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Positioning Alarm System of Smart Life Jacket Tube

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Abstract: With the recent development of IT industry, various IoT products are being introduced. IoT refers to the independent handling of tasks by devices connected via. a wired or a wireless communications network through the interactive exchange of information collected from sensors without the help of human beings. This study intends to design and realize a smart life jacket and life tube by applying an Arduino to life jackets and life tubes. Through the Java language-based Android studio, this system makes it possible to track the location of accident victims through smart phones. Using this system, it is expected to become easier and quicker to rescue accident victims on and in water.

Key words: Arduino, Java, smart phone, internet of things, Android studio, rescue accident

INTRODUCTION

Recent rises in income levels have resulted in an increase in the number of individuals who enjoy maritime and water sports. Despite a corresponding increase in distress accidents, difficulties in quickly responding to the accidents result in increasing concerns for safety. In light of such problems, there is an increasing need to undertake studies to protect the life and health of citizens from emergency situations, criminal activities and accidents. Under the current system in most cases of accidents, a request for assistance is made to a 119-emergency rescue team through mobile phones or two-way radios. However, due to difficulties associated with explaining the exact location of the distress accidents, much time is spent on initial search activities by first responders arriving at the scene, resulting in failure to meet adequate rescue times (Byoung-Gil and Chang-Su, 2003). Such circumstances have led to the need for further studies that can reduce human casualties associated with the occurrence of distress accidents.

Recently developed location notification technologies have been further developed alongside the commercialization of GPS (Glbal Positioning System) technologies. Such technologies have been applied across various fields for the purposes such as the preventing crime and missing children. This study focuses on a means of providing assistance to identify the locations of accident victims. A heart rate sensor monitors the development of emergency situations of accident victims and provides the location of accidents on a smartphone once an accident occurs. This system can reduce rescue time by accurately and quickly pinpointing the location of accident victims compared to existing methods of rescue that involve the reporting of accidents through mobile phones by initial witnesses or the victims of accidents. By indicating the exact location and emergency situation of an accident victim through this system, time spent on search activities prior to rescue and loss of life are expected to be reduced.

Literature review

Arduino: Arduino in Italian means friend and is a device that was created in 2005 by an Italian design school for the purpose of helping its students easily create controllable electronic circuit design products. Unlike other existing Micro-Controller Units (MCUs), the Arduino uses a single 8 bits flash memory chip to store its programs and applies an Atmel AVR-based board. The main components of an Arduino system include an Uno board that serves the MCU role, a Bluetooth module that oversees communications with wireless devices and a number of relays used to turn various electronic devices on and off. In addition, it includes ethernet shields used for internet communications by the Uno board as well as other communications-related shields such as WiFi

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shields used to make connections via. WiFi. A number of sensors measuring and detecting temperature, humidity, illumination intensity, acoustics, movements, heart beats and inclines provide input values to an Uno board also exist (Anonymous, 2018).

Internet of things: Jeremy Rifkin predicts the coming of a third revolution through a means that combines environmentally, friendly energy with the internet based on the internet of things. He mentioned that this will be at the heart of a sharing economy (Rifkin, 2014). An internet of things refers to an internet environment in relation to the creation, interaction and sharing of information by people, nearby things and data via connections on a wire or a wireless network. The internet of things is a concept regarding the creation of services based on the communication of networks and devices made of sensors (Nam, 2014).

Pulse sensor: A heart rate sensor is composed of an LED and a light detection sensor capable of detecting reflecting light. A green wavelength (525 nm) appropriate for the skin tone of Asians was selected as the wavelength of the LED light. Heart rates are measured by calculating differences in volumes of reflected light associated with differences in blood flow due to heartbeats by placing a sensor on areas of high blood flows where changes in blood flow is typically visible such as on one's fingers or ears.

Hardware of pulse sensor: This system is divided into 4 parts including sampling, filtering, calculating and output. Sampling receives a pulse signal from ADC Unit Pin A3 and has cycles every 500 msec. Filtering performs initializations every 500 msec to prevent the counting of light reflecting from the PPG as double pulses. Filtering also limits the system to 8 bits for the purpose of removing surges of the value extracted from the PPG. Calculating performs calculations of the number of heartbeats based on the value extracted from the PPG and output transmits the extracted data via Bluetooth communications using Pins 3, 4 (RX.TX) (Gong *et al*., 2015; Cho, 2015; Woo and Lee, 2016).

GPS module: The navigation equation used to determine the location of a moving object through GPS technology makes use of a geocentric coordinate system. If the distance of an object to a GPS satellite is known, the location of an object falls within the surface of a sphere having the GPS satellite at its center and the distance to the GPS satellite as its radius (Lim *et al*., 2009).

MATERIALS AND METHODS

Raspberry P_i-based automatic inventory management system

System design: This study regards the realization of a smart life jacket and tube location notifying system composed of a GPS module, LED lights and buzzers indicating the location of accident victims to nearby areas, wireless communication (Bluetooth, WiFi) linking web servers with applications, heart rate sensors used to measure the heart rate of a person and Arduino boards. Such location notifying systems can be used to immediately relay the location and emergency status of accident victims for further application in rescue operations. The system design drawings regarding the above were presented in Fig. 1. The design drawings of this system include a measuring module capable of measuring the heart rates of accident victims an Arduino module-based tool that indicates accident victim locations both visibly and audibly and a system that accurately indicates accident victim locations on maps in Android application environments.

Data communications for the Android App. was made possible using an Arduino module and Bluetooth module. The locations of accident victims on the application were made available through a web module. Shorter rescue times were induced by making the locations of accident victims easily and quickly available on smart phones through reading heart rates obtained from the measuring module.

A Bluetooth module was used to transmit location information obtained from the WiFi and GPS module to smartphones. The measuring module served the role of measuring and analyzing the heart rate of the person wearing the life jacket or life tube using a heart rate sensor. The indicator module served to function as a visible indicator of the accident victim to individuals nearby in the event that irregularities regarding the heart rate of the accident victim were detected.

Figure 2 shows the Arduino was remotely controlled via. an application using Bluetooth technology. During this process, using the heart rate sensor, emergency situations were monitored and the location of accident victims was found through GPS. Such information was transmitted to the application through WiFi.

System implementation: The system of this study was developed on Microsoft Windows 7 Home Premium K 64 bit. API 14: Android 4.0 (Ice Cream Sandwich) was set as the Android minimum required SDK and API 18: Android 4.4.2 (Kit Kat) was set as the target SDK. The operating principle of the LED and buzzer-based system

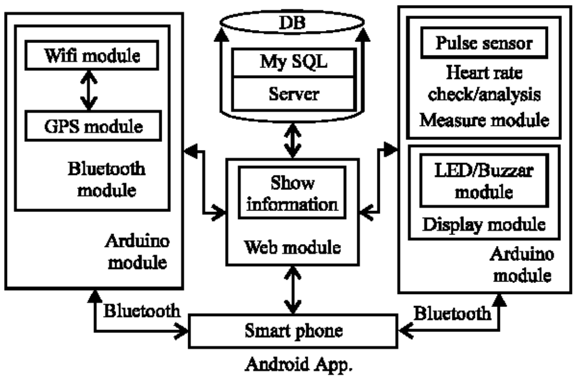

Fig. 1: System architecture

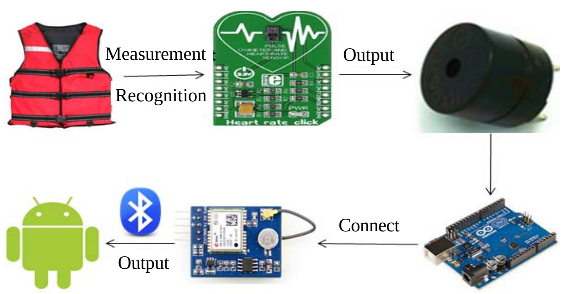

Fig. 2: System flow

set to operate when heart rate irregularities are detected through measurements taken from the Arduino and heart rate sensor is presented in Algorithm 1.

Algorithm 1; pulse measurement algorithm:

```
if (N>250){
if ((Signal>thresh) && (Pulse >110) && (N>(IBI/5)*3)){
Pulse = true
digitalWrite(blinkPin, HIGH)
tone(buzzer, 500, 1000)
IBI = sampleCounter-lastBeatTime
lastBeatTime = sampleCounter
if (secondBeat){
secondBeat = false
for (int = 0; i<=9; i++){
rate[i] = IBI; } }
................................Shortening.................................
rate[9] = IBI
runningTotal += rate (Woo and Lee, 2016)
runningTotal /=10
BPM = 60000/runningTotal
QS = true
}
}
if (Signal<thresh && Pulse <110){
digitalWrite(blinkPin, LOW)
```

Using the pseudo code algorithm presented in the measuring module is set to trigger LED lights and buzzer sounds through an IF function once a certain heart rate is measured by the heart rate sensor. The heart rate signal measurement cycle was set to 2 msec and the conditional function was set to trigger LED lights and buzzer sounds once heart rate measurements surpassed 110 bpm. The heart rate measurements can also be used to discern emergency and general situations. In addition, if rapid increases or decreases in heart rate measurements are detected such situations are regarded as emergency situations and location information in the form of coordinate values are provided by connecting the Arduino to the GPS module. Algorithm 2 presents the arduino source used to find coordinate values.

Algorithm 2; GPS connecting algorithm:

```
#include <SoftwareSerial.h>
SoftwareSerial GPS(11, 12)
void setup() {
Serial.begin(9600)
gps.begin(9600); }
void loop() {
if (gps.available()) {
Serial.write(gps.read()); } }
```

Algorithm 3; connecting algorithm:

```
#include <SoftwareSerial.h>
SoftwareSerial BTSerial(2, 3)
void setup() {
Serial.begin(9600)
BTSerial.begin(9600); }
void loop(){
while (BTSerial.available()){
byte data = BTSerial.read()
Serial.write(data); }
while (Serial.available()){
byte data = Serial.read()
BTSerial.write(data)
} }
```

The algorithm used to transmit the information values of each sensor and Arduino via. Bluetooth to the application is presented in Algorithm 3.

Implementation results: The results of realizing the system proposed in this study are as shown in Fig. 3 and 4. Figure 3a presents the initial display window after the application is run. By pressing the 'accident victim location' button on this window, the location of the accident victim is displayed on Google Maps using the coordinate values found using the GPS signal of the GPS module as shown in Fig. 3b. Using this location, the quick rescue of accident victims is made possible.

Figure 4 presents the actual life jacket that was used in this study. The Arduino used to measure heart rates and serve as a buzzer is one of the pockets and has been waterproofed using a product called Never Wet.

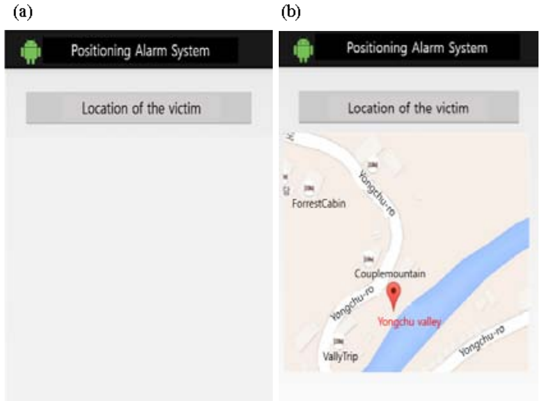

Fig. 3: a, b) System implementation results 1

Fig. 4: System implementation results 2

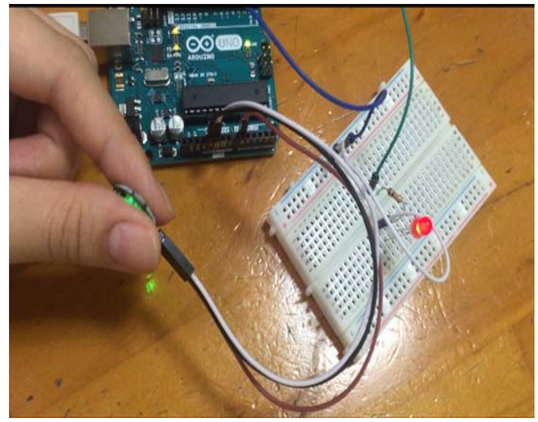

Fig. 5: Pulse sensor evaluation result 1

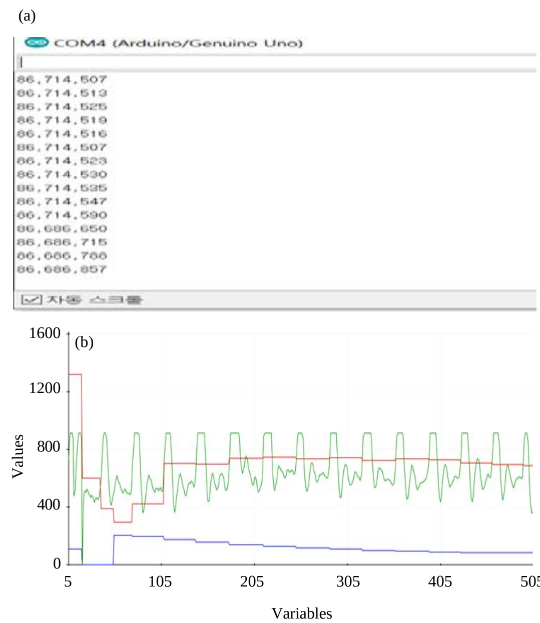

Fig. 6: a, b) Pulse sensor evaluation result 2

RESULTS AND DISCUSSION

Performance evaluation: A performance assessment of the smart life jacket and tube location notifying system was undertaken to assess the accuracy of LED and buzzer activations based on the accuracy of heart rate measurements and to assess how accurately the location of accident victims was presented. Figure 5 indicates that the LEDs lit up after heart rate irregularities were detected through heart rate measurements.

Figure 6 presents the window that displays measured heart rates taken from the heart rate sensor in the measuring module. The three numbers displayed on a serial monitor indicated BPM (heart rate), IBI (Inter-Beat Interval) and SIG (Signal), respectively. The red colored line of the serial plotter graph indicates IBI (Inter Beat Interval), the green colored line real-time heart beats and the blue colored line BPM (Beats Per Minute). As indicated, the location values regarding a total of 5 locations found using the longitudinal and latitudinal coordinates received from the GPS module were almost free of error. Figure 7a presented latitudinal errors and Fig. 7b presented longitudinal errors. Figure 7a presents in a graph in a more visually comprehensible manner. Upon examining the graph, it was found that

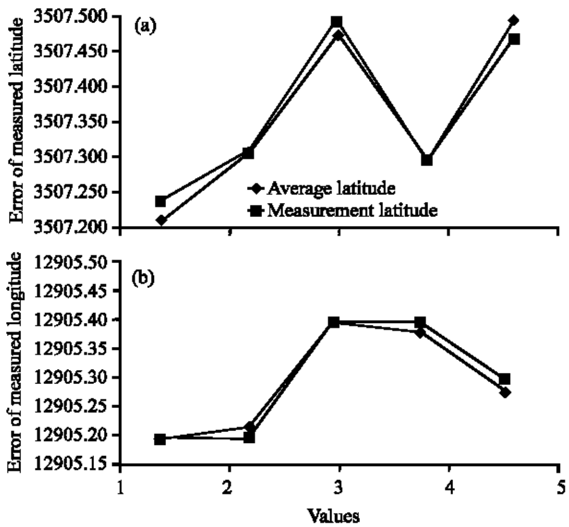

Fig. 7: Error of measured position

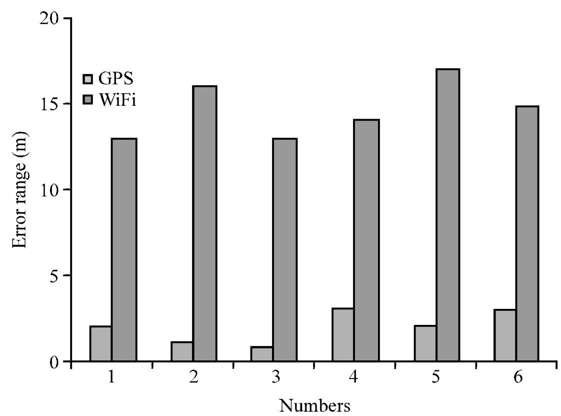

Fig. 8: Comparison of error range

there were almost no errors. The errors in this case are hardly noticeable with the unaided eye when comparing the location on display on the Android-based smartphone map. Figure 8 presents a graph indicating the location accuracies of measurements taken from 6 locations.

As indicated in Fig. 8, most outdoor locations such as beaches or valleys were accurately represented through GPS. However, measurements of some indoor sites such as indoor pools presented error margins of a minimum of 40 m to a maximum of 300 m due to the location being calculated through WiFi. However, this is expected to be less of a problem in sites having greater numbers of WiFi installation sites.

CONCLUSION

This study aimed to realize a location notification system composed of LED lights, a piezo buzzer, a heart rate sensor, a Bluetooth module, a WiFi module and Arduino boards. The system was designed for the purpose of accurately locating accident victims in a smartphone environment and assessing the degree of emergency of accident victims as quickly as possible. This system was designed to trigger LED lights and sound buzzers to notify people nearby in the event of emergencies and to indicate the location of accident victims to guardians, lifeguards and rescue personnel in remote areas for the purpose of assisting the initial search activities of rescue operations. Although, the current system is limited in that heart rate measurements can only be taken when the heart rate sensor makes direct contact with accident victims, future means of complementing the system capable of measuring heart rates simply by wearing the life jacket or tube are planned for development.

RECOMMENDATIONS

In the current system, the types of inventory products were identified by using a color sensor. Future studies will be conducted to enable the system to identify more types of products not only by referring to product colors but also by using color tags.

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