invalid or spam messages respectively. Spam filtering is done by an adaptive filter implemented as a trained feed-forward neural network controller in MATLAB/SIMULINK for message parsing and detection. Comparisons have been performed on the effect of modifying the standard hyperbolic tangent activation function used in the feed-forward neural network. Results show that better message filtering control can be achieved by using a modified version of the hyperbolic tangent activation.

Keywords – Adaptive filtering, Activation Function, Neural Network, Spam message

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1. INTRODUCTION

Adaptive Message filtering, describes the ability of a messaging system to adapt to changing filter requirements. Adaptive message filtering is useful for minimizing the influence of spam on the network and for maintaining stable states in message transfer. Routing time rate defines how fast the system will intelligently change course in the event of deadlock. Several intelligent approaches have been proposed for the design of intelligent messaging systems such as in (Noonan, 2013), using the JADE framework, intelligent techniques based on confidence levels (Tiernan et al, 2000) and the use of Multi-Agents (Meech et al, 2000). Currently, the rise in message volume and the accompanying task of automating these messages in a way and manner as to avoid spamming or introducing invalid or undesirable messages has become a core issue both for small, medium and large corporations/organizations. This makes it mandatory that intelligent messaging systems are system-capable to handle these prevailing challenges.

1.1 Statement of Problem

Most existing message systems are useful in the sense that they try to solve practical problems in the user-domain. However, in the design and development domain it becomes a challenge to develop more effective models that can facilitate message system planning and development and capture possible message system use-case scenario prior to deployment. Thus, it becomes necessary that such tools be developed in this regard that can facilitate research in this direction.

1.2 Objective

The objective of this research paper is to present a systems model of an adaptive intelligent messaging system in the MATLAB/SIMULINK Language. It is also the objective of this research work to report on the performances of a feed-forward neural network (with a modified activation) which is used as an adaptive filter in the messaging system.

2. RELATED WORKS

Noonan (2013) and Ganchev et al (2012) proposed Infostation which is an Ontology-based intelligent messaging system (IMeS) using a centralized architecture largely based on the JADE (Java Agent Development Environment) framework. iTrust Over SMS/HTTP. In (Lombera et al, 2012; Lombera, 2012; & Chuang, 2012) iTrust Over SMS/HTTP was developed. This form of messaging system uses a decentralized message parsing that supports search and retrieval among node peers (called the membership set) in the network. Similar to the iTrust over SMS-HTTP an attempt at decentralized messaging among the membership set was developed using the IEEE 802.11 WLAN protocol with a relative reduction in cost of network messaging (Lombera et al, 2013).

Dia et al (2013) proposed a theoretical framework called iTrust Reputation System using a statistical detection algorithm for checkmating malicious behaviour among potential node peers. Isaksson and Fiedler (2007) described a Multi-Criteria Decision Making (MCDM) defined by an Analytic Hierarchy Process (AHP) for streaming and messaging services. Specifically, this approach employed the fuzzy-sets thresh-holding criteria for multi-point scaling to describe a ranking function for evaluating which communication medium is more connection-appropriate i.e. "Always Best Connected". Thus, depending on the ranking for a messaging service, WLAN, UMTS, or GPRS may be selected as transmission backbone.

Goweder et al (2008) developed an intelligent messaging system artificial neural network (ANN) and GA with elitism for spam detection. Four benchmark datasets were evaluated to verify the effectiveness of their hybrid system. They discovered better results when the input features were increased confirming the big-data-better-learning theory. All these researches focused on implementation and less (if any) on the modelling aspect which this research is all about.

