

Multi-sensor Wearable for Child Safety

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Abstract— Now-a-days we can see that human life is becoming very fast. Moreover, the city life is getting very busy day- by-day. So in the daily busy schedule it is becoming very difficult for the parents to monitor their children closely. This paper discusses about a smart wearable device like a wristband which tracks the child from time to time to ensure their safety. If any problem occurs it would alert parents through the cell phone so that they can take immediate action. This paper focus on the SMS text enabled communication. Parents can send SMS with some keywords and the device reply back. The device can detect the child's approximate location, it can detect the body temperature and the surrounding temperature, humidity and also the heartbeat of a child. For the emergency situation, the device would have some measures like an alarm buzzer, SOS light which will notify the bystanders to help the child. So this paper is all about the safety and security of a child to help them to recover from any type of difficulty.

Keywords— *Wearable, wristband, child safety, IoT, location, SMS.*

I. INTRODUCTION

This paper is based on Internet of Things (IoT)[1]. IoT means a collection of systems and devices which are interconnected with the actuators and sensors(real-world) to Internet. Examples of some IoT based smart systems are smart city, smart lighting system, smart traffic control system, home automation etc. This paper also focuses on Wireless Sensor Networks[2] and used many sensors. The

usage of these smart systems are increasing day by day. The main motivation that works for this device is security and safety of a child who can face any trouble like lost in a crowded area, not finding their parents etc. This device helps the parents to track the child and to find them. There are quite a few wearable devices in Medical Internet of Things and their comparative analysis[3] which could be used as a base framework for designing the proposed device. There are many such wearable devices available today which tracks child's location, body temperature etc. using sensors through Wi-Fi[4] and Bluetooth[5]. But these two communication medium proved to be unreliable medium. One of the existing work like Wristband Vital[6] uses Bluetooth 4.1 module as a communication medium which is a very unreliable source. So another mode of communication is introduced which is SMS text enabled communication between parents and children in the GSM platform. In GSM platform the rate of failure is relatively small. Some works like Design and implementation of Microcontroller Based Short Message Control System[7], Child safety wearable device[8] uses SMS platform as a communication medium. This paper uses Arduino[9] Uno platform. Arduino GSM Shield provides all the functions like SMS send and receives calls etc. Parents can send SMS with some keywords and the device reply back. The device can detect the child's approximate location, it can detect the body temperature and the surrounding temperature to approximate the child's physical condition. If a child has

some allergy in high humid conditions then it can send an alert to notify the situation by measuring the humidity. The device can also measure the heartbeat of the child to track the child's level of physical exertion. Parents can send SMS with some keywords and the device reply back. The device can detect the child's approximate location, it can detect the body temperature and the surrounding temperature to approximate the child's physical condition. If a child has some allergy in high humid conditions then it can send an alert to notify the situation by measuring the humidity. The device can also measure the heartbeat of the child to track the child's level of physical exertion. There is a secondary module added like SOS light and Alarm Buzzer. When a parent sends an SMS to the device it makes the SOS light ON to alert the bystanders. SOS is programmed with Arduino. Similarly the Alarm will also work in this way. This design also includes some filtering of any kind of interference created due to skin friction or other environmental effects[10]. So the proposed wearable device will use SMS as a communication medium to ensure secured communication. The device could be customized as per the requirements by programming the Arduino System.

II. RELATED WORKS

Many wearable devices are available today. Some existing works like Design and implementation of Microcontroller Based short Message Control System[7] which exposes some applications of SMS technology other than call and sending and receiving SMS. This system gives some solution of some problems of daily life like home appliances (television, light) controlling, water pumping machine, ON/OFF of a switch etc. remotely when the user is not in house. These solutions are cost effective. The messages which are allowed by Short Message System (SMS) on a GSM platform has a length maximum of 160 characters. The main target of this paper is to designing a embedded device. Through sending some specific keyword SMS this embedded device can control up to 5 devices. Wristband Vital: A Wearable Multi-Sensor Microsystem for Real Time Assistance via Low-Power Bluetooth Link[6] is a wearable tracking device which is a light-weight and low-cost device used to help the people in a emergency situation like a child is locked into a car, the vital band sends an alert using the nearby Bluetooth devices to attend the child who is in trouble. Multiple sensors are used for sampling of data and these data are reported to the parent's cellphone and helps to find their child. But it uses Bluetooth as a communication platform which is very unreliable. Wearable Devices in Medical Internet of Things: Scientific Research and Commercially Available Devices[3] makes a comparative study of different health care devices both in commercial purpose and scientific papers. It compares wrist-worn devices like body-worn smart clothing, compares motion tracking devices for health monitoring. Child Safety Wearable Device[8] is a tracking safety device which also uses SMS text communication on a GSM platform. It has an advantage that it can be used in any

