

Design and Implementation of Safety Gear for Schoolkids

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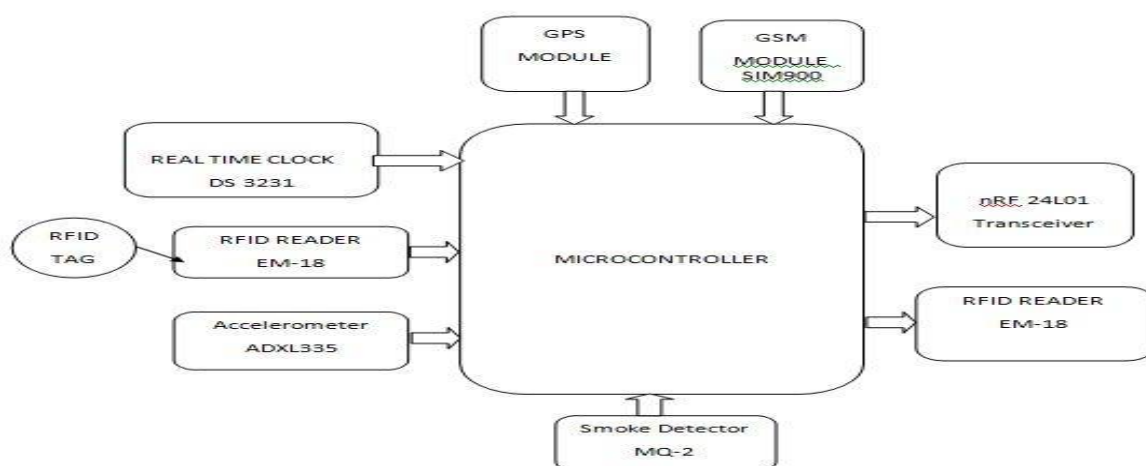
ABSTRACT - Child safety gear is a multipurpose generic device which can be used for safety of kids, patients, trekkers etc. with different modifications. By using GPS tracker(for positioning of user), GSM (for SMS alerts), RFID sensors (to know if kids have reached school or left from there), Temperature sensor (for fever alerts and other uses), Smoke detectors (for fire alarms and alerts if kids are smoking), accelerometer (for checking threatening fights in kids) and many more things to handle various kids' safety issues. It is a proposed idea for a generic multipurpose device which can be used at various levels.

KEYWORDS – Arduino Uno, RFID RC522, Accelerometer ADXL335, Smoke detector MQ2, GPS, GSM A7, NRF24L01, RTC DS3231, temperature sensor LM35

I. INTRODUCTION / ORIGIN OF IDEA

Any innovation or new idea is outcome of problems or issues in our surroundings or faced by people around us or society at large. I am student of class 9 and started travelling alone to school and classes nearby but my mother is always worried about me and my safety. She keeps on discussing various incidents and matters related to child safety and all. So, I always used to think about various problems and if we can do anything about it. I am a student of Robotics and learning Arduino programming too, my mind started thinking more and gained more knowledge from internet, books and my teachers. Then when I got to know about IJISERT and paper publishing, I started writing it in more constructive manner. This is how my idea originated.

II. BIRD'S EYE VIEW (BLOCK DIAGRAM)



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III. PROBLEMS AND PROPOSED SOLUTION (OVERVIEW)

1. Problem

- Kidnapping of kids
- Child trafficking
- Lost kids (specially for mentally challenged kids)

Proposed solution

- **GPS (global positioning system)** tracker can track 2D/3D positioning of child that is latitude/longitude/altitude

2. Problem

- Attendance of kids in school.
- Common parents (specially working mother) worries like whether kids reached school on time or left from school.
- Kids missing school bus due to normal delays.

Proposed solution

- **RFID (radio frequency identification technology)** readers can read the data and covert in printed readable forms with **GSM SIM900A (global system for mobile communication)**. example SMS to parents once kid reached school bus/school gate or leaves from there.
- RFID (long range RFID) readers in school bus can be designed to read from distance if any kids are near school bus and it can wait for few seconds more.

3. Problem

- Alerts for exams/fees and dues.
- Vaccination alerts.
- Date and time display.

Proposed solution

- **RTC DS3231 (real time clock)** can be designed to give SMS to parent for vaccination schedule, exam dates and fees alerts from school.

4. Problem

- Stressed kids due to exam or peer pressure goes to terrace.
- Even kids attempting suicide from terrace of school.