3. METHODOLOGY

3.1 Proposed System

The proposed system architectural model design is shown in Fig. 1. It is further developed into a MATLAB/SIMULINK systems model called iMess (see Appendix). The system includes the following key blocks:

- Message Block Unit
- The Client User Blocks
- Wi-Fi model with UDP transmission logic
- Intelligent training block (NN block)
- Display Unit blocks

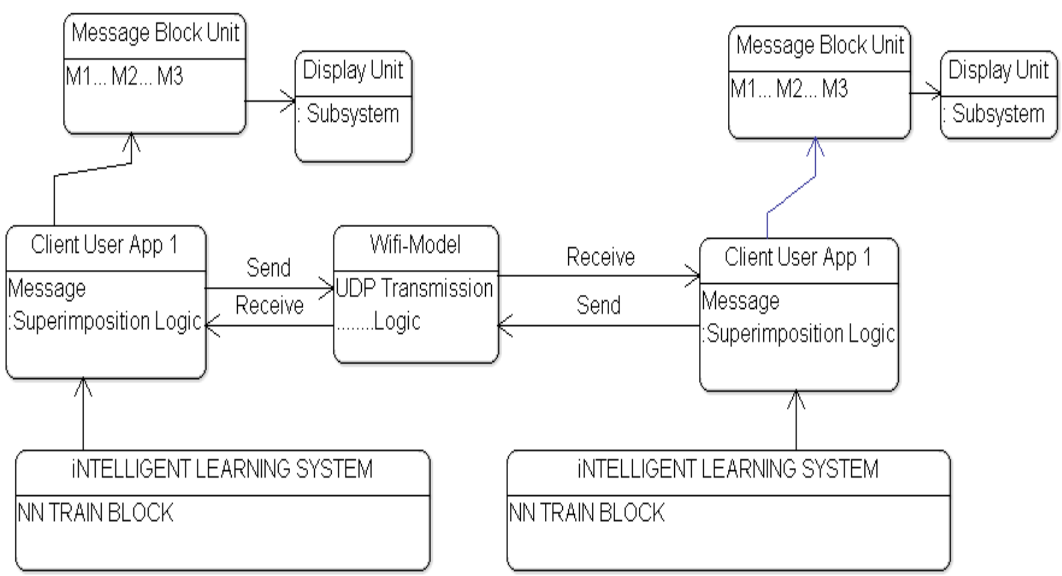

Fig.1. Proposed Systems Design Architecture

3.2 Description of block modules

The section describes the blocks used for the analysis and results generation.

The Message Block Unit

These blocks allows the peers or clients (users of the iMess Model) to enter message requests/or replies. It is actually modeled in MATLAB/SIMULINK using a constant block with a call-back function script for interactive data entry. The inputs are mixed by superimposition using a pad block before being fed to the Wi-Fi/UDP transmission layer.

The Client User Message Block
This block handles message send requirements through a call-back function script. Once a peer double-clicks this block, a message request or reply is sent through the Wi-Fi/UDP send block by running the systems model. The Peer Message Blocks must be activated before using this block.

The Wi-Fi/UDP SEND/RECEIVE Blocks
These blocks allows the transport of messages within the LAN system using UDP and operates in the non-blocking mode for seamless transmission of data in near real-time.

The INTELLIGENT TRAINING (NN) Block
This block performs intelligent learning of the communication data after a maximum specified data accumulation value DAV). The idea of NN block is to start learning when a DAV threshold is met then, stop training and begin prediction for the next number of input pair (receive/send) data sessions. It answers the question when to start training and when to stop training? It also serves the very important purpose of adaptive filtering to remove/prevent unwanted or undesired messages terminating at receiver end.

The DISPLAY Unit Block
These blocks captures read messages dynamically using an initialized apriori variable (IAV) stored as local workspace variables

4. RESULTS AND DISCUSSIONS

4.1 Experimental Details
Results of tests have been analyzed for message lengths using the specified adaptive network and data parameters (see Appendix) and performing several runs until reasonable error limits are met. For the neural network, the technique proposed in (Anireh and Osegi, 2017) is used to speed-up the learning phase. The dataset used in this research study is based on the work by Finkelstein et al (2002) and is provided in the Appendix. The basic structure of the dataset for the proposed system is shown in Table1.

