CS-321 PERIPHERAL LAB
SMART BACKPACK

Guided By:

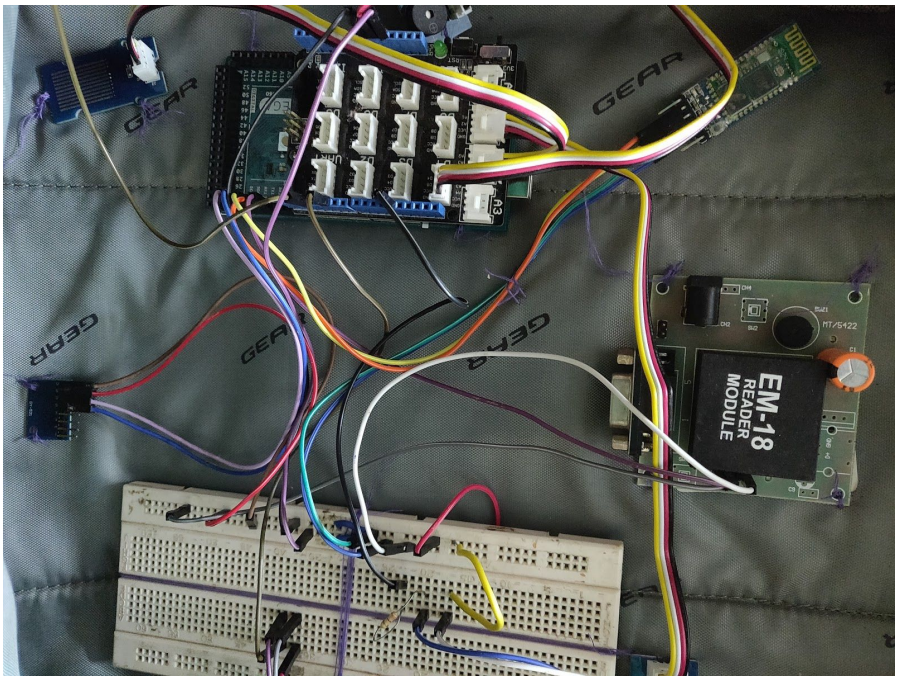
Prof: S.B. Nair
TA : Divya D Kulkarni
Ishita Gupta
Oza Jay

Group Members:-
Group - 03
Aadil Hoda(160101001)
Arpan Konar(160101014)
Arpit Gupta(160101015)
Debangshu Banerjee(160101081)

Date : 17th Nov, 2018

Index

Introduction



Smart backpack is an application-specific design that can be useful for almost everyone in the society. Smart means intelligent, the bag will be intelligent enough to carry out various features for everyday use.
As students, We use backpacks everyday, for carrying our stuffs. A smarter backpack system is badly needed to make it easier for students to develop and maintain healthy backpacking habits.

We took an attempt to make backpacks smarter, wherein the opportunity was provided as a course project in our hardware and peripherals lab.

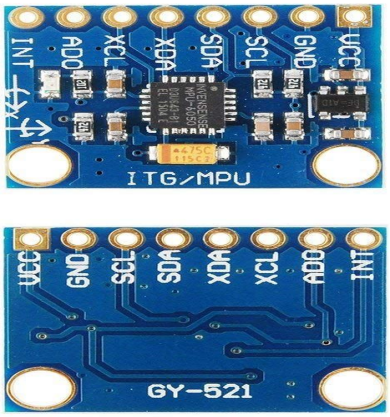
Since,we always want privacy with respect to the contents of our bag,we need some sort of theft prevention schemes,which we have provided through theft alarm and mobile notifications, using MPU sensor.

RFID Technology will be used to solve the problem of forgetfulness to pack the required items. The object to be placed inside the bag will have these RFID tags attached to them. These tags will then be read by the RFID reader. Anyone can get stuck in threatening situations at any time. So the emergency button present on the bag which when pressed will solve this problem in any emergency situation. When the button will be pressed, a buzzer will get activated and the location of the victim will be sent via SMS to three contacts and to the police control room.

