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Wearable Indoor Tracking Device using Wi-Fi Positioning System with PPG Sensor and Android Application

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Abstract - Many inventions that manifest the required qualities for the improvement of the search and rescue operations are made. However, the present inventions do not cover accurate tracking of the victims which contributes to a delay during operation. Thus, a Wearable Indoor Tracking Device using Wi-Fi Positioning System with PPG Sensor and Android Application is developed to uplift the limitations of the devices present today which can resolve the delay of search and rescue operation. This project focuses on detecting the specific location of the victims which includes distance and direction from rescuer's perspective as well as the victim's status. Moreover, the location and status of the victim can be viewed simultaneously through an Android Application. To achieve the tracking technology, trilateration technique is used. It manipulates the calculated distance of the beacons by finding their intersection. To get the measured distance the researchers use an algorithm named Free Space Path Loss wherein it converts the Wi-Fi strength into distance. For the direction, slope formula is used to determine the measured angle between the rescuer and the victim. Therefore, by making this wearable device, the search and rescue operation will increase its accuracy to 80% in finding the distance of the rescuer and the victim and by 100% in finding the direction of the rescuer from the victim.

Keywords –Indoor Tracking, PPG Sensor, Wi-Fi Positioning System

I. INTRODUCTION

Technology now plays a vital role in search and rescue operations. Advanced technological devices have been developed to help drop humanitarian aid to reduce time, energy and resources spent on operations. [1] Some of the technologies are the Wearable Heartbeat Detector using Photoplethysmography sensor with Android Mapping Application which uses Wi-Fi frequency and signal strength to track the victim and earthquake and down-hole trapped personnel searching and rescuing system which functions by a wireless data transmitting unit and a portable wireless data receiving equipment, and can work independently without relying on any other transmission networks.[2] Lastly is the project kwago which looks like a drone that aids in finding victims through detecting heat signatures in the parameter using a thermal imaging camera.[3] These inventions are intended to improve search and rescue operation in the aftermath of an earthquake. Today, Wi-Fi positioning system (WPS) is used for implementing indoor tracking. Unlike GPS, WPS can work in indoor spaces by identifying hot-spots or locating signals from a particular device. [4]The Wi-Fi positioning system can be implemented with the use of trilateration technique. Trilateration technique is the process of determining the absolute or relative position of an object.Thus, a research that will uplift the limitations of the devices present today is needed to bring improvement to the functionality and results of the invention which can resolve the delay of search and rescue operation.

II. BACKGROUND OF THE STUDY

Earthquakes are always happening somewhere. The National Earthquake Information Center locates about 12,000-14,000 earthquakes each year. It can either be small earthquakes such as magnitude 2 and smaller that happen several hundred times a day and not felt by human or great earthquakes with magnitude 7 that happen more than once a month and magnitude 8 and higher, occur about once a year. [5] During an earthquake, a person can be buried during and after an earthquake in a collapsed building. The person can either move or ask for help using a cellphone or by calling them. However, cellphones do not give the rescuers the location needed. Also, calling rescuers endlessly may lose the person's energy and can possibly result to death. [6] Rescuers are tirelessly searching for earthquake victims before it becomes too late. The rescue workers conducts physical search and rescue and use heavy machinery like bulldozer to destroy the collapsed debris, gesture for silence and used sniffer dog as they search for survivors. [7]

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Last February 6, 2016, a powerful and shallow 6.4 magnitude earthquake struck Tainan, Taiwan which resulted to a collapsed building with 256 people registered living in the 96 apartment available. [8]

Search and rescue teams have a hard time digging . Around 800 troops have been mobilized to help the rescue effort, with sniffer dogs also searching through the rubble. Rescue teams use cranes, ladders and sniffer dogs to track and pull out survivors. [9] In the Philippines, one of the remarkable earthquakes that struck the country is the magnitude 7.2 earthquake that happened last October of 2013 in the central Philippines specifically in Bohol province. The earthquake results to an estimated 200 people died, 600 injured and 20 missing. [10] Rescuers struggle to reach the isolated communities and the heavy equipment used for rescue was still unavailable so the rescuers have searched the area manually by digging and lifting the debris. [11] Several steps are followed during a rescue operation; the first procedure that occurs is the search for survivors. For this procedure, a thorough routine should be done carefully which can be classified into two search patterns: Primary search and Secondary Search. Also, there are different searching methods present that can enable to locate victims, namely: Canine search, Technical search, Hailing method procedure, Physical search pattern and Perimeter search. [12] When rescuing victims, it takes time, energy and effort on the part of the rescuer because of the difficulty of locating the precise point of victims leading to sacrificing a huge amount of resources and may result to injury or even death of rescuers.[13] The more time passes the less likely to find people alive. So, there are a lot of people that are willing to invest in integrating technologies that can able to find many possible survivors after a disaster like earthquakes. These technologies can detect human motions like chest rising and falling breathing. [14] There is also search and rescue technologies developed used to identify the victim's location like Global Positioning System (GPS) which determines the coordinates or the position of an object which depends on a satellite and there is also a Wi-Fi positioning concept that can also be used. However, GPS has limitations in indoor environment due to the signal transmitted from satellite is reflected due to barriers while the Received signal strength indicator (RSSI), one of the Wi-Fi positioning technique, uses the Wi-Fi signal strength to identify the location by converting it into distance. However, it does not indicate where to move or which direction to go which gives also a time factor during an operation. With this, the proponents came up with an idea of creating a system that will alleviate the current search and rescue operation by creating a device that will provide the rescuers an easy way of tracking the victims during post disaster situation.

