INVESTIGATION ON THE PEER-TO-PEER CONNECTIVITY OF SHORT RANGE DEVICES

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

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DEDICATION

Special Dedicated to

My beloved family,

My main supervisor and co-supervisor

and all my friends

ABSTRACT

A short range device can be used in an emergency communication due to natural disasters for a safe and rescue operation. This project focus on the algorithm for a peer-to-peer connectivity. The short range device requires the best algorithm for emergency communication to be used on a peer-to-peer connection. Short range devices in the market are lower in number especially devices that able to send a simple text message without using mobile network or the Internet. The raw algorithm for this device has a limitation of sending text but capable of setting up a connection between two devices. So, the objective of this project is to study and investigate algorithms for a peer-to-peer connection between two SRDs using RFM69 915MHz packet radio and Raspberry Pi 2 Model B+, then analyze the best method and technique of algorithms for the peer-to-peer connection. The project is carried out by first study the architecture of both RFM69HCW packet radio and Raspberry Pi 2 Model B+, then develop the algorithm and simulate the program to observe the connection time of all algorithms. All the algorithms design is constructed and simulated after the hardware is built. The simulation results in each stage of the projects are documented in this thesis. From the final algorithm design, the connection time is 3.24 seconds which 1.46 seconds faster than a made prototype. The final algorithm design also shows a slower receiving time to receive a text than a made prototype. The delay occurs in the final algorithm and future improvement is needed to cut or decrease time delay in the algorithm.

ABSTRAK

Sebuah peranti jarak jauh boleh digunakan dalam komunikasi kecemasan apabila berlakunya bencana alam untuk operasi penyelamatan. Projek ini memberi tumpuan kepada sambungan algoritma peer-to-peer. Dalam komunikasi kecemasan, peranti jarak pendek memerlukan algoritma yang terbaik untuk digunakan pada sambungan peer-to-peer. Peranti jarak dekat di pasaran adalah rendah bilangannya terutama peranti yang berkemamouan menghantar teks mesej tanpa menggunakan rangkaian mudah alih atau internet. Algoritma asli untuk peranti ini mempunyai batasan untuk menghantar teks tetapi mampu menyambungan pautan antara dua peranti. Oleh itu, matlamat projek ini adalah untuk mengkaji dan menyelidiki algoritma peer-to-peer antara dua perenti jarak dekat menggunakan radio paket RFM69 915MHz dan Raspberry Pi 2 Model B +, kemudian menganalisis kaedah dan teknik terbaik algoritma untuk sambungan peer-to-peer. Projek ini dijalankan melalui pemahaman terhadap seni bina radio paket RFM69HCW dan Raspberry Pi 2 Model B +, kemudian kembangkan algoritma dan simulasikan program untuk melihat masa diambil untuk menetapkan sambungan bagi semua algoritma. Semua reka bentuk algoritma dibina dan disimulasikan selepas prototaip dibina. Keputusan simulasi bagi setiap peringkat projek didokumentasikan dalam tesis ini. Berdasakarkan hasil pilihan algoritma, masa yang diambil untuk membuat sambungan adalah 3.24 saat, iaitu 1.46 saat lebih cepat berbanding prototaip yang sedia ada. Hasil pilihan algoritma juga menunjukkan masa penerimaan untuk menerima teks adalah lebih lambat berbanding prototaip yang sedia ada. Kelewatan dari segi masa yang berlaku dalam hasil pilihan algoritma harus dikurangkan dititikberatkan untuk menangani kelewatan masa dalam algoritma di masa akan datang.

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LIST OF SYMBOLS AND ABBREVIATIONS

RFM	:	Radio Frequency Module
SRD	:	Short Range Device
P2P	:	Peer-to-Peer
MS	:	Mobile Subscribers
GPIO	:	General-purpose Input Output
GSM	:	Global System for Mobiles
CDMA	:	Code Division Multiple Access
ATM	:	Asynchronous Transfer Mode
SoC	:	System on a Chip
ASI	:	Asynchronous Serial Interface
TCP/IP	:	Transmission Control Protocol and the Internet Protocol
UDP	:	User Datagram Protocol
VHF	:	Very High Frequency
MCU	:	Multipoint Control Unit

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CHAPTER 1

INTRODUCTION

An overview of the project is given followed by the problem statement, objectives, and scope of the project. A thesis outline is also given to give a brief idea on each chapter in this thesis

1.1 Research Background

Short Range Device, or usually termed SRD is an electronic device which transmits radio frequency for data transmission in wireless communication. Wireless communication plays an important role as an intermediate for device to device to exchange information. This technology introduced a transmission of information that can be done without necessitating electronic conductor, by using electromagnetic waves like IR, RF, satellite, etc. These days, the wireless communication technology mentions to a diversity of wireless communication devices and technologies going from smartphones to computers, tabs, laptops, Bluetooth Technology, printers. To communicate in remote operated areas, the wireless communication system has turn out to be a crucial part of various types of wireless communication devices. The radio frequency used in SRD has a low capability to cause interference to other devices that

also work based on the radio frequency. this kind of device typically employs low power transmitter to avoid such kind of interference. The power usually ranged between 25-100 mW for ERP (effective radiated power) or less. The amount of the SRD power depends on the frequency band used by the device itself. The requirement of user's license depends on the range of usage, cutting and limiting the range would have access for license-free.

1.2 Problem Statement

Mobile network operator provides mobile data on smartphones which are very crucial these days as it used for communication between two or more people. However, there is limitation to the coverage of mobile network operator specifically in a non-develop rural and inhabited areas. Poor connectivity in rural areas signifies the existence of a huge gap of communication abilities for people who have any emergency cases, work or business related in that area. Nowadays, as technology arise, people tend to engage with a mobile phone with LTE or GSM connectivity to communicate with one another, none of the mentioned connection will produce communication issues in terms of getting information from other peers which contributes to lacks of communication abilities. Besides that, in some cases, people tends to explore new areas especially in inhabited area as part of extreme sports or business activities. This could potentially risk their safety of lost in the wild with no accessible communication because some mobile network operator does not have strong and a complete coverage in certain parts of the map. Through years, engineers have been working on updating and upgrading the mobile network, yet the coverage is not entirely covered due to limitations and constraints in that particular areas.

With short range device(SRD), where this device capable of initiating a peer-to-peer communication wirelessly independent to mobile network namely LTE, 3G and GSM connectivity to operate communication but instead using a radio frequency module as a transceiver that transmits and receives data and information signals. This is an alternative way for a better communication between peer-to-peer. Walkie-talkie device is a good example of SRD, however, a standard walkie-talkie requires a license and could potentially interfering with other's licensed broadcasts. Besides walkie-talkie, using RFM packet radio also a good alternative and it has little advantages over walkie-talkie radio. Walkie-talkie can only transmit audio while RFM only capable of

sending text, other than that both are quite similar. Radio frequency module (RF module) packet radio typically shielded to limit unintended emissions and increased EMC immunity which gives fewer interferences to other devices. Other than that, RFM packet radio transceiver uses the license-free ISM band ("European ISM" and "American ISM" respectively with a wide range of frequency). RFM packet radio is inexpensive and can be program and embedded with microcontrollers to function as a transceiver. Application of RFM in emergency cases, business related, medical and safe and rescue is very suitable and reliable.

Therefore, in this project study on the algorithm methods and techniques of a peer-to-peer connection between two SRDs are needed to establish a connection that enables the exchange of simple text message. Furthermore, to achieve a good, reliable and secure connection, investigation analyzation on the algorithm methods and techniques is required. In addition to that, it will also determine and what algorithm is suitable and best to be used in any unexpected emergency conditions which requires a communication. The thing that will keep on eye are the peer-to-peer algorithm of connecting two devices. However, in this project, the upholding a sustainability & environmental friendly is important, where harmful pollution and hazardous waste has to be neglected and mitigated. The production process must be economic, logically simple and yet high productivity to be commercialized into a wide industry. This project is expected to show that communication without LTE, 3G and GSM can be achieved in this era of developing technology where communication highly depends on access network. Moreover, the SRDs that implemented with the radio frequency module (RFM) can be brought alongside with the development of technology in the near future. In addition, the analysis of best algorithm techniques for peer-to-peer connectivity between two short range devices (SRDs) can be used in many applications that requires reliable connection.

1.3 Objective of Research

The purpose of doing this project is to study algorithms for peer-to-peer connection between two SRDs using RFM69HCW 915MHz packet radio and Raspberry Pi 2 Model B+ and analyze best method and technique of algorithms for peer-to-peer connection between two SRDs using RFM69 915MHz packet radio and Raspberry Pi 2 Model B+ for wireless communication which capable of sending and receiving texts

in the range of 915MHz. The selected algorithm of peer-to-peer should be able to send and receive text messages, a faster rate of connection and a faster time to receive messages.

1.4 Scope of Project

The scope of work for this project are:

i. To determine what is the best algorithm method/technique used for peer-to-peer connectivity between two short range devices at least two or more algorithms are required to be compared and tested.
ii. Two main hardware are required to build the SRD which is a Raspberry Pi 2 (Model B+) will be the microprocessor and an RF module which is an RFM69HCW (915 MHz) where these two is wired together.
iii. A desktop and a Fieldfox device are required to access the raspberry pi using PuTTY software and to test and observed whether the 915 MHz signal frequency is emitted by the RF69HCW through the wire antenna.
iv. The antenna of the RF module is temporarily substituted with a specific length of wire that has been calculated using the Wave equation to compliment with the 915MHz frequency by considering velocity factor of 95%.

1.5 Thesis Outline

Chapter 1 describes an introduction of the SRD in wireless communication for peer-to-peer communication and the problem that encountered by most people that could be overcome through developing this project. Besides, the objective and the scope of work for this project was set in order to accomplish it at the end of the project.

Chapter 2 describes the literature review on the advantage of SRD over a cellular network, constraint affecting signal transmission between two devices, theory and specification of SRD, Raspberry Pi and radio module RFM69HCW as well as theory about wire antenna length, P2P connection, and its topology

Chapter 3 explains the methodology of the project with the use of flowchart. Then, step by step of development of the project will be discussed in details.

Chapter 4 include all the result mentioned in chapter 3 together along with the discussion of all the results.

Chapter 5 involve the conclusion of the overall project including the sustainable discussion, commercialization and also the future work of this particular project.

CHAPTER 2

LITERATURE REVIEW

This chapter includes a background review, previous study or previous researches done on a similar system, and also related theory which contributes a lot to better understanding, throughout this project.

2.1 Short Range Device

Short Range Device (SRD)is a generic term that encompasses all radio transmitters which provide either uni-directional or bi-directional communication or are designed for use at short range having a low potential for harmful interference with other radio communications. Applications include vehicle radar systems, alarms, wireless local area networks, radio-detection, on-site paging systems, telecom, identification systems, telemetry and remote controls. These devices may employ different types of modulation and may have speech application.

Short Range Devices (SRDs) are also referred to as Low Interference Potential Devices LIPDs, Restricted Radiation Devices RRDs and Low Power Devices (LPDs). Any radio communication device has a potential for harmful interference with other radio communication devices operating at the same or adjacent frequency bands. Due to low power characteristics of SRDs, this problem does not largely occur. Moreover, techniques like duty cycle management and carrier sensing systems further minimize

this problem. This gives support to the idea of unlicensed use of SRDs unless justified reasons are present for placing some restrictions.

Short Range Devices operate on a non-interference and non-protected basis where it does not cause harmful interference to other users of the band and cannot claim protection from interference received.

2.1.1 General Requirement

The basic requirements for SRD design are as follows:

a) The device shall not cause interference with other authorized radio-communication services and be able to tolerate any interference caused by other radio-communication services, electrical or electronic equipment.

b) The device shall not be constructed with any external or readily accessible control which permits the adjustments of its operation in a manner that is inconsistent with this Technical Code.

2.2 P2P Network

A P2P network should have the following requirements; The network should facilitate real-time transmission of data between peers, peers can operate as both server and client, the main content of the network is provided by the peers, the network gives control and autonomy to the peers and the peers are not necessarily always connected or have permanent IP addresses.

2.2.1 The topology of P2P Network

There is two common type of topologies of a peer-to-peer network which are unstructured and structured. Unstructured is when the P2P network not keeping track of connection between two nodes in an organized manner. For organizing data information among nodes, it requires implementation of techniques. Gnutella Freenet is an example of an unstructured network enforcing a protocol for the organization of data [1]. However, a structured P2P system is when a protocol organizing the overlay links is enforced. Structured P2P minimize the number of hops in the overlay graph when locating information. A good example of a structured P2P protocol is the Chord