Table1: Dataset Structure

S/NO	NAME OF ATTRIBUTE	DATA TYPE	DESCRIPTION
1.	Word 1	String	First word for similarity matching
2.	Word 2	String	Second word for similarity matching
3.	Human Score	Real	Describes the score or rating of similarity

4.2 Results using 4-bits and 6-bits data
Simulation graphs of neural network performance in MATLAB/SIMULINK are as shown in Figures 2 and 3 for the 4-bits and 6-bits case. The results show the training, validation and test response of the evolved neural network model. From Figures 2 and 3 it can be seen that the performance (MSE) is very good and that of 6-bits better than 4-bits (compare Fig2 and 3). However, for the 6-bits case (see Figure 3) more training iterations (epochs) are needed in other to attain appreciable error rates. Further investigations should be able to identify a possible explanation for this situation but is beyond the scope of this research paper.

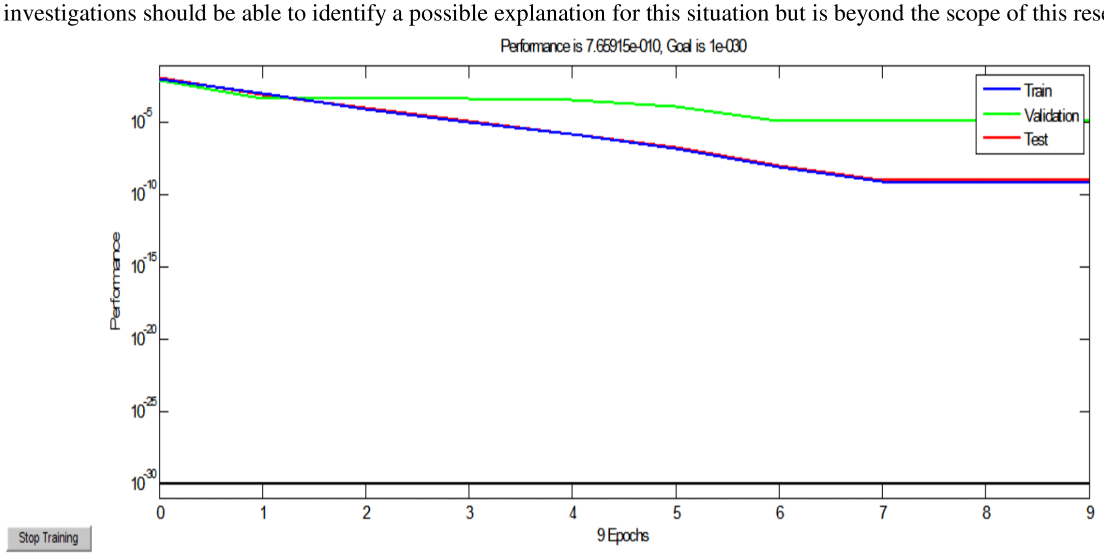

Fig.2. Neural Network Performance in Matlab/Simulink for data length <= 4 bits

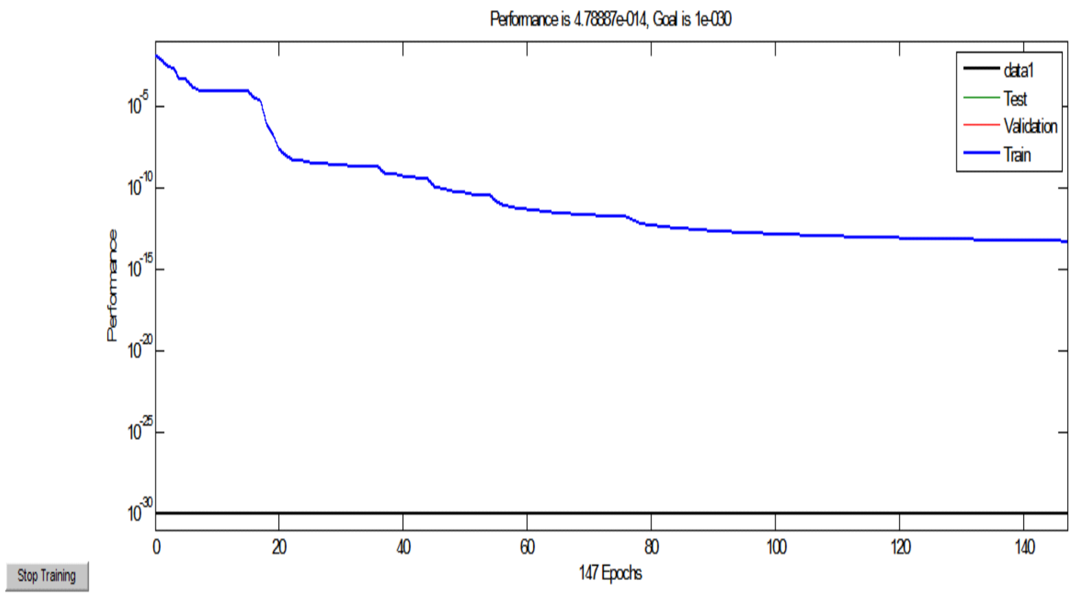

Fig.3. Neural Network Performance in MATLAB/SIMULINK for data of length >=6 bits

4.3 Comparative Evaluations

For the purposes of adaptive filter validation and the effectiveness of the proposed approach, the standard feed-forward neural network is compared to a modified one on the basis of their activation function. By modifying or tuning the parameters of the exponential function used in the Hyperbolic Tangent activation function, it has been shown that speed-ups in neural processing times is achievable. However, feed-forward networks still suffer from the problem of early convergence and repeated trial runs are necessary to obtain desired results (see Fig. 4 and 5). In addition, it was discovered through these repeated experiments that in most cases, the network with modified activation attains this state of desired performance much earlier than that of standard neural networks (see Tables 2 and 3). In particular, prediction performance is also much better for the modified case. The important point to note here is that it takes a longer number of trial runs to obtain a reasonable set of desired predictions for a feed-forward neural network using the standard activation function than that using a modified (Hyperbolic-Tangent) activation.