cellphone, doesn't require a smartphone. It also uses multiple sensors like temperature, location, humidity etc. to sense child's condition which are reported to their parent via SMS. These sensors are programmed with Arduino UNO. A New Wristband Wearable Sensor Using Adaptive Reduction Filter to Reduce Motion Artifact[10] helps to reduce artifact corruption by using some filtering technique for giving the exact measurement. A 3-axis MEMS accelerometer sensor is used with PPG sensor for wrist movement detection. It can produce more reliable signal without the corruption.

III. PROPOSED DESIGN AND ARCHITECTURE

After reviewing the comparative analysis a multi-sensor wearable device is proposed for child safety. It is a wristband type wearable device for the child to track them if they are in a trouble. The proposed device will use SMS text enabled communication medium for secured communication. This device will use some sensors to sense the child's whereabouts. Location sensor will be used to detect the child's approximate location and will send it to parent's device as a reply message against a specific message "LOCATION". Rather than using different sensors for temperature and humidity the proposed device can use a single sensor for measuring temperature and humidity (DHT 11 sensor). It can find out the variation of external temperature and body temperature. If the sensor senses high temperature and decreased humidity condition then it will alert for this situation. A heartbeat monitoring sensor will also be used to detect the child's level of physical exertion. If a parent send an SMS "HEARTBEAT" then the device will reply back with the rate of heartbeat to the parent. Arduino UNO microcontroller is programmed with all these sensors. The additional modules are SOS light and Alarm Buzzer which will be activated by sending specific SMS from parent's device to alert the bystanders.

The ideal design of the proposed device will work in different ways –

1. When the value of Pulse sensor and DHT11 exceeds the threshold value then the device will send an SMS to the parent to alert them.
2. If a parent request for a specific data at a specific time then the device will send a reply SMS with the requested data. Like if a parent request the child's location at a specific time then the device will reply back with the location of the child at that particular time.

Here the approach is bottom-up approach.

At first all the components are configured separately with Arduino and data is collected. Then all parts are integrated with the Arduino through the server.

A. Control Flow Diagram

The process control flow of the proposed design is given below in fig.1

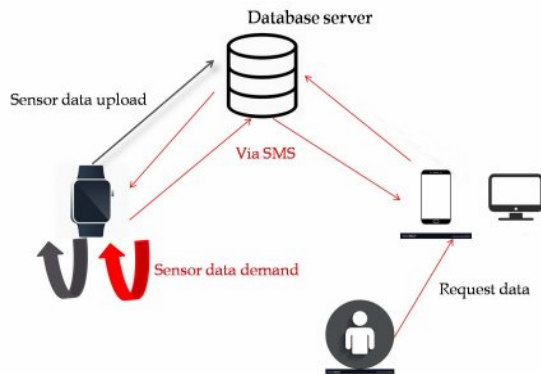


Fig 1. Control Flow Diagram of the proposed approach

B. Circuit Diagram

The circuit diagram of the proposed approach is given below in fig 2.