Proposed solution

- **NRF24L01 (Nordic radio frequency)** technology can be used to alarm in school office if any kid goes to terrace.
- The watch has a NRF installed on it and there is a NRF on the terrace, if they both come in range an alarm will be sent.
- Unique code of safety gear can help in identifying kid.

5. Problem

- Fever (common health issue)
- If kid removes the gear watch

Proposed solution

- **LM35 (temperature sensor)** can give us alerts for this by scanning body temperature.
- If the watch is removed it will sense the room temperature and send an alert.

6. Problem

- Big fights in kids.
- Violence by elder kids.

Proposed solution

- **ADXL335 (accelerometer)** can be used for detecting quick motions and tilt (in dance and PE period it can be switched off)
- Alternatively, a gyroscope can also be used.

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7. Problem

- smoking by teenage kids

Proposed solution

- MQ2(smoke detector) can be used for this.
- It can be programmed differently to detect more smoke(fire alerts).

8. Problem

- extreme bullying of kids
- Physical violence with kids at home or school.
- Sexual abuse of kids.

Proposed solution

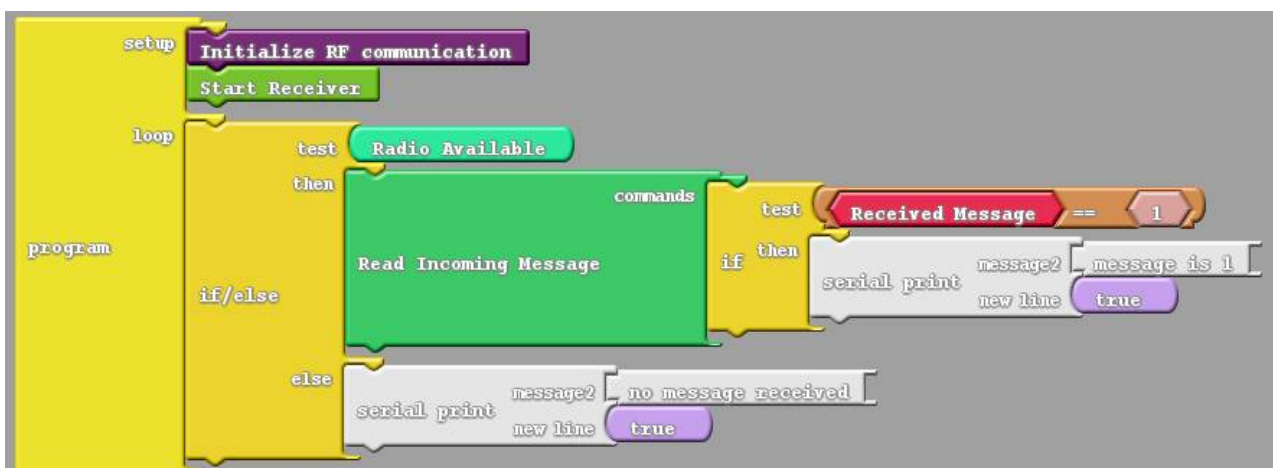
- Kids can directly message to child helpline(1098) through this device.
- GSM can be programmed that way.

IV. MATERIALS USED

- Micro – controller
- Battery
- GPS trackers
- RFID tag
- RTC DS3231
- NRF 24L01
- LM35 Temperature sensor
- ADXL335 accelerometer
- MQ2 smoke sensor
- GSM sim900A

V. PROPOSED IMPLEMENTATIONS

A microcontroller is a compact microcomputer designed to govern the operation of embedded systems in motor vehicles, robots, office machines, complex medical devices, mobile radio transceivers, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory and peripherals. This is an instance of Ardublock, it is a drag and drop application. This application makes it easy to write programs and debug errors. This is a program of NRF(Nordic Radio Frequency) receiver.



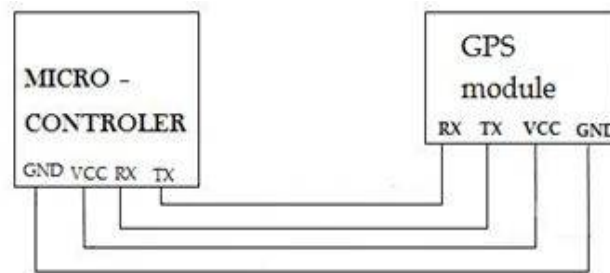
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1. GPS



GPS or Global Positioning System is a network of orbiting satellites that send precise details of their position in space back to earth. The signals are obtained by **GPS** receivers, such as navigation devices and are used to calculate the exact position, speed and time at the vehicles location. A **GPS** receiver must be locked on to the signal of at least 3 satellites to calculate a 2-D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3-D position (latitude, longitude and altitude).

