

Development of IEEE 802.11 Compliant Antenna with WLAN Mobile Multimedia Messaging Application for Emergency Communication Purposes



Vincent M. Musa, Jennifer B. Enriquez

Abstract: In emergency or disaster situations, when communications were interrupted due to damaged local network infrastructures, coordination are affected. Moreover, the deployment of specialized technologies such as satellite and shortwave communication network were found impractical. The objective of the study was first, to construct an improvised antenna that will be tested on an area with no cellular network and test the router's operating range using it, and second, to design and develop a mobile multimedia messaging application that utilizes WLAN to send data. Results of the testing shows that improvised antenna achieved operating range of 192 meters, the range achieved 215 meters in area with no cellular network, and the application was capable of sending multimedia messages over WLAN.

Index Terms: A Mobile Multimedia Messaging Application, Emergency Communication, WLAN Network Communication, Improvised Omnidirectional Antenna.

I. INTRODUCTION

Mobile technology was one of the greatest advancements we have in terms of technology. The transmission of information from text to multimedia between mobile platforms was a feature offered by this innovation in information technology [1][2][3]. Mobility, unique nature of mobile technology that enables users to communicate and interact with each other, access information remotely and transact business anywhere and anytime[4][1][5][6].

Disaster, either man-made or natural can occur anytime without warning. By this occurrence, local network infrastructures such as cell towers or cell sites were often rendered non-functional, hindering communications that affect disaster rescue plans and rescue actions [7]. It is very important for authorities like police, fire department, and rescue teams to have a reliable communication in order to have better coordination and cooperation to make quick and efficient interventions in emergency or disaster situation [8][9]. Some earlier papers mentioned four means of

communication that could be used in a typical event of emergency or disaster. First was the public communication network which was used as our normal method of communication, although it has a wide range, it was mostly subjected to unavailability when disaster happens since its infrastructure was prone to destruction. The second was the private communication network, which was intended particularly for the needs of government or public welfare but tends to be incompatible with other communication methods. The third was the satellite communication, this network provides a very wide coverage but when it comes to its transport bandwidth, it lacks the system capacity allowing only the access of special terminals. The fourth was the shortwave communication, though the stability and bandwidth performance of this network was poor, its strength was its survivability [10]. Utilization of satellite and short wave in emergency communication systems as a means of communication was adopted but requires specialized facilities and technologies. As a result, government units, military army, and telecommunication companies could only use such technologies [11][12]. On the viewpoint of the previous research papers, local network infrastructures were most likely be damaged and would not work properly or would stop functioning in case of disaster and would result on the interruption of communications between authorities, affecting their coordination and cooperation in rescuing persons at risk or an emergency situation. Moreover, when local network infrastructures were rendered non-functional, deployment of specialized technologies such as satellite and shortwave communication network was found impractical.

Thus, this study attempt to develop an IEEE 802.11 compliant antenna with a WLAN mobile multimedia messaging application for emergency communication purposes.

II. LITERATURE REVIEW

A. Importance of Communication in Emergency or Disaster Situation

Emergency communication means the communication methods multipurpose using different communication resources to ensure rescue and necessary communication when the natural or man-made emergency situation happens and the regular communication resource can't meet the suddenly increased communication needs [10].

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* Correspondence Author

Vincent M. Musa*, Department of Graduate Studies, Technological Institute of the Philippines-Manila, Philippines.

Jennifer B. Enriquez, Department of Graduate Studies, Technological Institute of the Philippines-Manila, Philippines.

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On the previous research paper, it mentioned emergency or disaster as a sudden event such as earthquakes, floods, tsunamis, fires, terrorist attacks, tornados, and other calamities that cause harm, suffering, or loss [8][7]. On the event of September 11 (9/11), where World Trade Center was attacked by terrorists using hijacked airplanes resulting to large scale damage of properties, several people were harmed and lots of them lost their lives on that disaster. During the rescue operations, the fire department suffered several casualties when the warning that the north tower was about to collapse from the police helicopter was not heard by firefighters. Furthermore, there was no proper dissemination of information between authorities that's why the evaluation of the towers was not advised by 911 operators to the callers since they were not well informed on the situation [8]. Also, a disaster occurred on Japan on March 2011, where an earthquake with a magnitude of 9.1 takes place at the northeast of Tokyo that causes a disaster through 30-foot waves damaging several nuclear reactors in that area. More than 22,000 confirmed combined deaths and missing during the disaster that is why the event was considered as the largest earthquake ever hit Japan. Communication facilities were seriously destroyed and created fear to the victims about rumors of nuclear leakage because of the interruption of communication [13][14].