III. OBJECTIVES

The general objective of this study is to develop a Wearable Indoor Tracking Device using Wi-Fi Positioning System with PPG Sensor and Android Application.

The project aims to achieve the following specific objectives:

- To integrate an indoor search and rescue device with the use of Wi-Fi positioning system and mobile application that detects the specific location of the victims which includes distance and direction from rescuer's perspective.
- To detect and view the victim simultaneously through the Android Application.
- To utilize the technology of Wi-Fi positioning system in tracking the location of the victim.
- To create a wearable device that sends status and location of the victim.

IV. METHODOLOGY

A. General Method Use

The study uses a descriptive research which shows the detail of the hardware component and the software design with the given model needed in developing the project. The purpose of this project is to observe the current situation of the search and rescue operation and elicit information regarding its need and problem. With the data gathered, the developers can now have the requirement and solution that can grant a more accurate result and more efficient service.

Fig. 1: Level 0 diagram of the Wearable Indoor Tracking Device using Wi-Fi Positioning System with PPG Sensor and Android Application

Fig. 1 shows the Level 0 for the Wearable indoor tracking device using Wi-Fi Positioning System with PPG sensor and Android Application. The pulse rate will serve as the input for the device while the light indicators, buzzer alarm, victim's heart rate and victim's location map serve as the output.

Fig. 2: Level 1 diagram of the Wearable Indoor Tracking Device using Wi-Fi Positioning System with PPG Sensor and Android Application

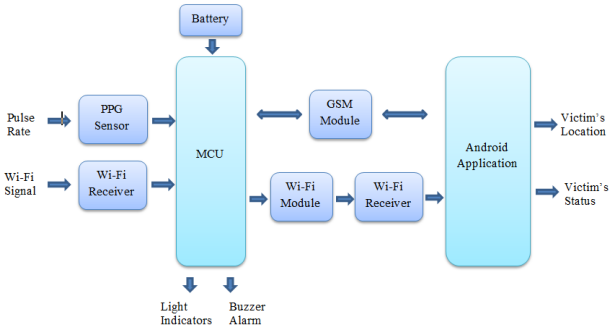

Fig. 2 shows the Level 1 for the Wearable indoor tracking device using Wi-Fi Positioning System with PPG sensor and Android Application. It shows that the inputs for the wearable device are the pulse from the user and the Wi-Fi signal. These inputs are generated by the wearable device and output the status and location of the user to be sent to the mobile application as input. The mobile application will then display the user's status and location.

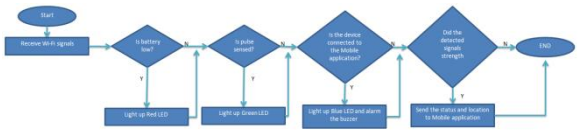

Fig. 3: System process flow of the Wearable device

Fig. 3 illustrates the flow of the wearable device. The device will receive W-Fi signals from the beacons which would be used to determine the location of the device. Then it will check if certain conditions are met which includes lighting the Red LED if the battery is low, lighting the Green
LED is the pulse is sensed, and lighting the Blue LED and alarming the buzzer of the device connected to the mobile application. Once the detected Wi-Fi signals changes, it will send its updated status and location to the mobile application through GSM.

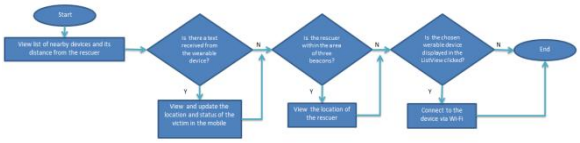

Fig. 4: System process flow of the Mobile Application

Fig. 4 illustrates the flow of the mobile application. The mobile application displays the list of scanned wearable devices including the user's information, status and distance away from the rescuer. Each item can be clicked where it will be connected to the chosen wearable device. If there is a message received from the wearable devices, it will display and update the plotted location of the device in the radar simultaneously. Meanwhile, if the rescuer's mobile device is within the area of the three beacons, it will also display and update the rescuer's plotted location in the radar in the mobile application simultaneously.

Fig. 5: Beacons are placed in a triangular manner

Fig. 5 The three (3) beacons should be turned place equidistant with each other forming a triangle position. Beacons must be switched on to operate. They emit Wi-Fi signals which are scanned by the wearable device.

Fig. 6: Wearable device

Fig. 6 shows the physical view of the wearable device. The wearable device should be within the trilateration and able to detect the Wi-Fi signals coming from the beacons which will be converted into distance. The GSM module will send a message to the mobile application that contains the distances of the beacons from the user. Then, it will be used in the formula of trilateration to identify the exact location of the user and the rescuer.