Hardware Modules

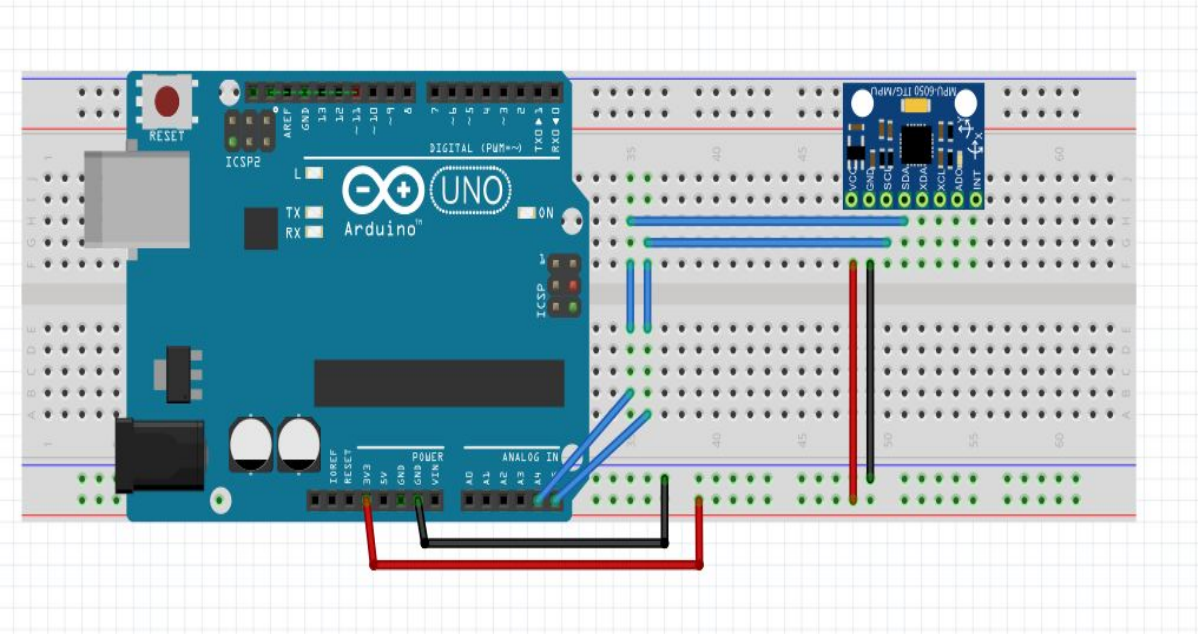
Sensors:

a) GY-521 MPU-6050 3 Axis Gyroscope + Accelerometer



- **Why used?**
  We have used this sensor to detect any movement of the bag without the user consent and informing the user accordingly.
- **What it is?**
  The MPU-6050 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel. Therefor it captures the x, y, and z channel at the same time. The sensor uses the I2C-bus to interface with the Arduino.

- **Integration with the project**



We are observing the change in acceleration in x, y, and z directions in every small unit of time and if we detect change for a considerable time periods, we are ringing the buzzer and informing the user through cell phone.

For the bag-movement-alarm,we need it to tell for how long there has been movement, and only if there is movement for say 5 seconds,does it trigger the “MOVED”, if it is moving for longer than 5 seconds then it has been stolen! The difficult part is that there may be moments in there where there is no movement, e.g. for a half second it may stop but then start moving again, and we don’t want that to ‘reset’ the movement time counter. Here is what we thought of as a possible approach:

we would store the ”moved” value in an array, shifting the new one in each time we take a reading.