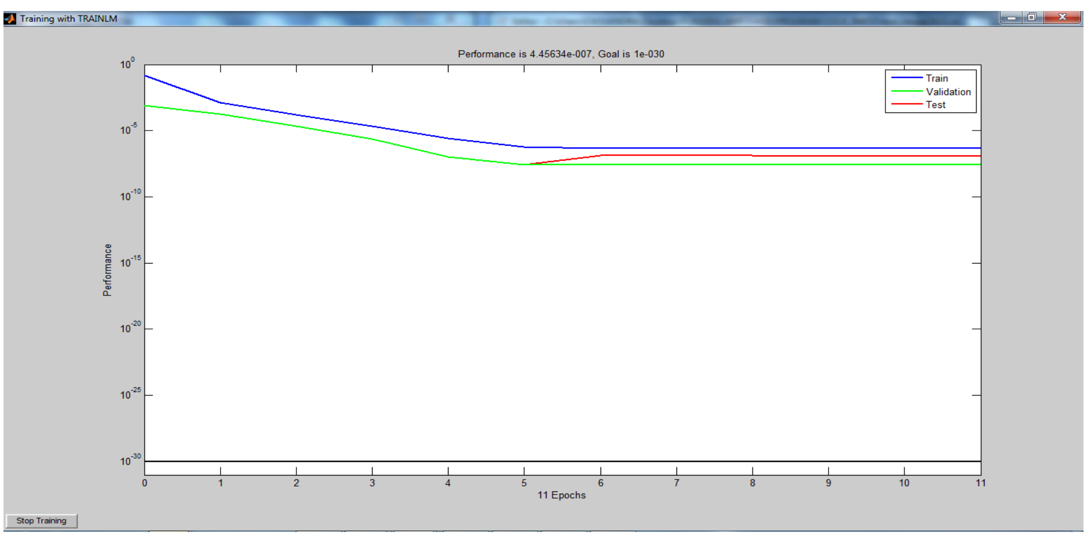

Fig.4 Performances using a modified (Hyperbolic Tangent) activation function

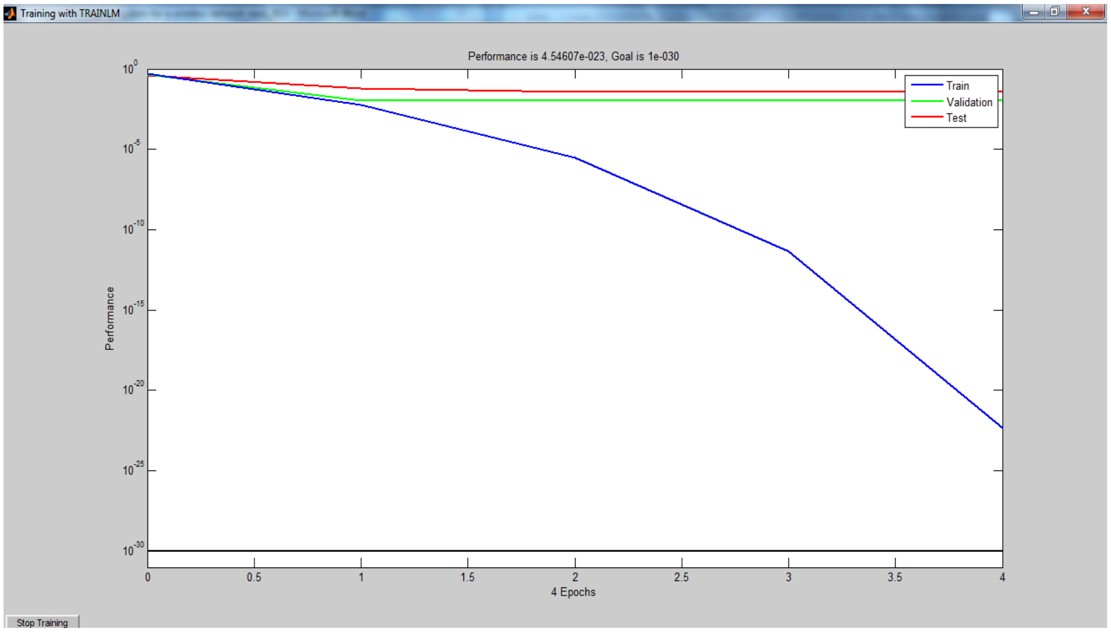

Fig.5 Performance using standard hyperbolic tangent activation function

Table 2: Prediction rating versus actual rating for modified hyperbolic tangent activation

s/n	Actual Rating	Predicted Rating
1	1	1.0020
2	1	0.9984
3	0	0.0004
4	1	1.0000
5	1	1.0000
6	0	-0.0002

Table3: Prediction rating versus actual rating for standard hyperbolic tangent activation

s/n	Actual Rating	Predicted Rating
1	1	1.0001
2	1	1.0002
3	0	-0.2102
4	1	0.5010
5	1	1.0232
6	0	-0.2599

5. CONCLUSION

A model of an intelligent messaging system has been developed using an adaptive filter algorithm based on back propagation feed-forward neural network algorithm. The system was applied to a word similarity dataset to facilitate message request and knowledge understanding as it pertain message filtering. Optimal performance is achieved by training with a bigger data bits and faster processing is achieved using an improved neural algorithm with a modified hyperbolic tangent activation function.

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APPENDIX

APPENDIX A (TRAINING DATA)

TABLE A.1 4-bit (4-bit maximum) data training sequences. For simulation purposes, vulgar word messages (vulgar or insolent words are not allowed) are given a low (0) rating otherwise a worded interpretation is given

s/n	Word	Rating
1	sex	love
2	car	move
3	fuck	0
4	food	eat
5	boy	lad
6	bird	cock
7	fool	0
8	idiot	0
9	bank	cash
10	419	0

TABLE A.2 6-bit (6-bit maximum) data training sequences. For simulation purposes, vulgar word messages (vulgar words are not allowed) are given a low (0) rating otherwise a worded interpretation is given

s/n	Word	Rating or Interpretation
1	money	wealth
2	tiger	animal
3	moon	planet
4	fucker	0
5	slich	0
6	queen	royal
7	cuntee	0
8	plane	travel
9	stock	company
10	dollar	money