B. Mobile Technologies

Mobile Technology was an innovation of technology that opened a huge opportunity for the future since the development of the Internet. It had pervaded the personal lives of almost every individual and changed the way communication was transmitted, the nature of work, and entertainment being delivered [7][15][16][17]. In spite of the way that innovation on mobile technology has existed throughout the previous fifteen years, scholastics can't achieve a conclusion on what really constitutes this innovation. There are two viewpoints in this regard. The primary considers wireless or mobile technology as "an alternative way to interact with a traditional Web site, albeit in a different format or on a more limited or constrained basis" [18]. However, some previous research papers noted that mobile services are special, trendy, and basically on another level. That is why it is as yet flawed in the matter of whether mobile technology is a one of a kind innovation or essentially a specialized expansion of fixed network systems and desktop that are fixed. By staying uncertain, this inquiry keeps firms upon responding to business openings offered by the organization that would like mobile technology distributions. For experts and scholastics, it ought to be clear with reference to in the case of existing learning on stationary desktop IT and fixed network systems that are appropriate to mobile technology or whether innovative models or methodologies must be presented [5][19][20][6].

C. Mobile Application Development

In developing a mobile application, there are three operating systems that compete around the world. (a) Windows operating system, a product of Microsoft that runs Windows devices such Windows smartphones and tablets, (b) iOS of Apple, runs the iPhones and iPads, and (c) Android, an

open source operating system developed by Google Company. It was based on Linux platform and Oracle's Java, one of the most popular programming languages in the Information Technology industry for its security and portability. Since it was an open source, the software framework is programmable and open for the public to modify and redesign resulting in a customized Android operating system. This operating system was not only designed for smartphones, nowadays, there are new and innovative consumer electronic devices such as smart television that are capable of network technology meaning, these electronic devices can connect and use the power of the internet [21][22][1]. For android application development, there were several development software tools to choose from. Eclipse Integrated Development Environment (IDE), an open source Java-based development platform known for its plug-ins that allow developers to develop and test code written in other programming languages. It provides a graphical interface enabling developers to perform development tasks faster. Since Android applications are written in Java programming language, Java Development Kit (JDK) must be installed on the computer. Android Software Development Kit (SDK), a set of development tools that need to be downloaded first before you can start developing an android application. In every version of Android that Google released there is also a corresponding version of SDK that is released in order to write programs with the latest features. An SDK contains an emulator, Android Virtual Device (AVD) that enables the developer to test their developed application on specific smartphones virtually on the computer. It was recommended that the lower version of Android was a good idea in creating an AVD for it enables accessibility for a wide range of Android users since the application developed on lower version is forward compatible with higher version [24].

D. Existing Mobile Communication System

FireChat is a peer-to-peer mesh networking mobile application that employs a mobile ad hoc network (MANET) in transmitting text-based messages in order to allow communications through Wi-Fi or Bluetooth. It was developed by Open Garden to provide an alternative means in communicating publicly. The Vice President of Sales and Marketing of Open Garden, Christophe Daligault stated that the mobile application was not intended for private or secure communication since it does not offer an encryption on every message transmitted, there was also an absence of authentication system so there could be a possibility that messages from the same username would actually be a message from different person [25]. The application gained its popularity because of the protest that happened in Hong Kong. Organizers of the pro-democracy protest required all the participants to download the application in order to organize themselves since there were rumors that the cellular networks would be shut down by the city's government. Although cellular networks were not shut down, cellular reception was bad as reported by some protesters so the FireChat played a big role on the protest [26][27][28][29][30].