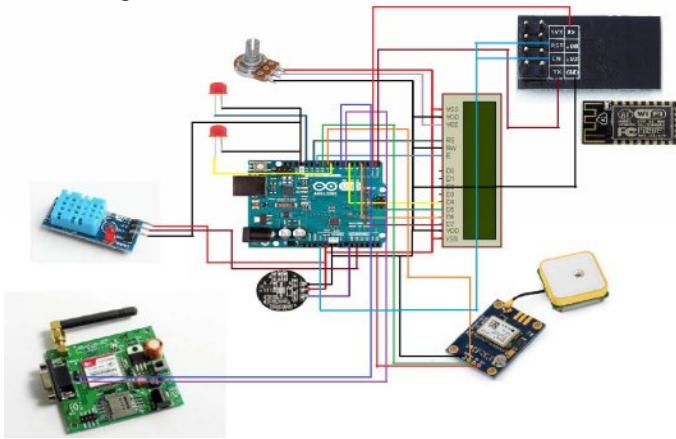


Fig2 : Circuit Diagram

Here, this figure describes the connection of Temperature and Humidity sensor(DHT-11),Heart rate pulse sensor, GPS module, GSM module(SIM900) and Wifi esp8266 module with Arduino UNO board. LCD, Potentiometer and the LED's are used for the connection of Pulse sensor. The data collected through Arduino and the results sent back to the parents through GSM platform.

C. Generalized Algorithm

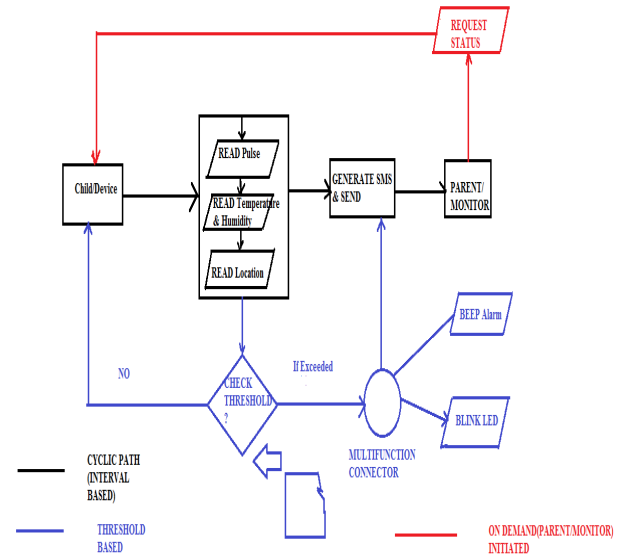


Fig 3. Generalized Algorithm of the proposed approach

IV. IMPLEMENTATION

A. Temperature and Humidity Sensor

Temperature and humidity sensor is used to measure the relative body temperature of a child and the child's relative humidity to indicate the child's physical condition. First, Read temperature as Celsius (the default) and read temperature as Fahrenheit (isFahrenheit = true). After that Check if any reads failed and exit early. Then Compute heat index in Fahrenheit (the default) and Compute heat index in Celsius (isFahrenheit = false). Then Print Humidity,temperature and Heat index. So,from the above result of the DHT11 sensor we can see that it can senses the external humidity,temperature and heat index. In the same way we can measure the child's body temperature, internal body humidity and heat index.If there are a remarkable difference between body measures and the external measures then it would detect an issue and it would sent to the parent's mobile through which they can take appropriate action to save their child.

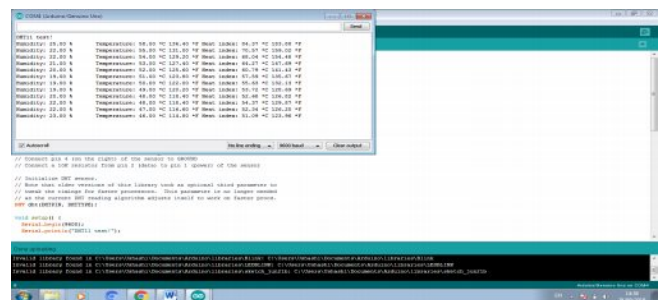


Fig 4. Output of Temperature and Humidity Sensor

B. Heart Rate Pulse Sensor

Heart rate Pulse sensor is used to measure the heart rate of a child. This sensor is based on the Principle of Photo Phlethysmography. The change in volume of blood is measured through any organ of the body which reflects a change in the light intensity in that organ. The pulse sensor is a plug-and-play heart rate sensor for Arduino. Firstly a threshold value is declared. Then Create an instance of the PulseSensorPlayground object and configure it. Then Call function on pulseSensor object that returns BPM as an "int" in the loop. Constantly check if "a beat happened". If test is "true", print a message "a heartbeat happened". Then Print phrase "BPM: " and Print the value inside of myBPM. When the finger is placed in on the sensor, LED will blink with the heartbeat. The reading is displayed both in the serial monitor.

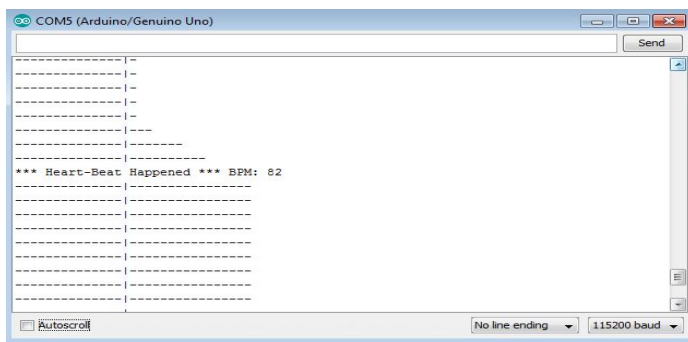


Fig 5. Output of Pulse Sensor

C. GPS(Global Positioning System)Module

Global positioning system is a navigation system based on satellite which consists of at least 24 satellites. GPS works 24 hours in every condition without any subscription fees. The satellites transmit at least 2 low power radio signals. First, Establish the connection. Then Create a new instance of the TinyGPSPlus object and Connect to the Serial with a baud rate of 9600. While gpsSerial is available Get the data from the GPS. If gps encode data Get the location, latitude and longitude and print them. So, the GPS module gives the child's approximate location as output by measuring the latitude and longitude through which the parent can know their child's whereabouts.

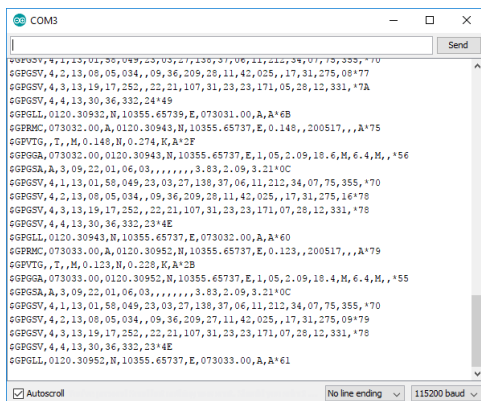


Fig 6. Output of GPS Module

D. GSM Module

A GSM(SIM 800) module is actually a GSM modem connected to a PCB with different types of output taken like RS232 directly from PC, TTL for Arduino. Here, we use SIM800 module which means it supports 800Mhz band. This module is powered using 12volts DC adapter. Firstly SIM card is inserted to the GSM module and locked. Then adapter is connected to the GSM module and turned ON. Next, wait for sometime and the blinking rate of Status/Network LED is observed. After the successful establishment of the connection, the LED's will blink continuously every 3secs. It can be tried by calling a mobile number. If ring back occurs then the connection established successfully. Here, we are sending the GPS location through SMS using SIM800 GSM module.

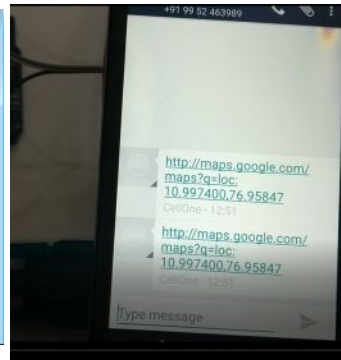


Fig 7. Output of GSM Module

E. Alarm Buzzer

Piezo buzzers are used for making beeps, alarms, and tones. They can be used in alarm systems, for keypad feedback, or some games. Light weight, simple construction and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc. Here, an alarm buzzer is used to alert the bystanders whenever the sensor value exceeds the threshold to indicate that the child is in a trouble. tone(buzzer, 1000) sends a 1KHz sound signal to pin 9, delay(1000) pause the program for one second and noTone(buzzer) stops the signal sound. The loop() routine will make this run again and again making a short beeping sound as an output.

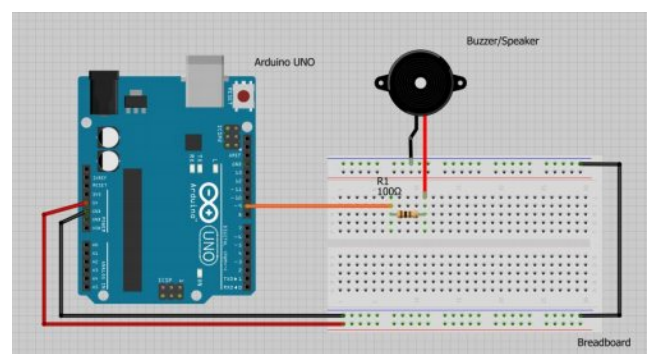


Fig 8. Alarm Buzzer with Arduino Circuit Diagram

F. SOS Light

LED is used as a SOS light. When the sensor values crosses the threshold then the light will blink to indicate that the child is in trouble. An LED is a small light (it stands for "light emitting diode") that works with relatively little power. First, The setup function runs after pressing the reset or power button. Then Initialize digital pin LED_BUILTIN as an output. The loop function runs over and over again forever. Then Turn the LED on and Wait for a Second. After that Turn the LED off by making the voltage LOW and Wait for a Second. As a result The LED will blink for a specific sensor value.

V. FUTURE SCOPE

The currently available wristband tracking devices are either GSM based or using Bluetooth platform. This research is aimed to develop a viable & portable wristband tracking system for children who are in a trouble (i.e. children who are lost or who are in a low physical condition).

We can observe that on successful completion of the previous stages there can be some up gradation like

- Such a device could also be further upgraded in future to support many more sensors to sense the child's actual physical condition.
- For surveillance of the child's surroundings, to get a clearer picture of the location, this wearable can also contain a camera module incorporated in it. The hardware that could be used would be a Adafruit TTL serial camera.
- An android app can be added. The idea behind the Android app has been derived from having an automated both to respond to text message responses from the user. It will provide the user with predefined response options at just the click of a button.

VI. CONCLUSION

The proposed device is cheaper to design and compatible to various platforms like android, IOS, windows etc. rather than apps. Communication in terms of bluetooth and GSM both viable. GSM is a better option because it can support both phone calls and SMS. Filtering of interference signals is required for better effectiveness. It will send data to the parents in a regular interval as well as on trigger based like when parent request for data and when the data exceeds the particular threshold value.

REFERENCES

- [1] Dorsemayne, B., Gaulier, J. P., Wary, J. P., Kheir, N., & Urien, P. (2015, September). Internet of things: a definition & taxonomy. In *Next Generation Mobile Applications, Services and Technologies, 2015 9th International Conference on* (pp. 72-77). IEEE.
- [2] Silva, F. A. (2014). Industrial wireless sensor networks: Applications, protocols, and standards [book news]. *IEEE Industrial Electronics Magazine*, 8(4), 67-68.
- [3] Haghi, M., Thurow, K., & Stoll, R. (2017). Wearable devices in medical internet of things: scientific research and commercially available devices. *Healthcare informatics research*, 23(1), 4-15.
- [4] Datar, R. V. (2008). WiFi and WiMax: break through in wireless access technologies.
- [5] Bhagwat, P. (2001). Bluetooth: technology for short-range wireless apps. *IEEE Internet Computing*, 5(3), 96-103.
- [6] Braam, K., Huang, T. C., Chen, C. H., Montgomery, E., Vo, S., & Beausoleil, R. (2015, December). Wristband Vital: A wearable multi-sensor microsystem for real-time assistance via low-power Bluetooth link. In *2015 IEEE 2nd World Forum on Internet of Things (WF-IoT)* (pp. 87-91). IEEE.
- [7] Prince, N. N. (2013, December). Design and implementation of microcontroller based short message service control system. In *Internet Technology and Secured Transactions (ICITST), 2013 8th International Conference for* (pp. 494-499). IEEE.
- [8] Moodbidri, A., & Shahnasser, H. (2017, January). Child safety wearable device. In *Information Networking (ICOIN), 2017 International Conference on* (pp. 438-444). IEEE.
- [9] Badamasi, Y. A. (2014, September). The working principle of an Arduino. In *Electronics, computer and computation (icecco), 2014 11th international conference on* (pp. 1-4). IEEE.
- [10] Wei, P., Guo, R., Zhang, J., & Zhang, Y. T. (2008, May). A new wristband wearable sensor using adaptive reduction filter to reduce motion artifact. In *Information Technology and Applications in Biomedicine, 2008. ITAB 2008. International Conference on* (pp. 278-281). IEEE.