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APPENDIX B

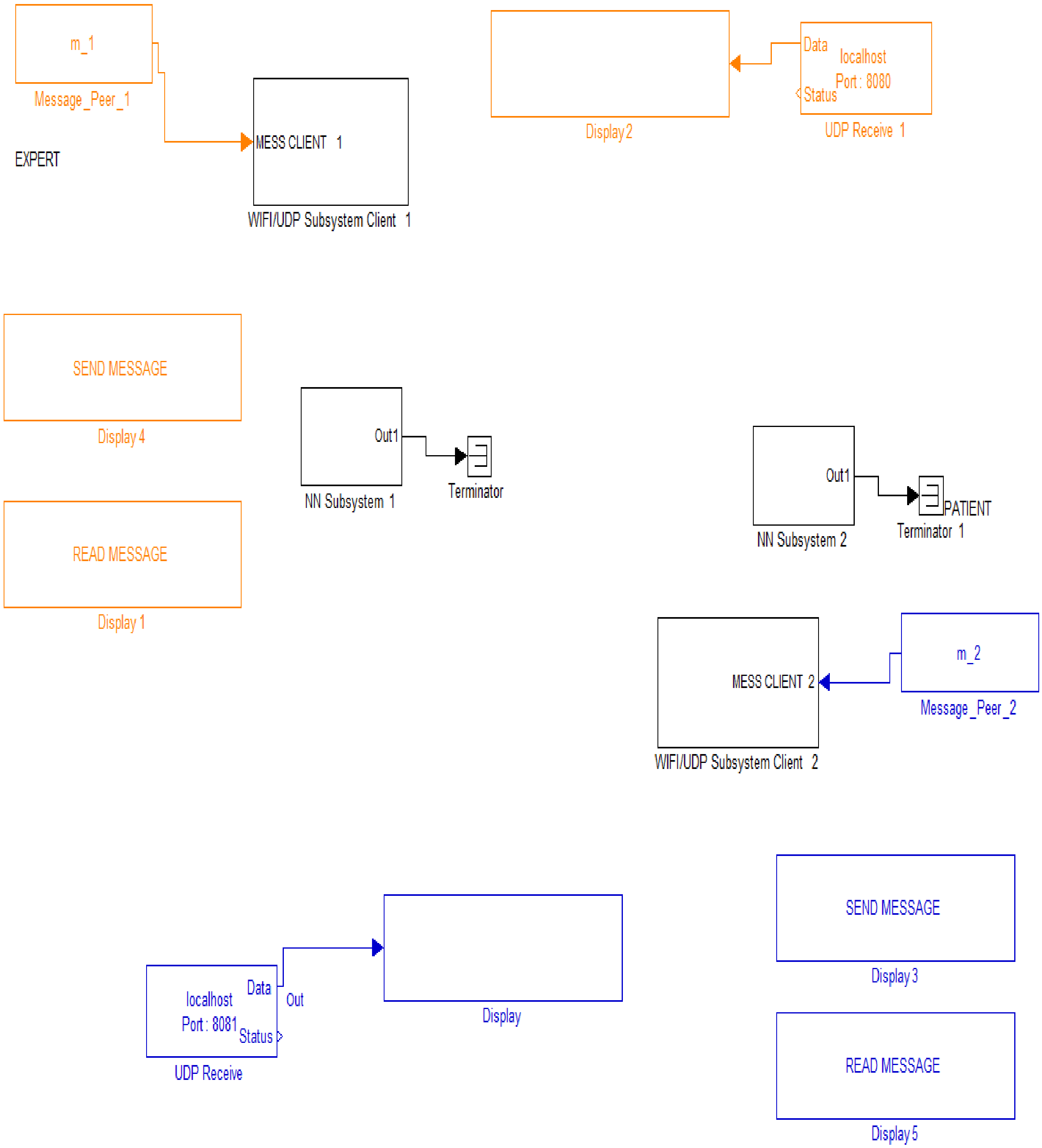

Figure B.1 Detailed System Model of the Intelligent Messaging System