Since we have the sensor reading at 1/3 of a second right now, to store the previous 5 seconds of “moved” would take

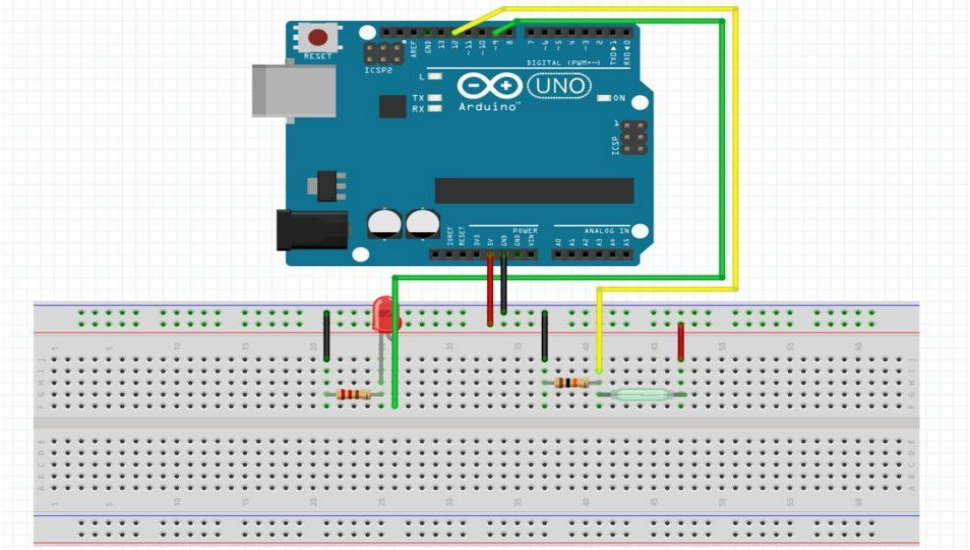
15 elements. Each time we read a sensor value, we drop the oldest one, and add the newest one to the array.Now, we would then look to see if there is a more than 5 second period between two moments of movement (i.e. it has been potentially been moving for more than 5 seconds). we may need to have another criteria: the number of seconds we are reviewing (e.g. may need to store the previous 10 seconds of data, and look at any more than 5 second period in that) but would need to think through if this is actually necessary given the second criteria. Furthermore, Then, we would loop through each element of the array and count how many are "moved" and how many are "not moved" between those two moments of movement, to see if it exceeds a threshold amount (say we allow 20% not movement).

b) Reed Switch

- **Why used?**

  We have used this to detect any unwanted opening of chains and to detect if we somehow have forgot to close the chains properly.
- **What is it?**

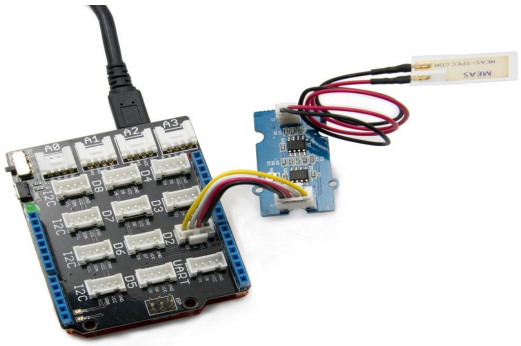
  A reed switch is an electromagnetic switch used to control the flow of electricity in a circuit. They are made from two or more ferrous reeds encased within a small glass tube-like envelope, which become magnetised and move together or separate when a magnetic field is moved towards the switch. The switch effectively works like a gate, or a bridge, in an electric circuit so when the two reeds are in contact, electricity can flow around the circuit operating a device.
- **Integration with the project**



  We have integrated Reed Switch at one part of the zip and a magnet on another, so when the zip is close, both the magnet and Reed Switch will be in contact and this completes the circuit , otherwise we can detect the zip is open.

c) Grove - Piezo Vibration Sensor

- **Why used?**
  We have used Vibration sensor to detect any calls and messages from our phone when we kept it in our bag in vibration mode.
- **What is it?**
  Grove-Piezo Vibration Sensor is suitable for measurements of flexibility, vibration, impact and touch. The module is based on PZT film sensor LDT0-028. When the sensor moves back and forth, a certain voltage will be generated by the voltage comparator inside of it. A wide dynamic range (0.001Hz~1000MHz) guarantees an excellent measuring performance.
- **Integration with the project**