Other previous research paper presented a developed mobile communication system that was not only text-based but also integrates images for emergency response and rescue. Because of the damage that was caused by disasters either man-made or natural, human lives were lost and properties were destroyed. In this manner, emergency managers especially those who were highly trained carry out activities such as immediate response and preparedness planning by incorporating jurisdictional resources, establishing management processes among the various government, non-government, and private sector entities involved in recovery. However, the situation reports where command personnel rely on was provided through a text-based message describing the scenario of the disaster that occurred. It makes the assessment of the disaster situation more difficult since the detail of textual reports were not the same as the level of detail that a visual report could deliver. Hence, [5] presented a system that could display situation reports related to a disaster with imagery taken by Emergency Management (EM) personnel or by citizens with text-based reports related to the disaster through an Apple iPad Application. In some areas where natural disaster frequently occurs such as western and central China, it is essential to set up an emergency communication network that is not dependent on communication base station since this stations are mostly damage during disasters. The integration of a system that is capable of transmission of multimedia information such as image, voice, and video was developed in order to offer stable transmitting communication services for accident information release over ad hoc technology [31].

E. Synthesis of the Study

Based on the gathered related literature and studies, it was found out that there were already existing communication systems that would be an alternative means for communication in an emergency or disaster situation. FireChat is an android application that enables text messages to be transmitted through everyone connected on the same network using Wi-Fi or Bluetooth connection [25]. There was also some existing mobile application that could send not only text-based messages but also images of an emergency or disaster situation. It was used by emergency management personnel to make rapid rescue plans and actions [32]. There also exists a mobile Java application that could transmit multimedia information such as image, voice, and video in order to have communication services for accident information release over Ad Hoc technology [31]. On the contrary, the proposed system would transmit multimedia such as text, image, voice, and video over Wireless Local Area Network. Using the text-based message as the foundation of communication system, sending of images will also be an advantage for injured persons trapped in a destroyed building due to disaster because sending the injured part of the body to the rescue team would help them to be assisted in applying first-aid.

III. METHODOLOGY

A. Software Development Life Cycle

This study utilizes the Sashimi Waterfall model, a modified

version of waterfall model developed by Peter DeGrace. In a Waterfall model, each phase must be completed before the next phase can begin and there is no overlapping in the phases. However, in the case of Sashimi Waterfall model, feedback where introduced meaning phases can overlap to each other. It is useful in identifying errors while in the process of development. There are four phases: Requirements Analysis, System Design, System Development, and System Implementation.

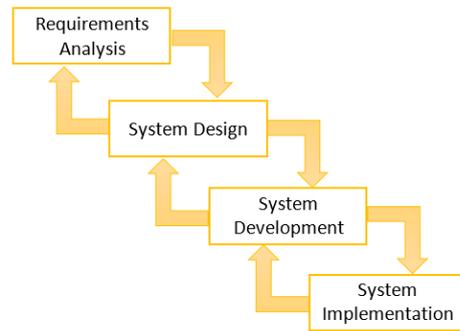


Fig. 1: Sashimi Waterfall Model

B. Architectural Design

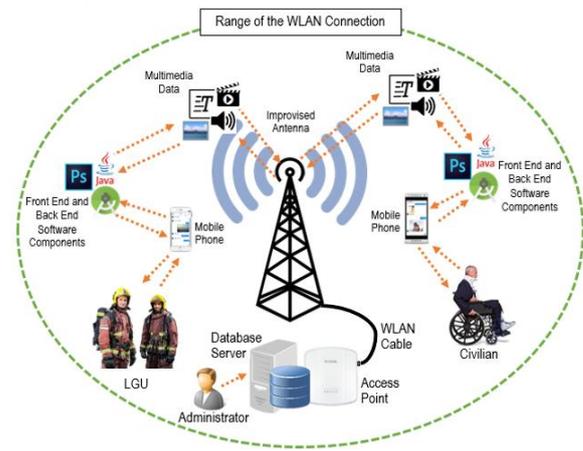


Fig. 2: System Architecture

Figure 2 shows the architectural design of the system. On the figure above, the improvised antenna is connected to the access point through a WLAN cable. The system uses Infrastructure Basic Service Set which involves an access point and all wireless stations are connected to it. The access point or the router will serve as a link to the authorities and civilian/s in order to build communication as long as within the range of the WLAN. The administrator will input the account details of the LGU to the database server after installation in order for them to be registered as authorities or rescue team. The civilian/s and authorities will use the system in their mobile phones to connect to the router and use it to convey multimedia messages. Software components such as Android Studio and Photoshop are used to develop the Graphical User Interface (GUI) and Java as for its program coding. Messages are then saved to the database server.

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C. System Components

For the development of the system, the following software components were used:

Android Application:

The mobile multimedia messaging application would be developed using Android Studio. It will be used as communication medium in an emergency or disaster situation to send text, audio, image, and video messages to its receiver. The application will also connect to the database in order to insert and retrieve multimedia messages.

Database:

This component would store user information, text, image, audio, and video messages sent by users using the Android Application. It utilizes MySQL Server.

Antenna:

The antenna would extend the operating range of the commercial router. It is a Do-It-Yourself (DIY) Omni-directional biquad antenna and is IEEE compliant. The materials used were 2 pieces of 250mm of 2.5mm² copper wire, N connector, and 150mm LMR-400 coaxial cable.

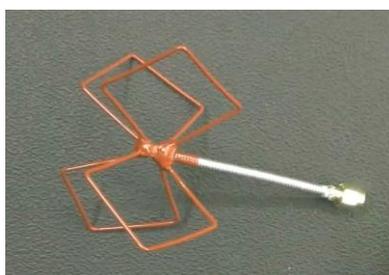


Figure 3. Omni-directional Biquad Antenna

Router:

The router would serve as a hotspot in order for users to connect. In this study, it uses a commercialized router specifically the TP-Link TL-WR841HP model. It should be able to accommodate 50 up to 100 connected devices, but in this study, it will be limited to at least 20 up to 30 devices in order to maintain the efficiency of the system.

Web Service:

This component would serve as a gateway portal for information to be stored and retrieved in the database. PHP script was utilized to create a server-client web service.

D. The Participants of the Study

The system was evaluated by 50 participants. Out of 50, 35 were civilians and 15 were Local Government Unit (LGU) employees located in Tablas, Romblon.

E. Research Instrument

The criteria and its descriptors used for the evaluation of the proposed system were based from the previous research paper [33] entitled "LeadCo: An Android Application for Crowdsourcing and Trend Analysis in Online Social Media using Best First Search Algorithm". The instrument used for the respondents employs the ISO 9126 model for software product quality evaluation and contains items that will measure the respondents' level of acceptability in terms of

application's functionality, reliability, usability, efficiency, maintainability, and portability.

IV. RESULTS AND DISCUSSIONS

A. Software Application Presentation

The mobile multimedia messaging application is an android application that can be used through an Android smartphone, tablet, or android emulator. After installation, the application will launch by selecting its icon.