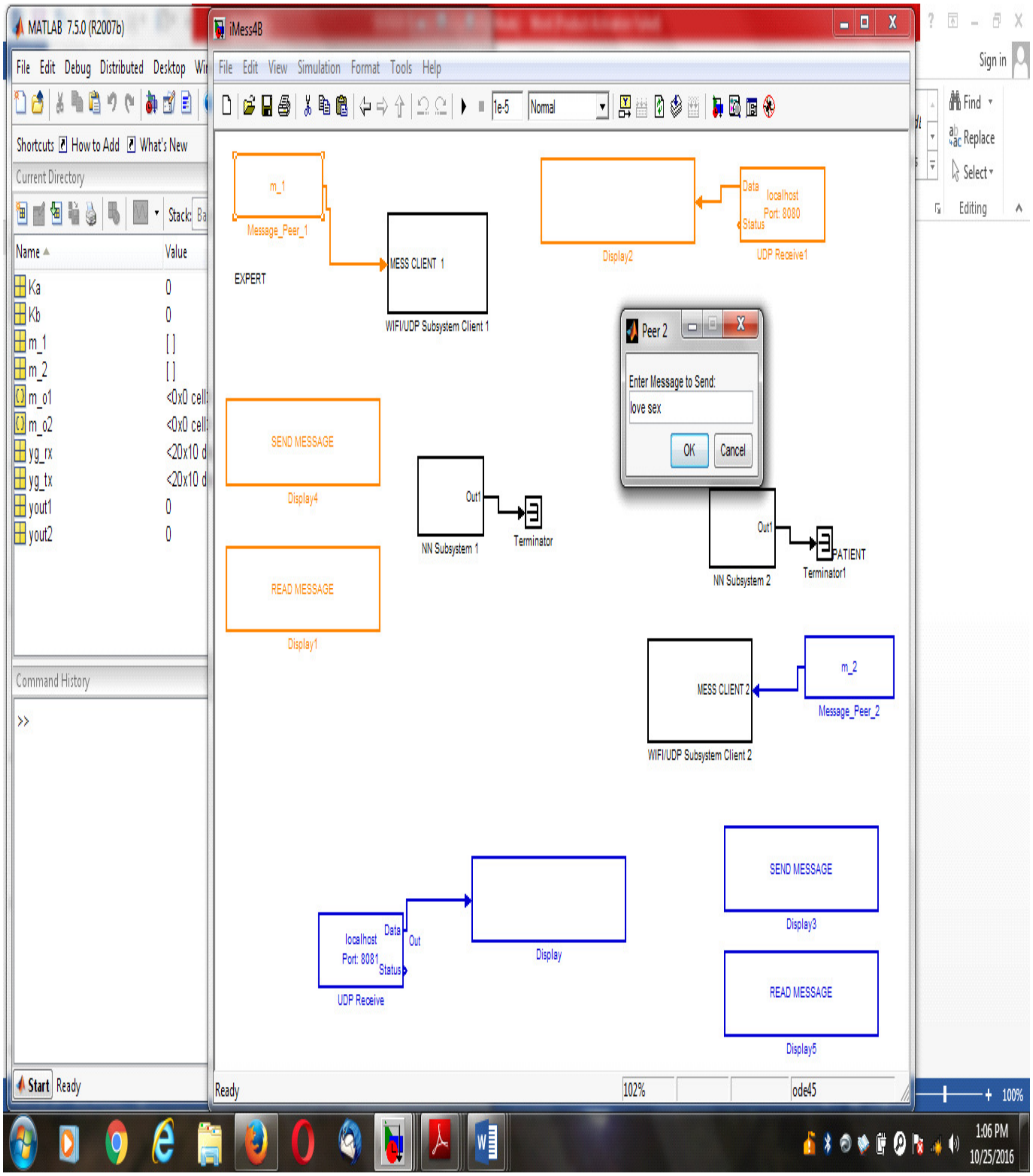

Figure B.2 Interactive User Interface of the Intelligent Messaging System with dialog prompt displaying