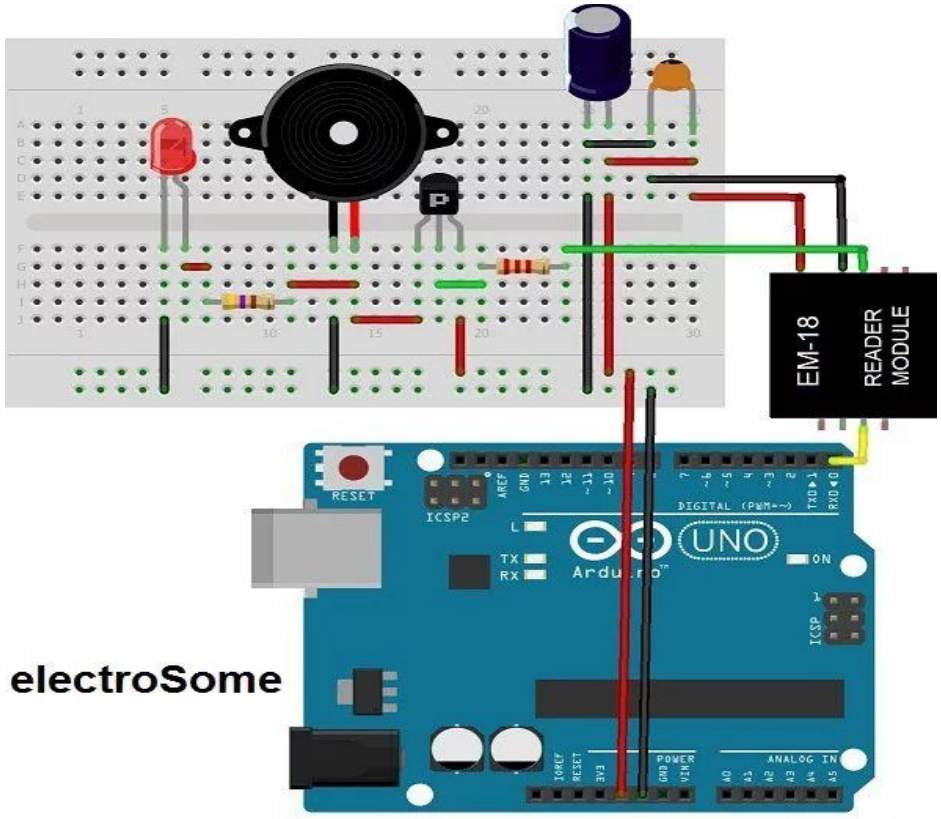
We have fixed the vibration sensor leaf with the phone so that when the phone vibrates, we can detect it and turn on the LED attached to the bag.

d) EM-18 RFID Reader

- **Why used?**
  We have used this to detect that our important things are inside the bag or not. So that we will not forget our items like keys, notebooks etc.

- **What is it?**
  The EM-18 RFID Reader module operating at 125kHz is an inexpensive solution for your RFID based application. The Reader module comes with an on-chip antenna and can be powered up with a 5V power supply. Power-up the module and connect the transmit pin of the module to receive pin of your microcontroller. Show your card within the reading distance and the card number is thrown at the output.

- **Integration with the project**



We are attaching the RFID tags to our items like keys, notebooks, etc.When we either keep or withdraw our items from the bag , RFID Reader will detect it, we are sending the tag number of the rfid which is already hardcoded in out app, and based on that and the previous status(present/absent) of the item in the bag, we are reversing it. So, the user can always view the status of items in his bag. Further modification in our app can allow the user to set reminders to take important items with him and remind him if he/she forgets those.

Switches:

a) Pushbutton

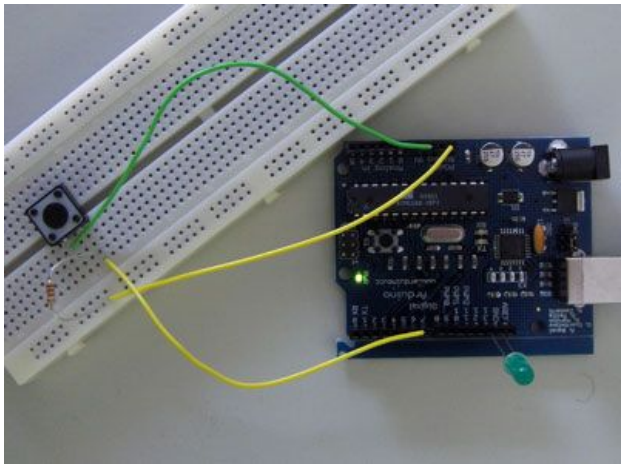
- **Why used?**

  We have used Push Button,so that user can press it in case of emergency, so that we can send a emergency message with user's location to three of his/her friends and family members.

