

DEVELOPMENT OF SAFETY HEALTH MONITORING DEVICE TO
PREVENT AND CONTROL RISK IN CONFINED SPACE

HUSSEIN ALI SAEED

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Universiti Tun Hussein Onn Malaysia

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First and foremost, praise is to Almighty Allah for all his blessings and for giving me patience and good health throughout the duration of this master's research. Profound appreciation and thanks are also given to my supervisor, Dr. Muhammad Hazli Bin Mazlan for his supervision, guidance, constructive suggestions and comments during the entire research period until its completion. His advice and support throughout the program have been invaluable. Without his tireless help, leadership and confidence in my ability, the completion of this project would not have been possible. I would also like to thank all post-graduate students of UTHM for their help, friendship and creating a pleasant working environment throughout my study in UTHM. I would like to thank my friends for accepting nothing less than excellence from me. Last but not the least, I would like to thank my family, the reason of my existence: my parents and to my brothers and sisters for supporting me spiritually throughout writing this thesis and my life in general - thank you for being by my side in every step I took during my study.



PERPUSTAKAAN TUNJATI TUN MAMINAH

ABSTRACT

IoT (the Internet of Things) has become an interesting topic in the field of technology research. It is basically connected to each other through the Internet from the device. We usually think of IoT in terms of independent cars and smart homes, but some of the best applications of Internet technology stuff in a very practical area. The main contribution of this thesis is to introduce an approach and provide a supporting platform for the automated synthesis of interoperability software artifacts. Such artifacts enable the interconnection between mobile Things that employ heterogeneous middleware protocols. Our platform further supports evaluating the effectiveness of the interconnection in terms of end-to-end QoS. More specifically, we derive formal conditions for successful interactions, and we enable performance modeling and analysis as well as end-to-end system tuning, while considering several system parameters related to the mobile IoT.



PERPUSTAKAAN TUNKU TUNJAL MINAH

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LIST OF SYMBOLS AND ABBREVIATIONS

IOT	- Internet of Things
WSN	- Wireless Sensor Networks
LCD	- Liquid Crystal Diode
LED	- Light Emitting Diode
BIM	- Building Information Modeling
FBG	- Fiber Bragg Rating



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CHAPTER 1

INTRODUCTION

1.1 Background Study

Confined space is a space where it is underground, in the cave or in any spaces that are dark, less oxygen and have much dust content in it. Such confined spaces could be underground piping for petrol or gases, underground tunnel in the mining, the cave and underwater tunnel. The characteristics of the confined spaces in terms of communications are:

1. Weak in signal strengths
2. Limited sources of energy or no sources of energy
3. Deep in distance and covered by thick obstacles.

The communication wireless signal propagates inside the confined space is more to tunnelling rather than spreading the signals all around the spaces. Due to many wall plus the thickness of the wall in the confined space, the signals will reflect inside the space and hard to reach the ground. To communicate between the receiver in the deep confined space and transmitter on the ground, there should be one router or repeater located at one point of the confined space. This repeater will act like 'middle-man', which re-amplified the signal so that both transmitter and receiver could get the signals. Due to the bad environment in most of the confined spaces, the communication signals not only being attenuated but human's health also affected. Working in long time in confined space will cause health system degraded.

This research is about the design and implementation of health monitoring system for a worker who works inside the confined space. The monitoring of health system suggested is using wireless. The workers' health conditions will be monitored once they come out from the confined spaced. The suggested idea to monitor the

health is using IoT (“Internet of Thing”) technology. IoT has, in the present times, become popular in communication technology. It has been developed in many ways and is called as the next big thing that will influence all areas of human lives. IoT is set to change many aspects of our lives as it changes the world we live in, including its application to maintain and optimize people’s safety. In the years to come, the number of IoT devices is expected to grow dramatically. Nowadays, the reach of IoT is estimated to be more than billion devices that can currently connect with internet, but by 2020, it is estimated that there will be 26 times more connected things with the internet. Today, everything around has the ability to get online and interact with other machines.

IoT refers to devices that can interact with the internet by making use of physical devices, sensors, microcontrollers, and network connectivity as shown in Figure 1.1. below. In order to collect the real time data consistently, each and every device has its unique identifier (UID), which makes the communication possible in an easy way like machine to machine (M2M) communication. A massive amount of data is collected from devices all over the world which is stored in the cloud.

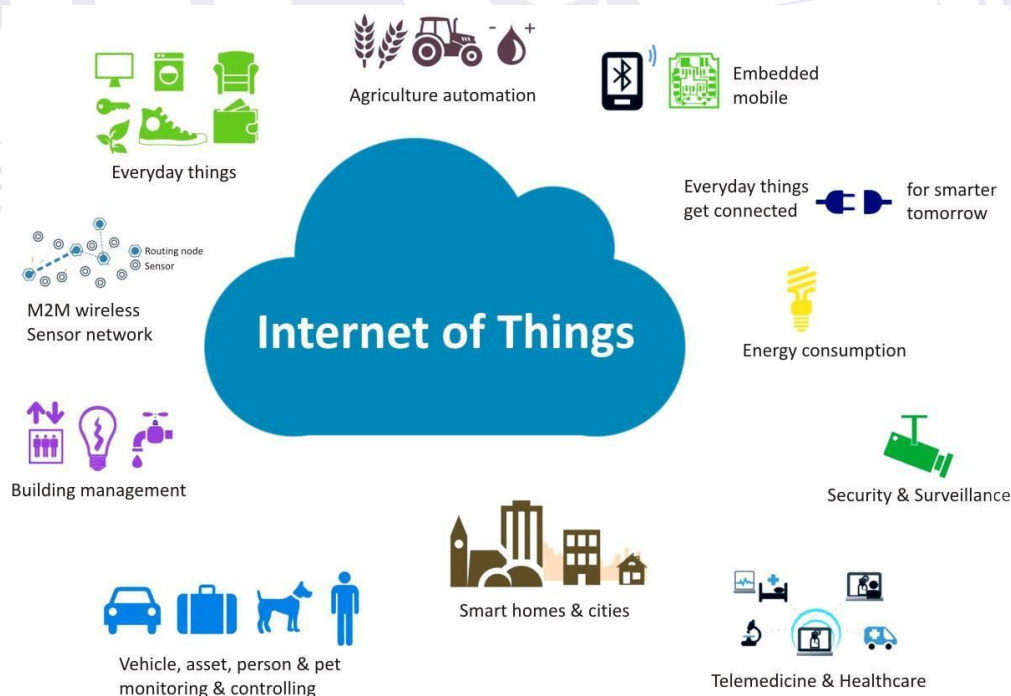


Figure 1.1: Internet of Things connected with many physical things and objects [1]

In IoT technology, there will be many wireless sensor nodes appear in the system. For the health monitoring system, there will be only one sensor node but many sensors used. Those sensors are temperature sensor, gas sensor, blood pressure sensor, GPS (Global Positioning System) and heart beat rate sensor. All the sensors are connected into one node (one microcontroller with internet access). The node will process the sensor's signals and send the signals to the monitoring system through internet network. As an observer, he or she can view the health condition of a worker from far distance. An internet platform or Apps usually designed to monitor the health of a worker. The general idea and design of the health monitoring system proposed in this research for a worker in confined space is shown in Figure 1.2.

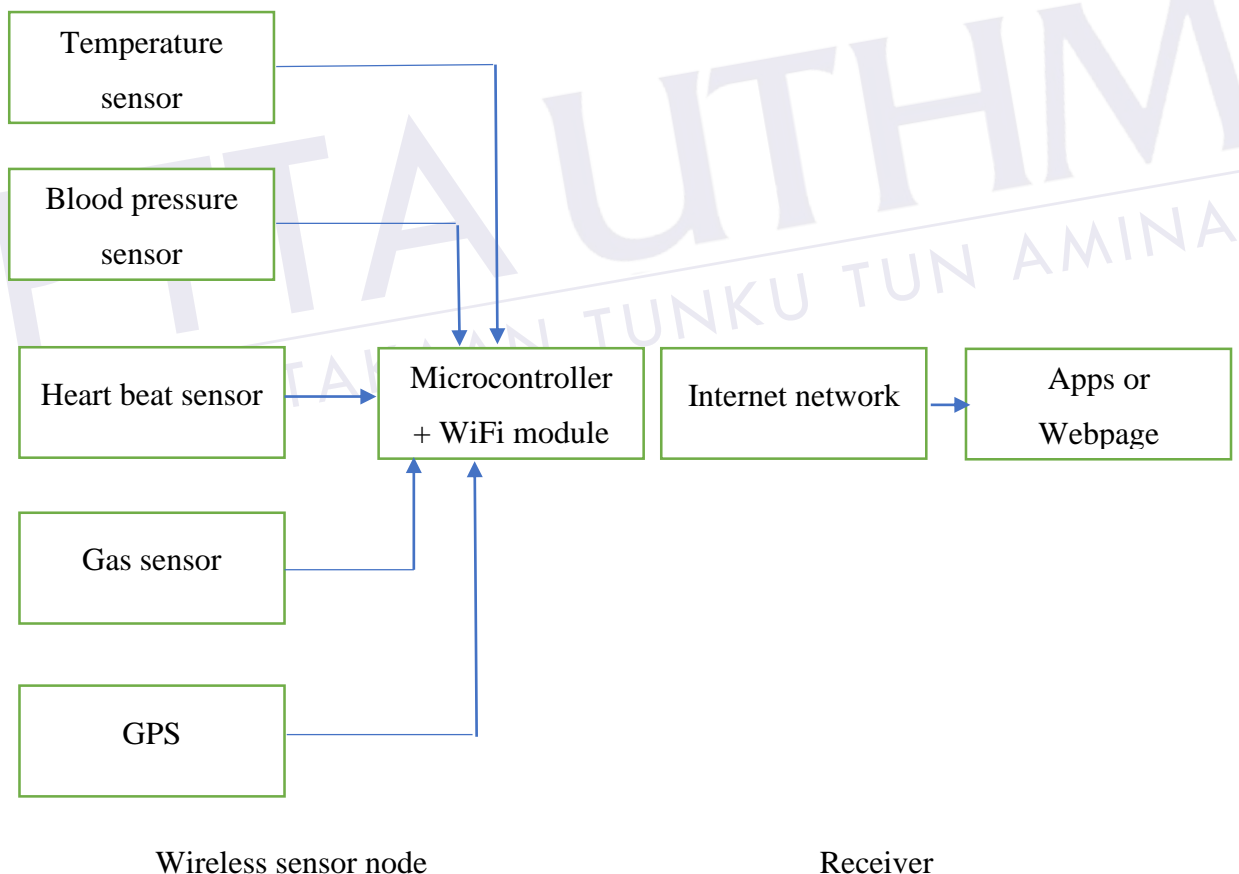


Figure 1.2: The concept and idea of the proposed confined health monitoring system

As seen in the proposed idea, the temperature sensor is a sensor used to measure the temperature of a worker. This sensor is an analogue sensor and it will be placed on the body of a worker to measure the temperature. Typical temperature sensor used is LM35. The blood pressure sensor is a sensor used to detect the blood pressure of a worker. The sensor proposed in this research is using light technology. A simple photo diode is used to detect the blood pressure by putting a fingertip on the surface of the sensor. As the light penetrate through the finger, it refracted and reflected. Hence the study of the return light signals will give information about the blood pressure. Chapter two will explain this sensor in detail.

The heart beat sensor is used to detect the heart beat rate of a worker. This sensor is an analogue sensor and consists of thin metal diaphragm. The diaphragm vibrates when detect the heart pumping the blood and oxygen. The vibration will result a pulse which represent the heart beat rate. The gas sensor is used to detect the LPG (Liquid Petrol Gas) in the confined space. This sensor has an exposed wide area to collect the LPG gas molecules. When the LPG gas molecule enters the sensor, it will react with the oxide materials in the sensor. The reaction will cause the signal generated by the sensor. The GPS is a module that can detect the position of a worker. Although inside the confined space is not possible, but when the worker come out from the confined space, his or her location will be known once the GPS detects the satellite signal and report the location information to the receiver. All the sensor signals will be processed and the system will produce alert when the health have problems. A more detail about the system design and implementation step by step based on the proposed block diagram shown in Figure 1.2 will be explained in chapter three.

1.2 Problem Statements

Today many confined space workers health are checked manually through medical sensors and devices. All these workers are get in touch with professional medical health checkers and nurses. The way this kind of checking is not so efficient because of:

1. First the professional medical staffs have to travel down to the place and collect the health data. This incurs cost of traveling and time wasted on the road.
2. In case the worker brings in infection, the person who check the heath will be infected by the viruses.
3. The checking process might take long time and a lot of procedures have to follow and forms have to fill in. Also, the information about the health have to key in manually into the computer for references or storage. Thus, consume time and slow down the work.

With the help from IoT technology and wireless sensor node (WSN), it helps the professional medical staffs to auto record the health data, make decision or alert on the health condition if the health have problem. Thus, this will reduce the works of recoding the health information. Also, because the professional medical staffs are not getting in touch to the workers, so any infection carried by the workers will be known and studied by the professional medical in far distance. Other benefits can get when using WSN and IoT technology to monitor the health are:

1. Reduces wiring of sensors connect to the microcontroller.
2. Reduce the circuit implementation and make the unit simple, portable and easy to troubleshoot.
3. Less maintenance works require.

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