Fig 7: Mobile Application

Fig.7 shows the home screen of the mobile application where it displays the list of scanned wearable devices including the user's information, status and location within the trilateration. Once the item is clicked, it connects the mobile application and the wearable device to notify the user that the rescuer is coming. The location of the rescuer and the user will be plotted in the radar every 15 seconds.

V. SUMMARY OF FINDINGS

This study summarizes the following findings:

- The acceptance test of the android application shows that the android application list downs the names of detected victims together with their picture and location. Also, an image representation of the location of victims is available to the rescuer. It enables to connect to a wearable device to activate the light indicator and buzzer to notify victims that rescue is coming. When the mobile application is opened, it sends a message to the available wearable device within the trilateration to trigger the wearable device to send the status and location of victim. One can create, update and delete a profile of a user of the wearable device.
- The acceptance test of light indicators and buzzer shows the connectivity of the android application and the wearable device. The blue LED and buzzer activates when the android application connects to the wearable device. The red LED lights up when the source is low on battery while the green LED lights

up when pulse is detected using the pulse rate sensor.

- The acceptance test of the Wi-Fi module as beacons shows that the wearable device detects the emitted signals from the three beacons to be used for the implementation of the trilateration.
- The acceptance test of using the GSM module shows that the location and status of victims is sent to the mobile application.
- The acceptance test of the pulse rate sensor shows that the green LED lights up when a pulse is detected from user.
- The acceptance test of connecting all the components of the wearable device in order to create a tracking device shows that the microcontroller used controls the pulse rate sensor and GSM module. Arduino Pro Mini is the microcontroller used. It controls the detection of pulse using the pulse rate sensor and sends the data to the mobile application. The GSM module was used in order to send text messages containing the status and location of victim to the mobile application. The mobile application detects the available wearable devices within the trilateration and lists down the name, status, location and photo of victim. The mobile application can connect to the wearable device which in return activates the blue light indicator and buzzer.
- The acceptance test of the lightweight battery shows that the wearable device is independently powered up which minimized the weight of the device. The battery can be recharged using a mini USB port which minimized frequent charging of the device.

VI. CONCLUSIONS

In order to achieve the wearable indoor tracking device, the researchers utilized the technology of Wi-Fi module, GSM, Pulse rate sensor, and a microcontroller. The pulse rate sensor was used to determine if pulse is detected from the victim wearing the device while the GSM module was used to be able to send the location and status of the victim to the android application. The researchers utilized the technology of Wi-Fi positioning system in tracking the location of the victim with use of Wi-Fi Module. This Wi-Fi module serves as beacons in which it provides Wi-Fi strengths that will be manipulated using the algorithm in the mobile application in order to achieve trilateration technique. Android application is used to give aid to the rescuers during operation. It will be used to track the victims with the wearable device. In the mobile application, the rescuer can simultaneously view the victim's location which includes its distance and direction from the rescuer's perspective.

RECOMMENDATIONS

For the next innovators, the following recommendations are suggested:

- The researchers recommend improving the case design of the wearable device to make it as small as possible to be used comfortably by the user.
- To enhance the post where the beacon is attached to look more presentable.
- To improve the range capacity of the Wi-Fi trilateration to cover a wide range over 200 meters.

REFERENCES

1. Anonymous. "When Disaster Strikes: Technology's Role in Disater Aid Relief," *Eastern Kentucky University Online, 2016*
2. "Earthquake and down-hole trapped personnel searching and rescuing system. "CN101308203A, 2008
3. Admin. "Filipino-made drone can help boost search and rescue operations", *The Summit Express*, 13-Feb-2016
4. D.S. Nirma and S.N. Kavish, "Basic of Wi-Fi based positioning system Wi-Fi Based Positioning System," 2016
5. Anonymous. "How Earthquakes Happen," *U.S. Deaprtment of the Interior*, U.S. Geological Survey, 2016. [Online] Available: Https://pubs.ysgs.gov/gip/earth1/how.html
6. R. Sharpe, "Systems for locating and identifying victims of manmade or natural disasters, "US20060148423A1, 2016
7. Anonymous, "Rescuers Tirelessly Search For Earthquake Victims in Mexico City, *"NBC News*, 22 Sept 2017
8. A. France-Presse. "Eleven dead after powerful Taiwan quake fells buildings. "Inquirer.net, 06 Feb 2016
9. A. France-Presse, '24 dead as rescuers race to save over 120 buried after Taiwan quake, "*Inquirer.net*, 04 Feb 2016
10. L. Smith-Spark, "Death toll climbs to 183 in Philippines earthquake. "CNN. 13 Oct 2013
11. Anonymous, "Time running out of for victim in Bohol rubble as quake deaths hit 158," GMA News, 2013
12. P. Singh, "Disaster Management & Rescue Operations, " Linkedln, 2015
13. U. Z. Khna, K. Turza, Muntasir Wahid Enamul, and T. Aquib, Tasnim Zaman Moumita, "A Navigation system for rescue operation during disaster management using LTE adbvanced network and WPAN, '2016
14. NAIROBI, "Rescue people trapped in a collapsed building, "IRIN, 2009

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