National marine electronic association (NMEA) is a format in which all GPS information comes. It supports AGPS (assisted GPS). It is capable of up to 10 Hz update rate and also capable of SBAS (satellite-based augmentation system). It has a LED indicator for GPS fix. It has built in micro battery to reserve system data for rapid satellite acquisition.

Every single location in the entire globe can be specified in terms of geographical coordinates. The geographical coordinate is a system which specifies any given location on the earth surface as latitude and longitude. There are devices which can read the geographical coordinates of a place with the help of the signals received from a number of satellites orbiting the earth. The system of satellites which helps in the positioning of a place is called Global Positioning System (GPS). The devices which can read the geographical coordinates of a place with the help of at least four GPS satellites are called GPS Receiver or simply GPS module.

The GPS module continuously produces a set of data regarding the position of the earth surface where it is situated which includes the current position with respect to the equator of the earth in terms of Latitude and Longitude. This data can be decoded and printed into the readable format with the help of a microcontroller only if the parent presses a button on his computer or mobile he should be redirected to a google map screen where he will be shown where his child is.

Applications

- Personal positioning and navigation
- Automotive navigation
- Marine navigation

2. RFID

Radio frequency identification (RFID): RFID enables identification from a distance, and unlike earlier bar-code technology (see the sidebar), it does so without requiring a line of sight. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance. RFID falls under two main categories: near-field systems that employ inductive (magnetic) coupling of the transponder tag to the reactive energy circulating around the reader antenna, and far-field systems that couple to the real power. The zone where the electromagnetic field separates from the antenna and propagates into free space is called far field, here the ratio of E to magnetic field H has a constant value of 120 pi or 377 ohm the distance where this transition zone happens is given by

$$r = \frac{\lambda}{2\pi} \text{ where } r \text{ is distance from antenna}$$

It is also important to expression is valid for small antennas where $D < \lambda$ where D is maximum dimension of radiating structure. We can divide RFID devices into two more classes: active and passive. Active tags require a power source—they're either connected to a powered infrastructure or use energy stored in an integrated battery. In the latter

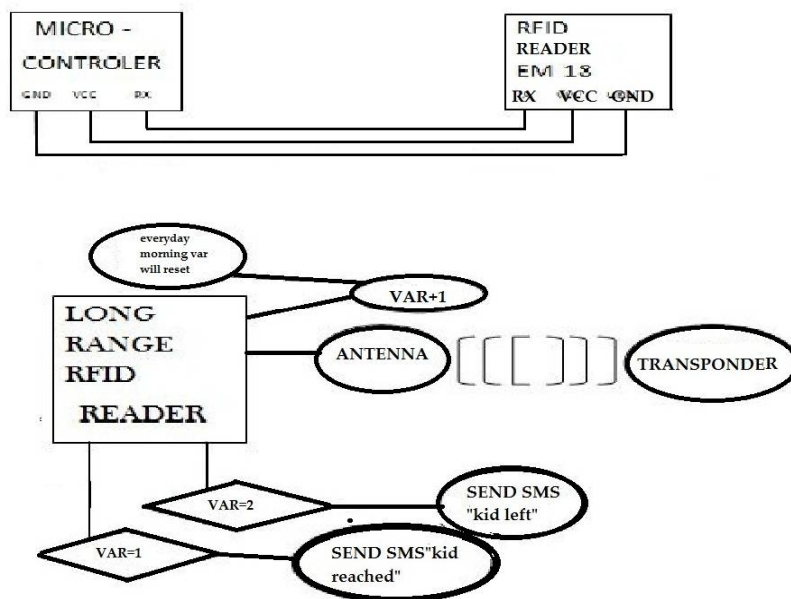
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case, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo. Example is a LoJack device attached to a car, which incorporates cellular technology and a GPS to locate the car if stolen.