- **What is it?**

  The pushbutton is a component that connects two points in a circuit when you press it.

- **Integration with the project**



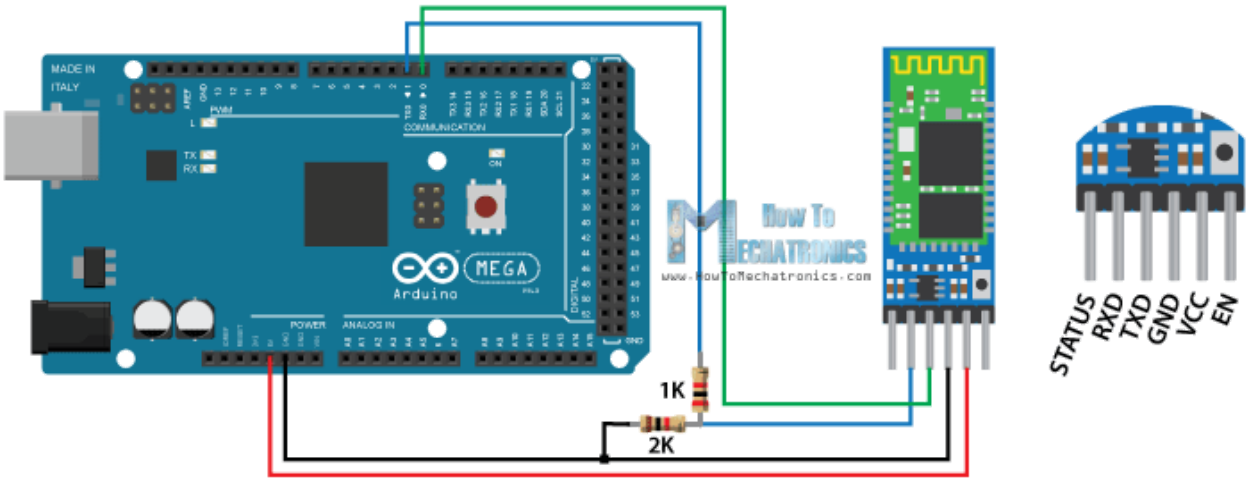
We have integrated Push Button with a particular pin of arduino, so that when it is pressed, output of that pin changes and we can actually send user's location(using his phone's GPS) to his/her friends and family members.The phone is connected to the arduino through Bluetooth module.

Bluetooth Module:

a) HC-05 Bluetooth Module

- **Why used?**
  We have used this module to make connection between Arduino and user's Phone. So we can inform of any updates to user through text messages and send emergency message through user's phone.
- **What is it?**
  HC-05 is a Bluetooth device used for wireless communication with Bluetooth enabled devices (like smartphone). It communicates with microcontrollers using serial communication (USART).

