

IoT Based Child Localization System

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ABSTRACT— This paper discusses the concept of a smart wearable device for little children. The major advantage of this wearable over other wearable is that it can be used in any mobile phone and doesn't necessarily require an expensive smart phone and not a very tech savvy individual to operate. The purpose of this device is to help parents locate their children with ease. At the moment there are many safety wearable devices in the market which helps to track the daily activity of children and also help find the child using Wi-Fi and Bluetooth services present on the device. But Wi-Fi and Bluetooth appear to be an unreliable medium of communication between the parent and child. Therefore, the focus of this paper is to have an SMS text enabled communication medium between the child's wearable and the parent as the environment for GSM mobile communication is almost present everywhere. The parent can send a text with specific keywords such as "LOCATION" "TEMPERATURE" "UV" "LIGHT" "BUZZ", etc., the wearable device will reply back with a text containing the real time accurate location of the child which upon tapping will provide directions to the child's location on google maps app and will also provide the surrounding temperature, UV radiation index so that the parents can keep track if the temperature or UV radiation is not suitable for the child. The secondary measure implemented was using a bright Light and distress alarm buzzer present on the wearable device which when activated by the parents via SMS text should display the light signal brightly and sound an alarm which a bystander can easily spot as a sign of distress. Another feature added to the device is HEART BEAT SENSOR which will monitor the child's heart beat and sends an intimation message to the parents once its removed from the child. Hence this paper aims at providing parents with a sense of security for their child in today's time.

I. INTRODUCTION

The Internet of Things System (IoT) refers to the set of devices and systems that stay interconnected with real-world sensors and actuators to the Internet. IoT includes many different systems like smart cars, wearable devices and even human implanted devices, home automation systems and lighting controls; smart phones which are increasingly being used to measure the world around them. Similarly, wireless sensor networks that measure weather, flood defences, tides and more. There are two key aspects to the IoT: the devices

themselves and the server side architecture that supports them. The motivation for this wearable comes from the increasing need for safety for little children in current times as there could be scenarios of the child getting lost in the major crowded areas. This paper focuses on the key aspect that lost child can be helped by the people around the child and can play a significant role in the child's safety until reunited with the parents. Most of the wearable's available today are focused on providing the location, activity, etc. of the child to the parents via Wi-Fi and Bluetooth. But Wi-Fi and Bluetooth seem a very unreliable source to transfer information. Therefore it is intended to use SMS as the mode of communication between the parent and child's wearable device, as this has fewer chances of failing compared to Wi-Fi and Bluetooth

II. SYSTEM DESIGN AND ARCHITECTURE

This section discusses the architecture and the design methodologies chosen for the development of the Child Safety wearable device.

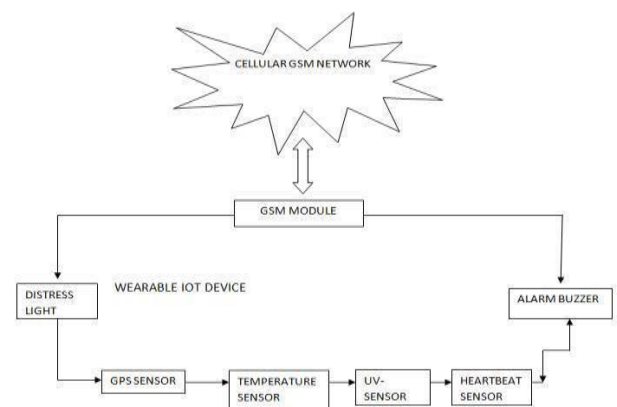


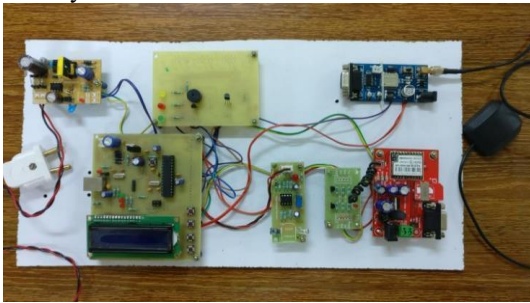
Figure 1. architecture of the proposed model

That coordinates to the user's smartphone. The user can just tap on the coordinates which will open up the default GPS application installed on the phone and will show the user the distance between the child and the user.

A. Wearable IoT Device

The wearable device, for now, is not built on a SoC model, rather has been proposed using larger components and can later build on the SoC platform once put into manufacture. The wearable IoT device tasked with acquiring various data from all the different modules connected. It comprises of Arduino Uno based on the ATmega328P microcontroller.

It receives the data from its various physically connected modules, anatomizes this data and refines the data in a more user understandable format to the different available user interfaces. The user, therefore, can conveniently view the information on their cellphone. The physical characteristics of the wearable device are proposed to be as a wrist watch which remains placed around the wrist of the child during times when the child is not being accompanied by an adult/parent. For the moment the design is not made compact, since the main focus now has been to show that this concept of smart wearables would be highly impactful for the safety of children



1) GPS Location Sensor

For determining the real time location of the child Parallax PMB-648 GPS module has been used which communicates with the Arduino Uno through a 4800 bps TTL-level interface. The connections between the Arduino Uno and the GPS module established with three wired connections which enable the Arduino to read the GPS data. The GPS module receives location information from the various satellites present in the NAVSTAR (American Satellites Timing and Ranging Global Positioning System) GPS system. It has a low power consumption and size of the only 32x32mm, which is very compact. 20 parallel satellite-tracking channels for fast acquisition and reacquisition. on the Arduino Uno via jumper cables. Similarly, the GND (black wire) pin on the GPS module is connected to the module is in the following format: GND pin on the Arduino Uno via jumper cables. The TXD (yellow wire) is connected to pin 6 of the Arduino Uno via jumper cables on the breadboard. The pin six on the Arduino Uno is a digital pin which can also be used for PWM (Pulse Width Modulation) applications. Once the SMS trigger text "LOCATION" is sent from the cell phone of the user, this text is received by the Arduino GSM Shield which in turn triggers the Arduino Uno to execute the GPS code to fetch the current, accurate location of the GPS module. The location output received from the GPS module is in the following format:

The latitude and longitude coordinates received are stored in variables called "lat" and "lon," which are then called upon when the SMS text received on the GSM module matches with the keyword "LOCATION." If an SMS text is received which contains none of the pre programmed keywords, then the Arduino GSM shield automatically deletes the text message and does not reply back the user the with any location details.

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Module Then the final results for latitude and longitude are inserted into

the following URL format:

<http://maps.google.com/?q=<lat>,<lng>>.

2) Temperature Sensor

In order to measure the temperature of the surroundings of the child, a seed studio grove temperature sensor was used. The sensor module is equipped with a thermistor for measuring the ambient temperature and the fluctuations with high accuracy. The observable temperature detectability for this sensor ranges from -40°C to -125°C and the precise accuracy for this device range from +1.5°C to -1.5°C. The temperature is connected to the Arduino Uno and GSM shield using a Grove base shield which contains eight digital ports ranging from D1 to D8, four analog ports ranging from AO to A3 and 4 I2C ports. Therefore, the temperature sensor is connected to the A2 analog port of the base shield. The temperature value is stored in a string getTemp(a), where "a" is the integer type. Hence the getTemp(a) is called by the GSM module upon receiving the proper SMS keyword "TEMPERATURE" by the user's smartphone.