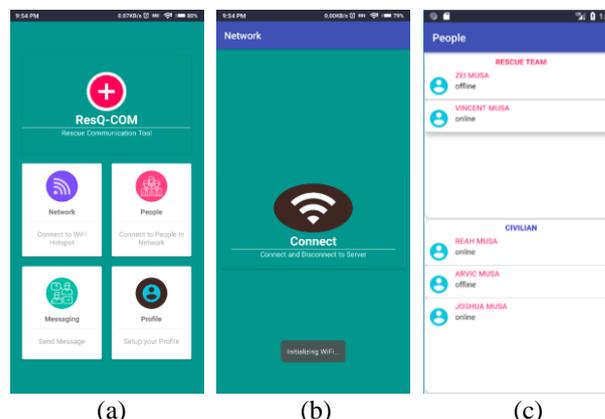


Fig. 4: a) Application's Home Screen, b) Network Screen, and c) People Screen

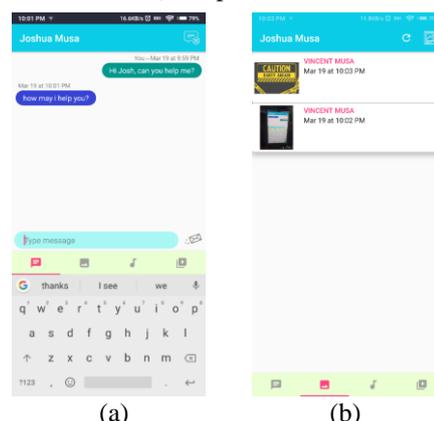


Fig. 5: a) Application's Text Message Screen, and b) Image Message Screen

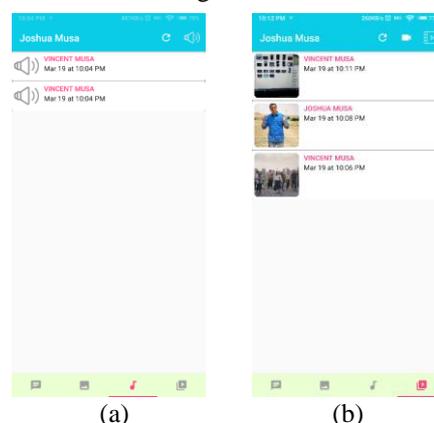


Fig. 6: a) Application's Audio Message Screen, and b) Video Message Screen

B. System Evaluation

The research instruments used in the evaluation contains six (6) criteria and twelve (12) descriptors that would measure the participants' level of acceptability on the android application.

Table I signifies the Mobile Multimedia Messaging Application's overall acceptability obtained an average mean of 4.53 and a descriptive interpretation of Strongly Agree to the participants which means the application is functional, reliable, usable, efficient, maintainable, and portable. It also shows that the highest scores among the criteria were usability (M = 4.78, DI = SA), portability (M = 4.70, DI = SA), and functionality (M = 4.55, DI = SA). While the criteria with the lowest score is reliability (M =4.27, DI = MA).

Table I: Summary table for the overall mean scores of the application

CRITERIA	M	DI
Functionality	4.55	SA
Reliability	4.27	MA
Usability	4.78	SA
Efficiency	4.43	MA
Maintainability	4.41	MA
Portability	4.70	SA
Over-all Mean	4.53	SA

V. CONCLUSION AND FUTURE WORKS

It was known in this study that, first, in comparison to the built-in omnidirectional of most common commercialized wireless routers where the wireless range it can cover is up to 100 meters, the improvised 802.11 omnidirectional antenna can amplify the signal strength of a wireless router or access point gaining 9dBi up to 11 dBi. Second, it was found that the signal strength of the improvised antenna was much stronger in areas where there is no cellular coverage for there is no interference to its frequency. Third, the improvised antenna exceeds the 100 meters coverage of the built-in antenna from the commercialized wireless routers. Fourth, android mobile multimedia messaging application was developed that can transmit and receive text, image, audio, and video message using Wireless Local Area Network (WLAN) technology. Lastly, the Android mobile multimedia messaging application was found functional, reliable, usable, efficient, maintainable, and portable by the respondents based on the overall mean score of 4.53 with Descriptive Interpretation of Strongly Agree. It was then concluded that the system would provide emergency communication system.

For future work, the use of portable routers or battery powered routers to enable the system to be more mobile in emergency or disaster situations. Widen the study about improvised antenna to enable combinations of two (2) antenna in order to strengthen the signal and widen the coverage of the wireless network. Integrate Voice and Video Call to the Android mobile multimedia messaging application to aid in rescue operations.

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AUTHORS PROFILE



Vincent M. Musa is a faculty of Institute of Information Technology at Romblon State University main campus. He received his Bachelor of Science degree in Information Technology from Romblon State University in Odiongan, Romblon, Philippines. He is currently taking up Master in Information Technology



Jennifer B. Enriquez obtained his Bachelor of Science degree in Computer Engineering from Pamantasan ng Lungsod ng Maynila (PLM) in 1999. She finished her Master degree in Engineering with specialization in Computer Engineering in 2005 from Pamantasan ng Lungsod ng Maynila (PLM). She is currently taking up Doctor of Technology at the Technological University of the Philippines Manila, Philippines. Her research interests include Embedded System, Software Development Management and Technopreneurship.