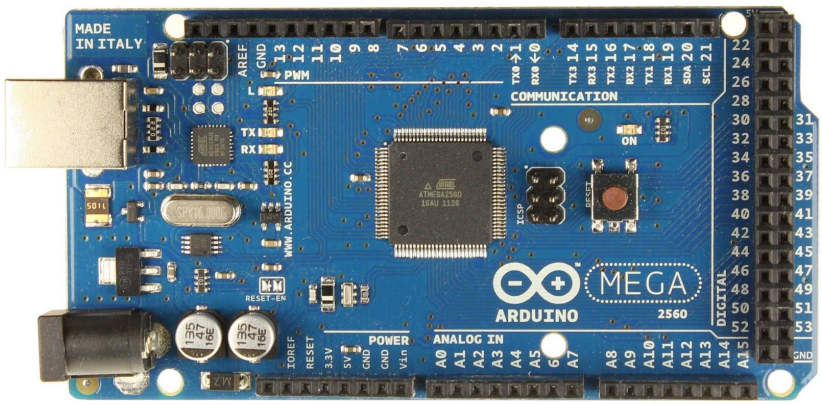
- **Integration with the project**



The bluetooth module is integrated with the arduino using it's Tx pin. On the other hand, it is connected to an android phone, for which we created our own application.
We can control the theft mode from our application. And also check if our items are present/absent using the rfid feature. The emergency feature on our bag uses the bluetooth connection to determine the location of the user with the phone and send it to three contacts.We also send notifications to the user on the phone related to activities like theft, bag zip opened, emergency.

Microcontrollers:

a) Arduino Board (Arduino Mega 2560)



- **Why used?**

  We have used Arduino Board to control the sensors and sending notifications to user's phone through Bluetooth module of Arduino.

- **What is it?**

  The Mega 2560 is a microcontroller board based on the ATmega2560 . It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

- **Integration with the project**

  Arduino board is used for controlling all the above described sensor.

  Additionally, for mqtt purposes, raspberry pi is used to receive data from the smart-cubicle project group(whether the owner is in his/her cubicle or not) to set the theft mode automatically .Raspberry pi receives data through mqtt and sends it to arduino through USB serial communication.

For mqtt, we have used mosquitto,an open source mqtt broker which has a python wrapper paho.mqtt to be used as a module in raspberry pi python code.

b) **Raspberry pi 2**:

- **Why used ?**

  We have used raspberry pi for mqtt purposes. We have subscribed to data published by smart-cubicle project group(group no - 16).With this data we detect the owner is present in his/her cubicle or not this help us set the theft-mode automatically.

- **What is it ?**

  The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables us to explore computing. The best thing about raspberry pi is its ability to interact with the outside world.

- **Integration with the project**

  For mqtt purposes raspberry pi is used to receive data from the smart-cubicle project group(whether the owner is in his/her cubicle or not) to set the theft mode automatically .Raspberry pi receives

data through mqtt and sends it to arduino through USB serial communication.

For mqtt, we have used mosquitto,an open source mqtt broker which has a python wrapper paho.mqtt to be used as a module in raspberry pi python code.

MQTT Protocol :

- **What is it ?**

  MQTT (Message Queuing Telemetry Transport) is a lightweight messaging protocol that provides resource-constrained network clients with a simple way to distribute telemetry information. The protocol, which uses a publish/subscribe communication pattern, is used for machine-to-machine (M2M) communication and plays an important role in the internet of things (IoT).

- **Integration with the project**

  Using mqtt protocol we have subscribed to the data published by smart cubicle group (group - 16). They continuously publishing string of “1” s and “0” s denoting the owner is present in the cubicle or not respectively.After receiving this data we are forwarding it to arduino board through usb serial communication. If the owner is present in his/her cubicle and working in his/her desktop then we are turning the theft-mode on automatically.

Salient features of this project

a) Anti-theft feature:

As described earlier we are using a MPU-6050 sensor to detect any unnatural movement of the bag. Our smart bag can operate in two different modes - (1) User-mode and (2) Theft-mode. In user-mode any kind of movement detected by MPU-6050 will be ignored but in theft-mode if any kind of unnatural movement detected then the user will be notified through his/her cell phone and buzzer will start ringing indicating that the bag is stolen. Apart from this we are using a magnetic reed switch to check that the chain of the bag is open or not . With theft mode on everytime the chain is opened the user will be notified through his/her cell phone.

