On a Touch-Activated Wearable Device with Automated Location Sending Capability

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Received 02 March 2018; received in revised form 08 May 2018; accepted 28 May 2018

Abstract

This study proposes a device that enables a person in distress to remotely seek for help. It is a wearable device consisting of a microcontroller and a GPS-GSM module that has the capability to determine the closest police stations based on the current location of the wearer. When being triggered, it sends the current coordinates of the wearer via SMS messages to the corresponding nearest police station, and a pre-defined contact number. Afterwards, the device sounds off an alarm to fend off any threat, or to serve as an alert of your location.

Keywords: GPS, GSM, SMS, wearable, coordinates, closest police station, alarm, program

1. Introduction

According to data released by the Philippine Star on March 6, 2016, every 53 minutes, a woman or a child is raped. [1] Furthermore, this claim has been supported by the Philippine National Police (PNP) on their submitted Annual National Report for FY 2015 which implicates that rape is the 5th most prevalent crime in the Philippines. Moreover, Quezon City, Davao City and Manila are the top three cities with the highest number of rape cases nationwide.

The project aims to design and develop a prototype of a device that will enable women to seek for help in case of distress or apparent threat. The goals of the project shall be accomplished through analyzing existing similar devices in the market, researching wireless protocols whether are available and applicable to the project, establishing the block diagram of the whole system, and finally developing the design and prototype of the device.

Similar existing devices are already in the market abroad, and there are others that are being developed. These are wearable devices in the form of pendants, rings, bracelets, undergarments, and belts. Some just serve as an alarm while some have complex functions. “Suraksha” is designed to send the exact location of the victim to the police, and it is actuated by voice, switch and shock. [2] “FEMME”, a Bluetooth device, is triggered by pressing the emergency button. Depending on how the button is pressed, the device can send distress messages and the location of the person to the police, can record the audio of the incident and can initiate a call. [3] In the paper entitled, “Smart Girls Security System”, a device was designed in the form of a belt. This device sends the location of the person to the police control room emits an alarm and generates an electric shock to injure the attacker. [4] The paper entitled “Smart security solution for women based on Internet of Things (IOT)” presented a wearable band that is connected to the internet through a smartphone. The device is preprogrammed to record and assess the wearer’s behavior and reactions, and to send the results to the smartphone. If it receives an emergency signal, the software application sends help requests to the nearest police station and people in the near radius of the application. [5]

The difference with the proposed design and these devices is that the proposed design is a standalone device that has the capability to know which police stations are the closest. Then, it can send a message to a registered contact number and the

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closest police station informing the coordinates of the user and then emit an alarm. This is what the automated location sending capability of the design means.

2. Block Diagram

Fig. 1 shows the proposed system-architecture of the study. The 3.7V battery serves as the power supply to the microcontroller unit (MCU). When the device is touched, the sensor-based switch turns to ON state. This event triggers the alarm system. Also, the GPS acquires the coordinates (longitude and latitude) of the position of the wearer from the GPS satellite and transfers it to the MCU. Then, the MCU processes this information and locate the nearest mobile number as to where the SMS text will be sent to using GSM. The mobile number of the possible recipients is determined using the great-circle formula between two points algorithm, which is encoded as a program in the microcontroller.

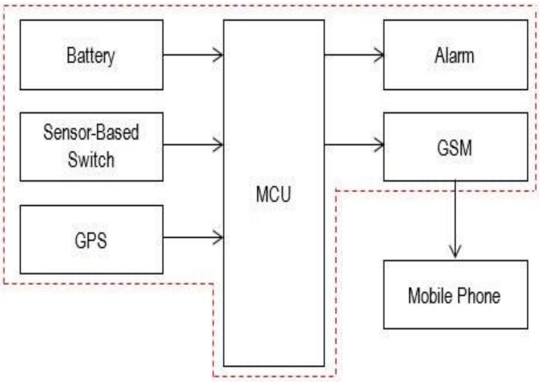

Fig. 1 System architecture

3. System Flowchart

The system flowchart presented in Fig. 2 shows how the device operates. First, the device is activated by a sensor-based switch, particularly a capacitive touch sensor. If the switch is activated for at least 2 seconds, the alarm trigger causes a loud noise to be emitted. The 2-second allowance is configured to avoid false triggering. Afterwards, the device acquires the wearer's position from a GPS satellite. Given the present location of the user, the microcontroller calculates the nearest predetermined location of where the device will send an SMS to. The content of the SMS is the acquired coordinates of the wearer.

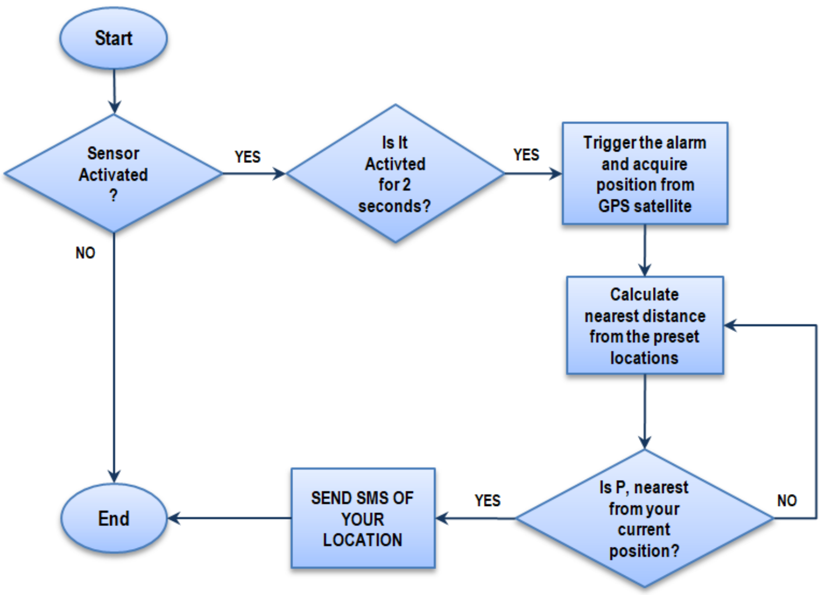

Fig. 2 System flowchart of the design

4. Design Model

The 3D model of the prototype, as illustrated in Fig. 3, consists of the mechanical dimensions and the shape of the device. In this project, the point is on the core wherein the device is encased.

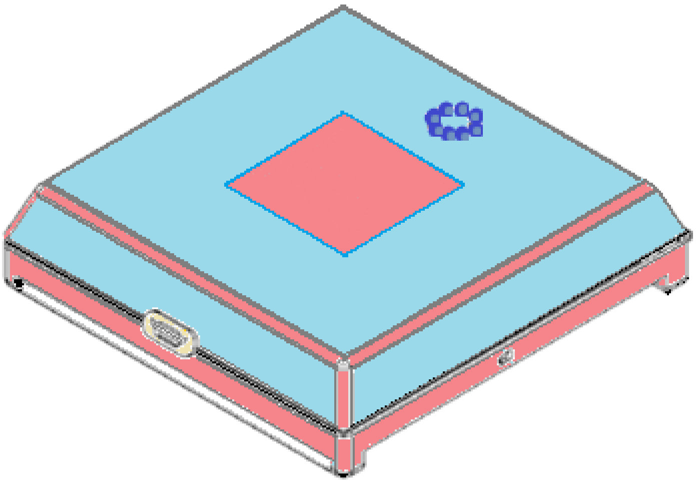

Fig. 3 Design of the prototype

The dimension of the proposed prototype will be approximately 4.6cm x 4.6cm x 2cm while the length is especially designed for the average women's size of wrist, which is typically around 16.5cm to 20.3cm; according to the claim by Klingenberg. In terms of the straps, the said prototype used Nylon Kernmantle rope as its primary material because of its comfortable-to-wear quality and it's good for the hard grip of its main part. Besides, with this kind of non-metal bracelet, the end-users can easily adjust it depending on their most comfortable fit. Moreover, the core is made of acrylic, ideal for physical protection of the internal part of the prototype against the possible external damage.

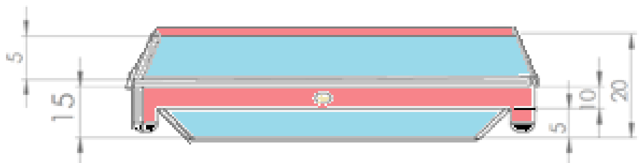

Fig. 4 3D model side view

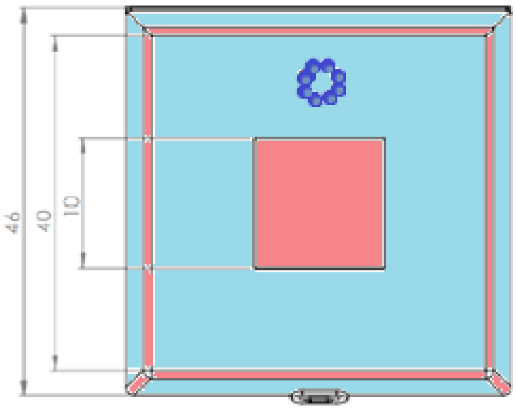

Fig. 5 3D model top view

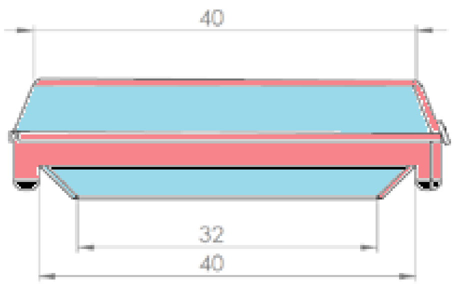

Fig. 6 3D model back view

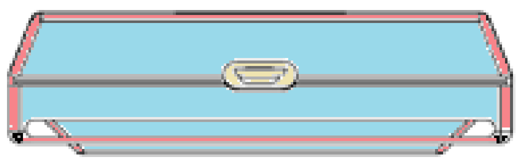

Fig. 7 3D model front view

Fig. 4 shows the side view of the device. The height of the device is approximately 20mm. However, there are no switches or buttons on the sides of the device. Fig. 5 shows the top view of the device. At the center is a 10x10mm square allotment for the electrode used in the touch sensor. At the top of the square is a set of holes in a circular pattern for the vent of the alarm. Fig. 6 shows the back view of the device. The width of the device seen here is approximately 40mm not including the strap attaching portion. Fig. 7 shows the front view of the core of the device. The dimensions are the same as above but the only difference is that there is an allotment for the Micro USB port. The purpose of the Micro USB is mainly for the charging of the device since gadgets nowadays generally use the Micro-B USB for general purposes.

5. Technical Specification

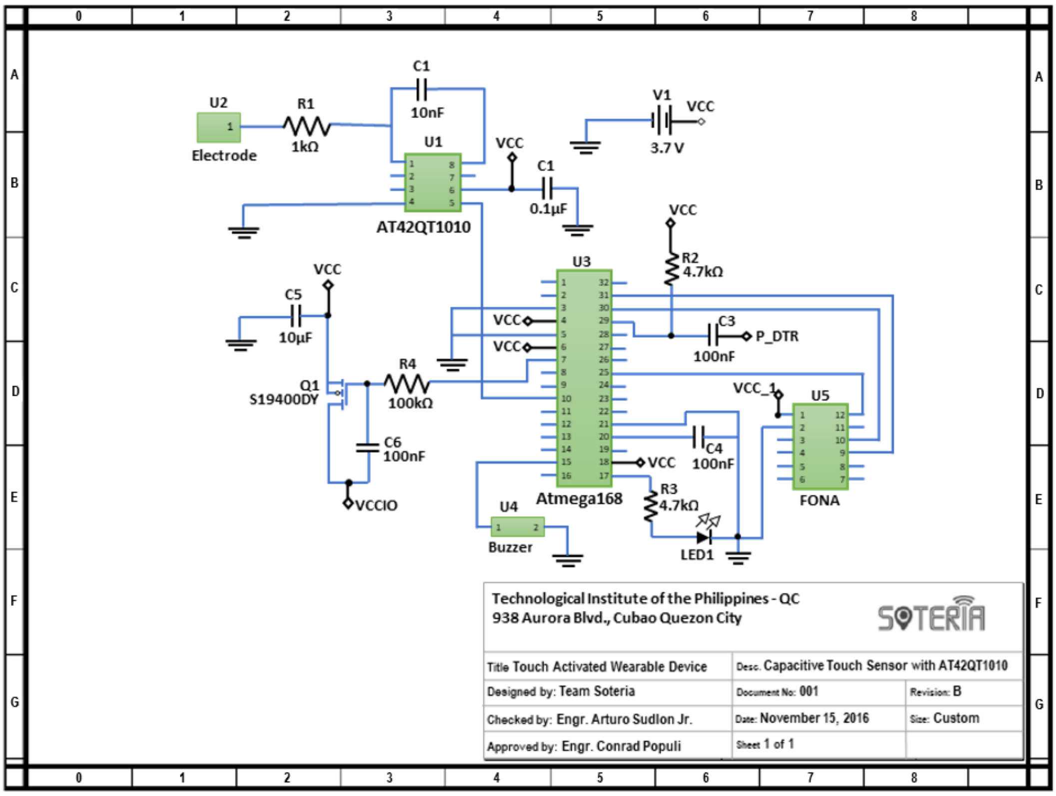

Fig. 8 Circuit digram of the prototype

Fig. 8 shows the circuit diagram of all the components in the prototype. The Atmega168 in the middle represents the microcontroller uHex and its pins are connected to the other main components specifically the GPS/GSM module FONA 808, the capacitive touch controller AT42QT1010, the buzzer CMT-4023S, and the 3.7V battery. The connection of the FONA 808 starts with its Vcc and the Rx and Tx pins. The buzzer is connected to a General Purpose Input Output (GPIO) pin in the microcontroller. Another connection thru the General Purpose Input Output pin is with the output of the Capacitive Touch Sensor.

6. Discussion

Table 1 Selected police station in Marikina city

Point	Station Location
1	PCP 1 Kalumpang 14.623368, 121.090450
2	PCP 3 Sta. Elena 14.633126, 121.095471
3	PCP 8 Marikina Heights 14.649818, 121.117315
4	PCP 9 Parang 14.659243, 121.111994
5	PCP 6 Concepcion Uno 14.653430, 121.102467

To test the device in general, the proponents selected five police stations in Marikina city listed in Table 1. The coordinates of the locations of these police stations were gathered in terms of latitude and longitude. The testing was done in an open area because one of the limitations of GPS is that it is unable to work effectively indoors. A serial monitor was included in the program in order to validate if the device computes for the nearest location and sends it to the default receiver and nearest police station. The proponents provided a comparison of the measured distances with the measured distances from Google Earth. Table 2 shows the actual location of the user and the computed location of the police stations, while Fig. 9 shows the information flow diagram of the SMS.

Table 2 Test data for the first location

Point	Station Location	Location of the User	Measured Distance from the Device	Distance from Google Earth	Percent Difference
1	PCP 1 Kalumpang 14.623368 121.090450	14.6255846023, 121.0621185302	3057.81762 m	3.06km	0.07132%
2	PCP 3 Sta. Elena 14.633126 121.095471		3685.41650 m	3.69 km	0.12421%
3	PCP 8 Marikina Heights 14.649818 121.117315		6521.36669 m	6.52 km	0.02096%
4	PCP 9 Parang 14.659243 121.111994		6541.88232 m	6.54 km	0.02878%
5	PCP 6 Concepcion Uno 14.653430 121.102467		5332.29345 m	5.33 km	0.04303%

Fig. 9 Information flow diagram

7. Conclusions

The proponents were able to design and prototype a sensor-based switch that will trigger the device to turn on. Through a profound understanding with the language of C++, the proponents were also able to program the microcontroller so as to calculate the nearest predetermined location of where the device will send an SMS to. The SMS contains the exact location of the user, which was determined through the Global Positioning System in terms of latitude and longitude. Once the proponents reach the held objectives, the testing procedures followed and applied in the area of Marikina city.

8. Recommendations

To the future designers, this design uses just one module for both the GSM/GPS. Since other pins were left unused in this project, it would be better if the future designers would make a module that would incorporate only the pins they needed. Also, it would be best to use different approach in debugging or testing the prototype in order to get the desired results or outcomes.

This design is limited by the module it uses. The GPS and GSM module employs an antenna. To further boost the signal being captured by the said module, it is recommended to design a new antenna instead of using the antenna bought with the module. In order to not stray from the objectives plus the condition of being time-bound, the proponents decided to not include designing an antenna in this design project.

References

[1] R. Villanueva, “One woman or child is raped every 53 minutes,” The Philippine Star, March 5, 2016.
[2] N.Bhardwaj and N. Aggarwal, “Design and development of ‘Suraksha’ - a women safety device,” International Journal of Information & Computation Technology, vol. 4, no. 8, pp. 787-792, February 2014.
[3] D. Monisha, M. Monisha, G. Pavithra, and R. Subhashini, “Women safety device and application – FEMME,” Indian Journal of Science and Technology, vol. 9, no. 10, pp. 1-6, March 2016.
[4] B. Chougula, A. Naik, M. Monu, P. Patil, and P. Das, “Smart girls security system,” International Journal of Application or Innovation in Engineering & Management, pp. 281-284, April 2014.
[5] G. C. Harikiran, K. Menasinkai, and S. Shirol, “Smart security solution for women based on internet of things (IOT),” International Conference on Electrical, Electronics, and Optimization Techniques, IEEE Press, March 2016, pp. 3551-3554.