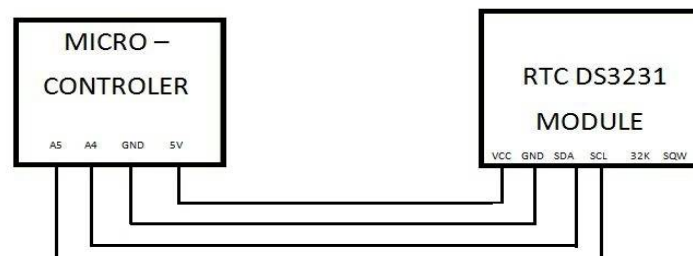


3. RTC

The RTC maintains seconds, minutes, hours, day, date, month, and year information. The date at the end of the month is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with an AM/PM indicator.

Applications

- Servers
- Utility Power Meters
- GPS



4. GSM

GSM/GPRS Modem-RS232 is built with Dual Band GSM/GPRS engine- SIM900A, works on frequencies 900/ 1800 MHz's. The Modem is coming with RS232 interface, which allows you connect PC as well as microcontroller. The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. Using this modem, you can make audio calls, SMS, Read SMS, attend the incoming calls and internet through simple AT commands. GSM (Global System for Mobile communication) uses a variation of time division multiple access (TDMA) and is the most widely used of the three digital wireless telephony technologies (TDMA, GSM, and CDMA).

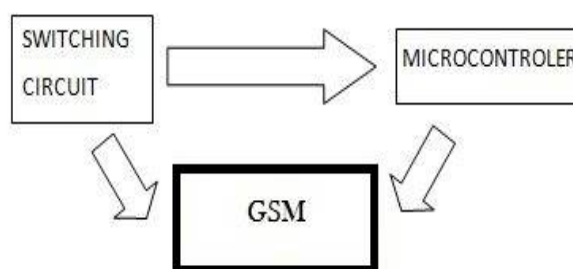
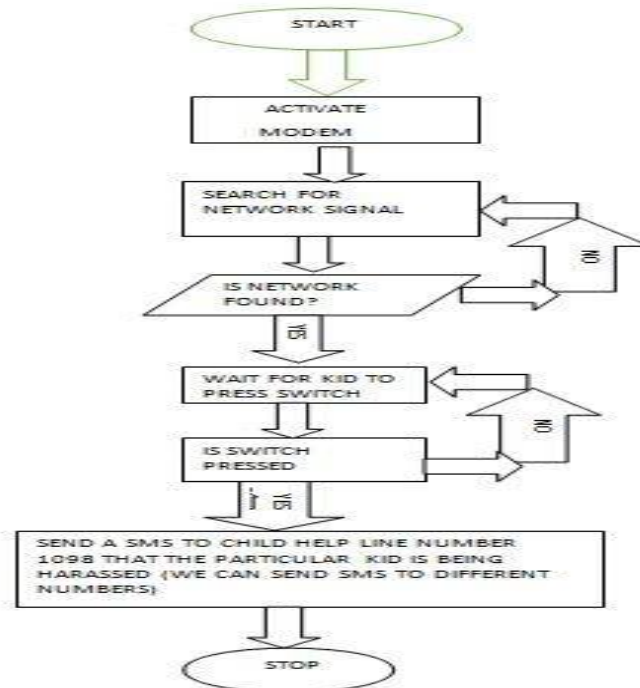
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LOGICAL ALGORITHM (EXAMPLE TO EXPLAIN WORKING OF GSM)



5. Smoke detector

A smoke detector is a device that senses smoke, typically as an indicator of fire. Smoke can be detected either optically (photoelectric) or by physical process detectors may use either, or both, methods. The Optical Smoke Detector, also referred to as a Photoelectric Type Device, uses a light source to detect smoke. The Infra-Red LED is a lens that shoots a beam over a large area. If smoke is present in the room, it enters the optical chamber, having smoke particles scatter and sensor sets off the alarm. Sensitive material of MQ-2 gas sensor is SnO₂ (Tin Dioxide), which with lower conductivity in clean air. The sensor's conductivity is higher along with the gas concentration.

Application

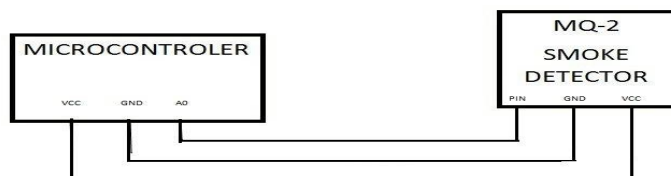
- Domestic gas leakage detector
- Industrial Combustible gas detector
- Portable gas detector

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6. Accelerometer

An accelerometer is an electromechanical device that will measure acceleration forces. These forces may be static, like the constant force of gravity pulling at your feet, or they could be dynamic - caused by moving or vibrating the accelerometer. The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage output. By measuring the amount of static acceleration due to gravity, you can find out the angle the device is tilted at with respect to the earth. By sensing the amount of dynamic acceleration, you can analyse the way the device is moving. The principle of working of an accelerometer can be explained by a simple mass (m) attached to a spring of stiffness (k) that in turn is attached to a casing, The mass used in accelerometers is often called the seismic-mass or proof-mass. It may contain a dashpot with damping coefficient(c) attached in parallel with the spring. When the system is subjected to linear acceleration the force applied will be $\text{mass} \times \text{acceleration}$, some kind of damping is required to stabilize the system. Now derive an equation according to newton's 2 nd law

$$F(\text{applied}) - F(\text{damping}) - F(\text{spring}) = mr$$

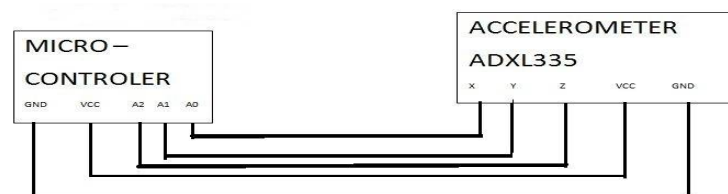
$$Mr - F(\text{damping}) - F(\text{spring}) = mr$$

$$mr + kr + cr = F$$

where, k = spring constant

APPLICATIONS

- Cost effective, low power, motion- and tilt-sensing applications
- Mobile devices
- Gaming systems
- Disk drive protection
- Image stabilization



7. Temperature Sensor

LM35 is a temperature sensor, it converts temperature in electrical signals. The LM35 is an integrated circuit sensor to measure temperature with an electrical output proportional to the temperature. We can measure temperature from 0 to 150 degrees Celsius using LM35. We have to convert the analog value to degree Celsius by a formula($\{\text{value} \times 5 \times 100\} / 1024$). The output voltage varies from 10mv in response to every degree Celsius.



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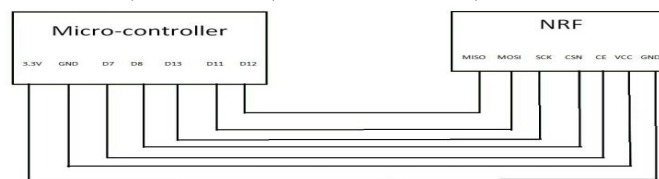
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8. NRF

The nrf24l01 is a single chip 2.4GHz transceiver designed for ultra-low power wireless applications. The nrf24l01 is designed for operation in the world-wide ISM frequency band 2.400 – 2.4835GHz. The connections for transmitter and receiver are same. CE and CSN are used to activate the chip. SCK is used to synchronize signals between transmitter and receiver. MISO (master in slave out) and MOSI (master out slave in) are used for data transfer.



V. POWER MANAGEMENT

- Power management means powering the gear.
- Lithium Ion which is used in mobiles can be used in suggested gear.
- Most devices work on 3.3V, so we can have a battery of 4.3V or maximum 5V.
- All devices have to be managed for efficient power utilisation.
- A lithium-ion battery or Li-ion battery is a type of rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging.
- Because of the inherent instability of lithium metal, especially during charging, research shifted to a non-metallic lithium battery using lithium ions. Although slightly lower in energy density than lithium metal, lithium-ion is safe

VI. EXPECTED OUTPUT

- Google maps
- SMS in pre-decided format
- Alerts and alarms
- Time and date display
- Continuous monitoring or tracking

VII. IMPLEMENTATION AND OTHER ISSUES

- Major issue is balancing high speed, minimum space with least power consumption.
- We have to choose a particular battery with proper current rating so we can manage so much peripherals or interfaces.
- For handling so many peripherals we have to be very particular in programming.

VIII. RESULTS

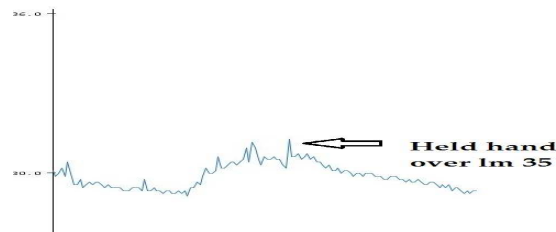
This is the photo of the prototype I made using the above-mentioned sensor models and under it is Arduino Uno Atmel Atmega 328 the microcontroller I used for the prototype. The RTC gives date and time both together. The RFID sensor shows “kid reached” when scanned first and displays “kid left” when scanned second time. The accelerometer if tilted after a certain extent in any direction then it displays that the kid is involved in a fight. If the NRF is in range with another NRF it displays that the kid is on terrace. The GPS gives data in the NMEA pre-decided format. The LM 35 gives the data in a graphical format.

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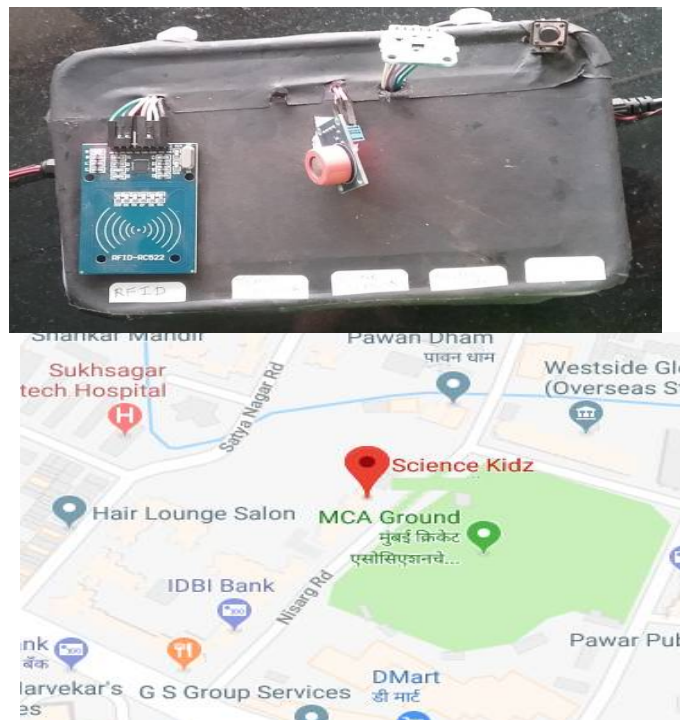
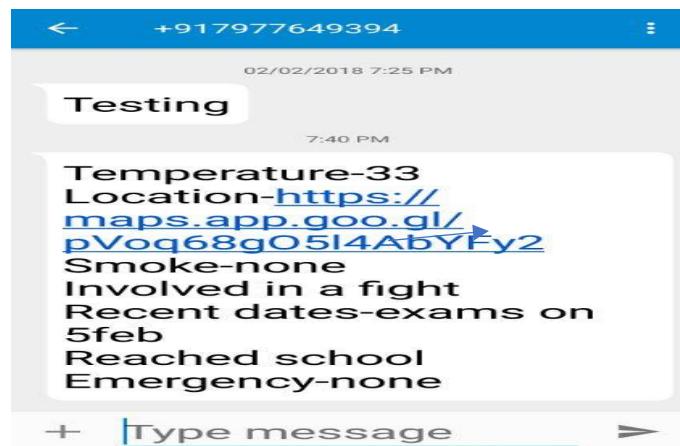
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If the smoke detector detects more amount of smoke it shows that there is a fire and if detects small amount of smoke it sends the alert that the particular kid is involved in smoking. This is the final result of message received when the accelerometer was tilted.



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IX. FUTURE MODIFICATIONS

1. We can use ARM microcontroller or Raspberry Pi which will enable it to use internet and give a more stable connection than using node MCU or ESP8266. We can send the alerts through internet too.
2. The prototype I made measures 18 x 12 x 5 cm but we can make it as small as a smart watch by integrating all components on a single PCB and doing VLSI that is making hardware specially for the gear.

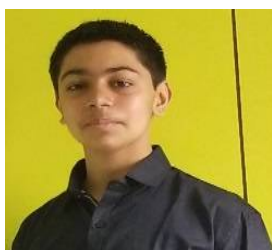
X. PRACTICAL USAGE (WITH DIFFERENT MODIFICATIONS)

- School kids
- Mentally challenged kids
- Alzheimer disease patients
- Mountaineers
- Car safety

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BIOGRAPHY



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