According to the algorithm described earlier we observe the movement of the bag over a period of time and ring the buzzer when there is continuous movement over certain a period of time.This ensures that the buzzer is not rung when the bag falls over or gets moved slightly.This along with the magnetic reed switch detecting the chain is open or close provides complete anti-theft protection.

b) Automatic mode detection:

This feature enables us to detect user-mode and theft-mode automatically. To implement this feature we are using the data collected by group no - . Using the data shared through mqtt protocol we can detect the owner is working in the cubicle or not. So everytime the owner is busy working in his desktop the theft-mode will automatically be turned on.This way his/her bag will not be stolen while he/she is busy working in the desktop.

c) Tracking important items:

Important items such as keys, notebook can be tracked using rfid tags attached to them. So everytime a item bearing a rfid tag moved in or out the bag its status is updated in owner's cell phone. This helps the owner keep track of his belongings and detect if he is leaving something important behind or not.

d) Getting notification from devices kept in vibration mode:

Devices such as tablets which are difficult to carry in pockets are often kept in the bag with its vibration mode on.So it becomes difficult to receive any kind of notifications.Here we have used a vibration sensor to detect the the device kept in the bag is vibrating or not, everytime vibration is detected we are blinking a led notifying the user that a notification has arrived.

e)Emergency Button:

We have a emergency Push-Button, which send a help-seeking message to three of the user's friends and family members with his/her current location.We are getting the location from the user's phone GPS and phone is connected through Bluetooth Module of Arduino.

Limitations:

Limitations in sensing vibration:

This piezo vibration sensor shows high receptivity for strong impact,so we may miss some notifications as the mobile vibration doesn't always provide an impact strong enough to trigger the alarm from outside.This sensor requires the to-and-fro movement of the leaf of the sensor, therefore, we need to fix the leaf near vibration motor of the phone.

Limitation in anti-theft feature:

MPU-6050 sensor may provide some false positive readings which can trigger theft alarm in some cases as the MOVED bits may get set due to others interferences.But we have tested rigorously and such cases were minimal(5-10%).

Limitation in reading RFID tags :

Our RFID reader was sometime unable to detect the RFID tags smoothly and took more than 10 seconds some of the times.

Challenges:

Dropping the water-sensing feature :

Earlier we thought of using water sensor for sensing water inside the bag because rainwater or water from leaky water bottle may damage notebooks, laptop and other valuable things kept in the bag.
But, using a water sensor to detect water inside the bag is highly debatable as it is not cost-effective.Based on the discussions we had among ourselves and with the TAs we have arrived at the conclusions listed below:

1. Use case involving rainwater was discarded because water-proof bags are there, which are way less costlier and more reasonable things to use under this situation.
2. Water sensing with arduino would take additional programming time and space as far as embedded coding perspectives are concerned,which otherwise unnecessarily adds to the dispensable comlexity of the code.
3. Additionally,according to the usage, we will get the notification only when the bag is already wet, so whatever we are trying to protect, may have already been damaged.
4. The water sensor works only when it comes in direct contact with water. So it is very difficult to place the water sensor in correct position.Apart from this to cover the entire area we need multiple water sensors which is not cost-efficient.

Therefore,having these factors into consideration, we finally decided to drop that functionality/feature.

Discussion and Probable improvements on salient features:

a) Anti-theft feature:

Alternative approach implemented by the other group:

We can also implement the anti-theft feature by measuring the distance between the bag and the connected device(owner's cell phone in this case).If the distance between the bag and connected device crosses a certain threshold we can conclude that the bag is stolen. This was implemented by group no -2 to detect the bag is stolen or not.

Why it has not been implemented that way:

The major drawback of this approach is that we are considering the distance between owner and the bag not the movement of the bag itself.So if the owner keeps the bag in secure place say,for example in a locker and move away from it he/she will be notified that the bag is stolen which is incorrect.But the way we have implemented this problem will not occur as there is no unnatural movement of the bag.

b) Improvement of automatic mode detection:

We can improve automatic mode detection feature further by taking into account the distance between the owner and the bag. If the distance between the connection between the connected device and the bag exceeds certain threshold value we can turn the theft-mode on. This way we can make our automatic mode detection feature better without creating the problem described earlier.

c) Getting notifications in better way:

Everytime we get a notification we are blinking a led with may go unnoitced .In order to overcome this problem we can attach a vibration motor to strap of the bag. So everytime any notification comes it will start vibrating. It reduce the chances of missing notifications.

Precautions

- Reed Switch should be handled with care, as it is very fragile and breaks easily.
- All voltage supplies should not be more than 5V to ensure safe functioning.
- The setup needs to be handled with care some connection might get loose.

Pictures of entire circuit: