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Short Paper

Smart Tracking Device with Pulse Sensor via GSM/GPS Module

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Abstract

Purpose – This device was to detect the user's location using a GSM/GPS module with a SIM card. It triggers when the user presses the push button twice and sends messages with the user's location and pulse rate to the mobile phone.

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Method – Applied, quantitative, and descriptive types of research were the methods and designs used for the development of the working prototype. Likewise, closed-ended survey questionnaires for the 25 randomly selected respondents used the five-point rating scale that is based on ISO/IEC 9126 and ISO/IEC 27000, and hardware and software components, and analytical tools were integrated into the study.

Results – The tabulated survey yielded a computed weighted mean of 4.43 with an overall verbal interpretation of "Agree" which means most of the respondents believed that the prototype was effective in terms of sending accurate information such as location and pulse BPM that helps a person with a medical condition or encountering an emergency such as being kidnapped by alerting their parents or guardians.

Conclusion – In the final analysis, the study showed that the device has a user-friendly interface, is easy to use, and can operate efficiently based on the results of the survey conducted to determine its acceptability.

Recommendations – The researchers recommend for those who wish to replicate this prototype that there is much more to develop and improve than the current prototype, which has difficulties in the following areas: maximizing battery power from 12 hours to 14 hours, minimizing the design of the prototype by using Arduino Nano, use vibration motor as an indicator. Likewise, the A9G GPRS/GSM+ GPS/BDS module should be used to minimize the dimensions of the prototype and include the emergency hotline or the number of police stations or barangay halls that can receive the message.

Practical Implications – The device can track location effectively and provide heart rate measurements, making it a promising solution for personal tracking and health monitoring.

Keywords – Arduino Microcontroller, GSM/GPS Module, Pulse Sensor, Tracking Device

INTRODUCTION

The cases of kidnapping are still happening here in the Philippines. Last year, according to data gathered 25 of these incidents, or 80.64 percent, happened on the island of Luzon with seven cases in the cities of Paranaque, Pasay, and the province of Pampanga (Tupas, 2022). As time passes by technology is also making progress, one of the technologies that were developed is the Global Positioning System (GPS), which provides a method to navigate, measure speed, and determine location.

The Philippines' hot dry season begins, where more blood may flow to the skin because of high humidity and temperatures. This causes the heart to beat more quickly while pumping twice as much blood per minute as it would on an average day (Cleveland Heartlab, 2019). The ability to foresee heart attacks is lifesaving and one always chooses

prevention over treatment. The number of times the heart beats in a minute, or in technical terminology, beats per minute (BPM), can be used to identify heart attacks. The deviation of the pulse rate from the upper and lower boundaries (60-90) is regarded as a warning of an impending emergency (Santhana & Geeta, 2019). Tachycardia is the medical term for an abnormally high heart rate; there are various types of tachycardia such as multifocal atrial, ventricular, and sinus. However, age and general health may also affect how quickly a person can move (Schulman, 2024).

This study aimed to develop a device capable of tracking a user's location using a GSM with a SIM (Subscriber Identity Module) card and GPS (Global Positioning System) integrated with a pulse sensor. As a result of the alarming situation in the Philippines, the researchers built a device to secure the safety of the people.

The device triggers when the user presses the push button twice with a pulse sensor. This device will send messages with the user's location and pulse rate to the mobile phone. Likewise, a SIM card; however, some areas have poor signals or dead spots. When the user is in the dead-spot area, the device cannot send SMS messages to the mobile phone.

Objectives of the Study

The study has the following objectives:

1. To help other people when there is danger or an emergency.
2. To aid in the prevention of possible kidnapping cases and to save someone's life.
3. To monitor the user's heart rate and keep track of the user's location.
4. To conduct field tests and user evaluations to assess the device's performance, accuracy, and user acceptance in real-world scenarios.

For the delimitation, the NEO-6M module may struggle to receive GPS signals in areas with poor satellite visibility or obstructed environments such as dense urban areas, deep canyons, or dense foliage. It requires a clear line of sight to multiple GPS satellites for accurate positioning. GPS signals are significantly weakened or completely lost indoors or in areas with limited sky visibility. The NEO-6M module relies on direct line-of-sight signals from GPS satellites, making it less effective for indoor tracking or navigating. The GSM SIM800L module operates within specific frequency bands and may not support all GSM networks worldwide. Its signal coverage may be limited to regions or areas with adequate network infrastructure. The SIM 800L module operates on GSM networks, which have extensive coverage in many parts of the world, providing reliable communication in urban and rural areas. Mobile network providers often employ spam or content filters to protect users from unwanted or malicious messages. These filters may sometimes block or filter out messages that contain links, especially if they are flagged as potentially harmful or suspicious.

LITERATURE REVIEW

GSM/GPS Modules

According to Chavan et al., (2022) GPS and GSM modules are used for the health monitoring tracking system, which detects a person's location and sends messages to the contacts of the phone.

Joseph (2022) suggested the best components of GSM and GPS before starting a tracking project available in the market. He also cited the things that are considered before purchasing a GPS module.

According to Vani et al., (2019), they created a device that allows women and children to send an SMS warning to the pre-selected emergency numbers when they click the button. The device can track location and will help to avoid the incidence of kidnapping and similar crimes. The researchers used GSM for transmitting SMS and a GPS module to provide an accurate location of the user's device.

Singh and Kumari (2019) discussed an effective anti-theft automotive security integrated with the Global System for Mobile (GSM). The system presented has two tracking modes: online tracking, which uses GPS to receive vehicle location information from satellites and offline tracking. The vehicle's GSM system is installed to transmit information to the owner. Preventive measures, such as engine ignition cutoff, are installed and controlled by the owner's or user's GSM mobile phone. The owner can lock or unlock the vehicle via SMS.

Location Tracking Systems

The location tracking system which was developed by Thin Thin Htwe et al. (2019) as part of their research, can create a device that sends notifications through text that contains latitude and longitude. To identify the location, it uses a GSM module to transmit SMS messages and GPS for the exact location.

As attested by Tummanapally et al. (2021) they built a device that can track a vehicle's location. The idea of the project is to help drivers locate their car if it goes missing or is rented. They used GPS NEO 6M to get the location of the device. The GSM sends SMS to locations that use latitude and longitude. The user will use Google Maps to locate the car. With the device, drivers and owners can avoid car napping incidents.

In the research conducted by Khin and Oo (2018), the vehicle tracking system, which is widely used around the world by fleets and owners of vehicles, has long been established in this age. It's excellent and safe technology. The real-time tracking system was proposed

by the researchers. By using GPS and GSM, it will develop a system to track and position all vehicles.

Pulse Sensors

Puviarasi (2019) mentioned a similar project that can store data on the server for later use. The data contains the previously monitored heart rate of the user and is sent to the server using the HTTP protocol. The Node MCU is used as a Wi-Fi module to connect the pulse sensor to the server.

As expressed by Shanmugam et al. (2018), the internet-of-things (IoT) enables the linking of numerous smart gadgets. The system created is a functional prototype for monitoring patients and heart attacks. It is used to help the health sector build and identify patients with heart attacks effectively. The fundamental concept is to periodically gather health-related data, which is then made accessible through Thing speak which is a real-time interface.

Irawan et al., (2019) reiterated that in the human body, the heart is the primary organ through which other significant organs are influenced by how well the heart works. Although a person's health can be maintained by knowing the state of their heartbeat, this does not necessitate costly medical attention; instead, everything can be a normal lifestyle. The researchers used pulse sensors and Arduino circuits to monitor the heart rate in this study as an alternative to maintaining health.

Sihombing et al., (2020) talked about how heart attacks are now one of the most dangerous diseases affecting people. The human heartbeat, a health indicator of the human cardiovascular system, can be used to determine this attack even if it cannot be foreseen. Heart rate reflects the cardiovascular system's health as influenced by stress at work, physical exertion before or after, and psychological factors. Sadly, some people don't know their heart rate before or after exercising. The study suggests a method for detecting heart rate that uses an Android smartphone, an Arduino microcontroller, and a pulse sensor.

METHODOLOGY

Applied, quantitative, and descriptive types of research were the methods and designs used for the development of the working prototype. Likewise, closed-ended survey questionnaires for the 25 randomly selected respondents used the five-point rating scale that is based on ISO/IEC 9126 and ISO/IEC 27000, and hardware and software components, analytical tools were integrated into the study.

The hardware components in the development of the prototype of the study were as follows: Arduino Uno board, SIM 800L GSM Module, GPS NEO 6-M, push button, resistors, pulse sensor, jumper wires, and Light Emitting Diodes (LEDs).

The software requirements for writing the codes were Arduino Integrated Development Environment (IDE) and C++ programming language.

RESULTS

The tabulated survey yielded a computed weighted mean of 4.43 with an overall verbal interpretation of "Agree" which means most of the respondents believed that the prototype was effective in terms of sending accurate information such as location and pulse BPM that helps a person with a medical condition or encountering an emergency such as being kidnapped by alerting their parents or guardians.

Figures 1, 2, 3, 4, 5, 6, 7, 8, and Table 1 below describe the system development life cycle model, block diagram, push button and text message flow chart, 3D circuit and schematic diagrams, screenshots of the source codes and the android-based application, visual location in 360 degrees, the visual target and the average resting heart rates in terms of age.

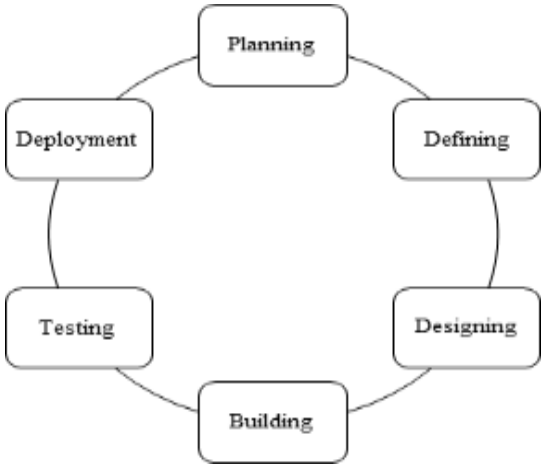

Figure 1. System Development Life Cycle Model

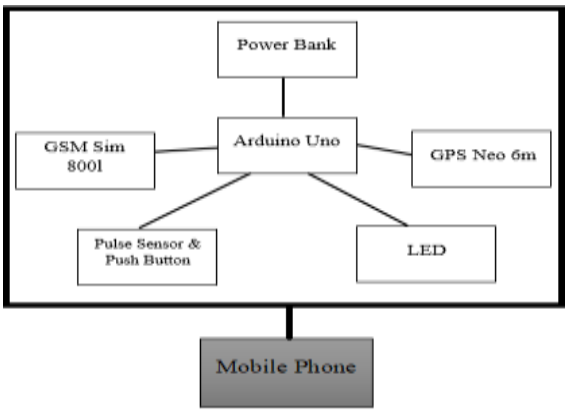

Figure 2. Block Diagram of the Tracking Device

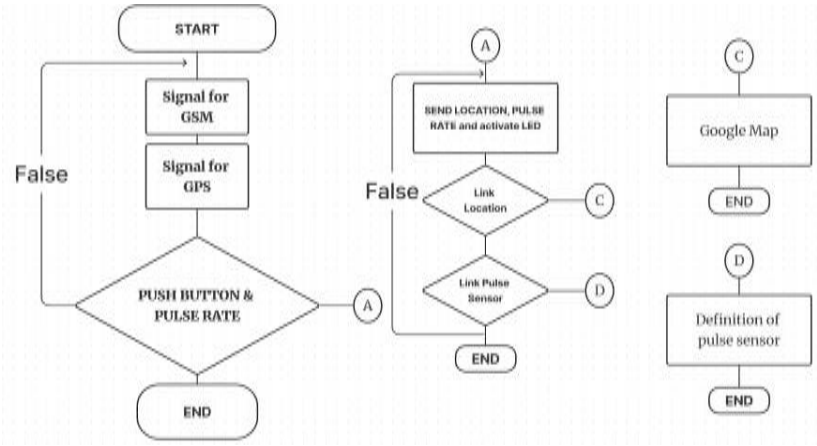

Figure 3. Push Button and Text Message Flow Chart

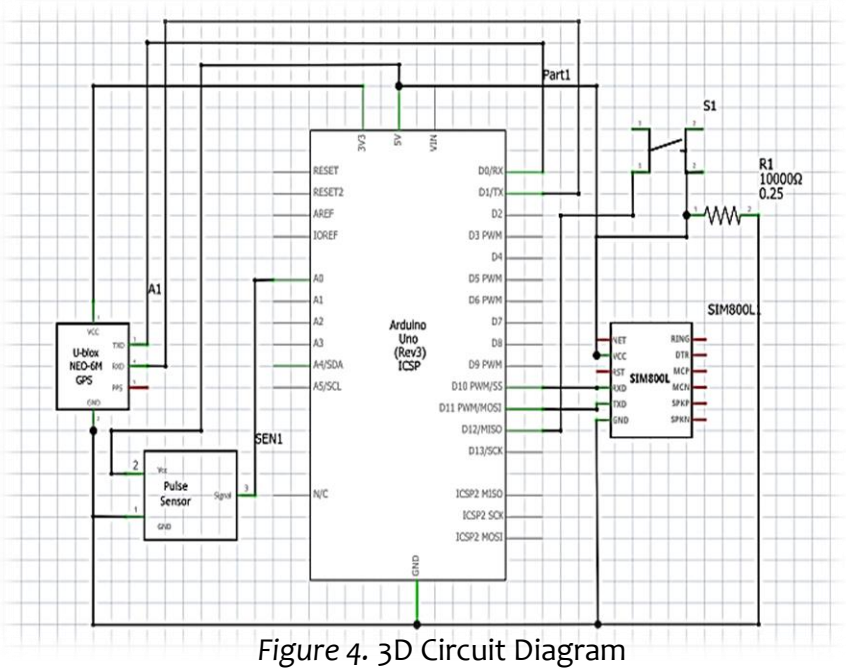

Figure 4. 3D Circuit Diagram

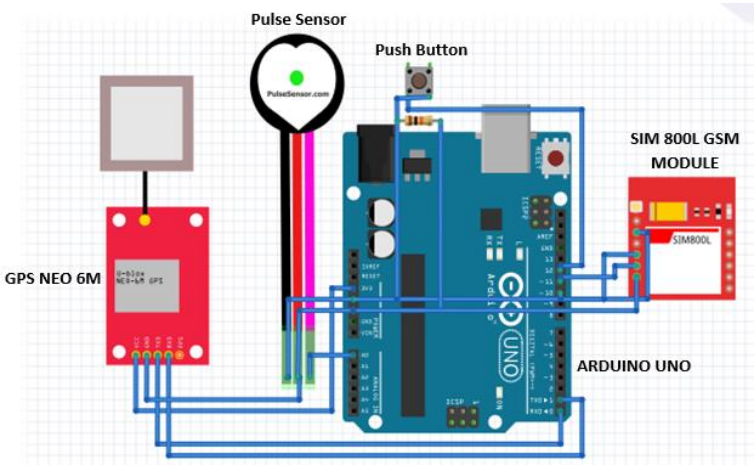

Figure 5. Schematic Diagram of the Tracking Device

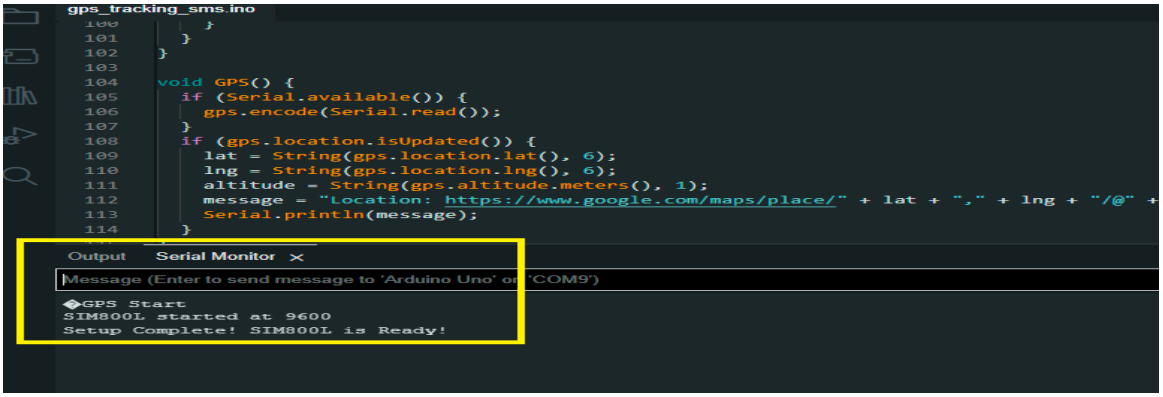

Figure 6. Source Codes in C++

Figure 7. Application Screenshot

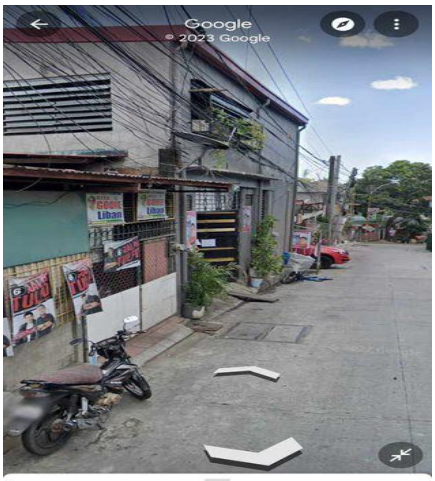

Figure 8. Visual Location in Google Maps 360 degrees

Table 1. The Visual Target Heart Rate and the Average Resting Heart Rate

Age (Years)	Target Heart Rate (50% to 85%) (bpm)	Average Resting Heart Rate (bpm)
20	100 to 170	81.6
30	95 to 162	80.2
35	93 to 157	78.5
40	90 to 153	75.3
45	88 to 149	73.9
50	85 to 145	73.0
55	83 to 140	74.2
60	80 to 136	78.1
65	78 to 132	81.6
70	75 to 128	80.2

DISCUSSION

Figure 1 illustrates the life cycle model from planning, defining, designing, building, testing, and deployment of the prototype. It starts with the planning stage, where the researchers gather the information necessary for the device. The defining stage involves gathering information from related literature and how to build the device. In the design stage, create a layout of the product or device using Target 3000 and other necessary applications to help design the product. In the building stage, purchase all materials to build the device. In the testing stage, the trial-and-error method is being used, trying the device multiple times to collect errors will help the researchers to make it perfectly. In the deployment stage, the device created and managed the mistakes that the researchers collected.

Figure 2 shows the relationships between Arduino Uno as the microcontroller board controlling other components, such as the power bank as the primary source of power, the GSM SIM 800L as the sender of the details, the GPS Neo 6M as the locator, the pulse sensor as the sensor of the BPM, and the LED as an indicator.

Figure 3 presents the operational flow of the system, offering a clear and comprehensive visual representation of how it functions. These are the options; the user can choose between these two options. Push the button to send the location to the cell phone, click the location link to see the Google Maps website, or click the pulse link to see the image of your target heart rate.

Figure 4 explains the connection of the components to the microcontroller. The blue lines indicate the connection of the circuit to the components of the device.

Figure 5 displays the elements of each component of the device and the connection of the devices from the microcontroller.

Figure 6 exhibits the source code in Arduino IDE of the microcontroller board, the codes are then uploaded to initiate an action. The action initiated can be monitored and displayed through the serial monitor.

Figure 7 demonstrates what the device looks like when used, and the message is sent through text forms. It includes a link that directs to Google Maps and the pulse, as well as a link to a diagram of the different BPMs. The notification that the device had already sent a message to the user's cell phone was visible to the user. This means that the user is informed that the message has been sent.

Figure 8 indicates the 360-degree visual location if the link in the message sent is clicked and provides an accurate location of the device in Google Maps.

Table 1 presents the visual target heart rate based on the person’s age. It also shows the average resting heart rate from adolescents to adults.

CONCLUSIONS AND RECOMMENDATIONS

In the final analysis, the study showed that the device has a user-friendly interface, is easy to use, and can operate efficiently based on the results of the survey conducted to determine its acceptability.

The researchers recommend for those who wish to replicate this prototype that there is much more to develop and improve than the current prototype, which has difficulties in the following areas: maximizing battery power from 12 hours to 14 hours, minimizing the design of the prototype by using Arduino Nano, use vibration motor as an indicator. Likewise, the A9G GPRS/GSM+ GPS/BDS module should be used to minimize the

dimensions of the prototype and include the emergency hotline or the number of police stations or barangay halls that can receive the message.

PRACTICAL IMPLICATIONS

The device can track location effectively and provide heart rate measurements, making it a promising solution for personal tracking and health monitoring.

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DECLARATIONS

Conflict of Interest

No conflicts of interest were declared among all the authors.

Informed Consent

Full consent to all participants was agreed upon before taking part in the conduct of this study.

Ethics Approval

The Research Ethics Committee of the Asian Institute of Computer Studies duly approved this study after it conformed to the local and international accepted ethical guidelines.

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Mr. Aljohn L. Dorado is a BS Computer Engineering graduate from the Asian Institute of Computer Studies and works at Alorica, Inc. Mr. Dorado has a keen interest in emerging technologies, supports scientific projects, and fosters creative thinking. He also possesses exceptional leadership skills and teamwork abilities.