3) SoS Light

The another theory that this paper focuses on is that by standers are the fast mode of help for a missing child. The purpose of the SOS light is to be able to alert the people nearby that the child might be in distress since the light will be flashing the universal

SOS light symbol which many people nowadays know for to be a sign for help. This can be activated by the parent itself by sending an SMS text with the keyword "SOS" to the child's wearable which will activate the SOS light flashing. The SOS light works on the principal of Morse code in which "S" stands for three short dots and the "O" stands for three long dashes. Since a very long time, the SOS signal has been universally known for being the sign of distress and help. The SOS signal is referred to by all security personals, who if find the child to be missing can act and help locate the parents with surplus resources present at their disposal. The SOS Light is connected to the pin 13 of the base shield.

4) Distress Alarm Buzzer

In the scenario, if a child is separated from his/her parents. The parent can locate their child by sounding a very loud alarm on the wearable. To achieve this, grove seed studio buzzer was used, which has a piezoelectric module which is responsible for emitting a strong tone upon the output being set to HIGH. The grove buzzer module is activated upon sending an SMS text with the keyword "BUZZ" from a cell phone. Also, this buzzer works similar to the SOS led by alerting the people nearby with the distressed tone that the child might be lost and is in need of assistance. The buzzer is connected to the D4 digital port of the base shield

5) Heart beat sensor

The basic heartbeat sensor consists of a light emitting diode and a detector like a light detecting resistor or a photodiode. The heart beat pulses causes a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e. light emitted by the led, it either reflects (a finger tissue) or transmits the light (earlobe). Some of the light is absorbed by the blood and the transmitted or the reflected light is received by the light detector. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in form of electrical signal and is proportional to the heart beat rate. To achieve the task of getting the AC signal, the output from the detector is first filtered using a 2 stage HP-LP circuit and is then converted to digital pulses using a comparator circuit or using simple ADC. The digital pulses are given to a microcontroller for calculating the heart beat rate

B. Gateway: Arduino GSM Shield

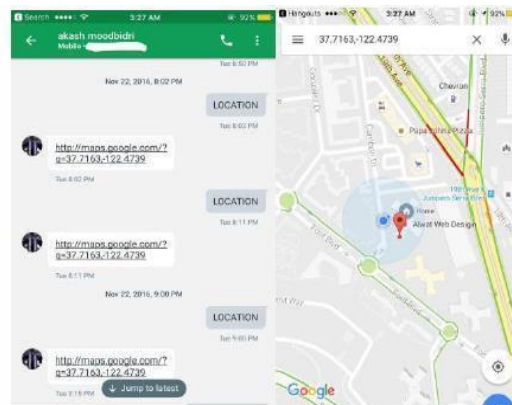
It transfers the information over to the user via SMS by using General Packet Radio Service (GPRS) which can provide data rates around 56-114 Kbit/sec. Arduino provides various libraries such as Ethernet, Wi-Fi for the different Arduino shields. Similarly, Arduino provides GSM libraries for their official GSM shield as well which allows the GSM shield to make/receive a call, send/receive SMS and act as a client/server. The Arduino GSM shield receives 5V power supply directly from the 5V pin connection at the Arduino Uno 5V. The serial communication between the Arduino Uno and Arduino gsm shield is performed between the software serial digital pins 2,3 and also reset pins 7. The GSM shield has been programmed to receive SMS text messages from the parent's cellphone. The GSM shield will constantly be scanning the received text messages for the specific keywords such as "LOCATION" "TEMPERATURE" "UV" "BUZZ" "SOSSince the GSM shield is an Arduino produced device, it has the necessary GSM libraries installed into the Arduino IDE which makes the interfacing with Arduino Uno much more reliable

III. RESULTS

In this section, the experimental tests were performed to determine the various components of the proposed wearable device.

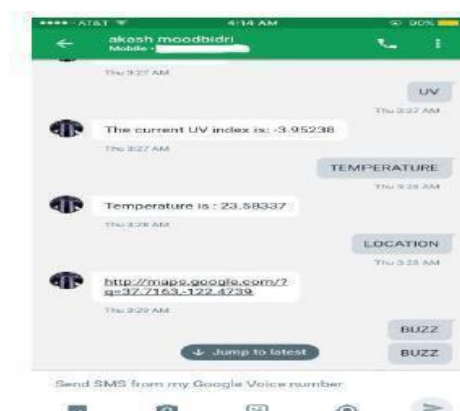
A. GPS Location Sensor

Upon testing the wearable device multiple times with repeated SMS texts. The GPS location sensor was able to respond back with precise latitude and longitude coordinates of the wearable device to the user's cellphone, which then the user would click on the received Google maps URL which would, in turn, open the google maps app and display the pinpoint location. The GPS turned out to be so precise with the location that it performed even better than the GPS on an expensive smartphone. As shown in the image below, the GPS module (red bubble) was able to show the current location of the wearable with pinpoint accuracy and also show exactly at which side of the building it is present



B. Temperature and UV sensor

Similar to the GPS location sensor, the Temperature, and UV sensors were tested multiple times under different temperatures and higher intensities of sunlight. Both the sensors performed exceptionally well to the test performed. The response time to receive a response back to the keywords "TEMPERATURE" and "UV" was under a minute. Also, the temperature sensor was subjected to higher temperatures and compared with a thermostat reading present in the room which would differ with the sensor reading by $+0.2^{\circ}\text{C}$ to -0.2°C . Also, the UV sensor was measured under different intensities of sunlight. The UV sensor was quick in responding to the changes in the intensity of sunlight. The response time to receive a response back to the keywords "UV" was under a minute as well.



C. SoS Light and Distress Alarm Buzzer

The light and buzzer differ from the above sensors in the SMS trigger mechanism. Upon sending an SMS with either "SoS" or "BUZZ," this would trigger the light and buzzer to perform an output function instead of providing measurements back to the user's cellphone such as in the scenario of the other sensors. Upon receiving the correct keywords, the SOS light and Alarm Buzzer would first perform the particular task of flashing the SOS light and sounding a distress alarm which can take a little longer than their sensor counterparts. After completion of their respective functions, the response is sent back to the user's cell phone stating: "SoS Signal Sent" and "Playing Buzzer

IV. FUTURE SCOPE

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. Since the major focus of this wearable project is the GSM module which is a better alternative than Bluetooth, Wi-Fi or ZigBee due to the short range and connectivity issues of these technologies. Therefore, for this project using the GSM technologies is beneficial as the cellular range is vast and since all the communication between the wearable and the user is taking place via SMS, therefore no internet connectivity is required at all. But, still, the Arduino

GSM shield possess the added advantage of using GPRS which enables the board to use the internet if required. Whereas for the camera module which supports video streaming but due to the constraint of trying to use only sms, therefore only four wire connections will be taking place. The red and black wires will be connected directly to +5V and GND respectively to the Arduino uno board. Whereas for the RX pin which will be used for sending data via arduino uno and arduino gsm board and for the TX pin which will be utilized for receiving incoming data via from the modules. The IOK resistor divider, the camera's serial data pins are 3.3v logic, and it would be a good idea to divide the 5V down so that its 2.5V. Normally the output from the digital 0 pin is 5V high, the way we connected the resistors is so the camera input (white wire) never goes above 3.3V. To talk to the camera, the Arduino uno will be using two digital pins and a software serial port to talk to the camera. Since the camera or the Arduino Uno do not have enough onboard memory to save snapshots clicked and store it temporarily, therefore an external storage source microSD breakout board will be used to save the images temporarily. The camera works on a standard baud rate of 38400 baud. The camera will be collecting information in the same manner as the GPS module. It will be on standby conserving power waiting for the particular keyword

"SNAPSHOT" to be sent from the user's smartphone to the GSM shield will activate the camera to start clicking a

snapshot of the surrounding and save the file temporarily on the external microSD card. After which Arduino Uno will access the saved image from the microSD storage and transfer it to the GSM module which send it to the user via SMS/MMS text.

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