CS 321 - Project

Topic - Indoor Localization

Group Number: 1

Akash Rakheja (140101007)
Krishna Rohila (140101032)
Kuldeep Singh Parewa (140101034)
Sahil Sharma (140101062)

Brief Description

Our project on Indoor Localization helps students and other people by providing information of the Professor and his whereabouts in the department.It stores professor's location in the department and provide his current position.We have used MQTT protocol to publish a professor's information. Any person subscribed to one or many professor's topic will receive notification regarding his current location.We are also hosting all this data on our website, where it can also be made sure whether a professor is present in his room or not.

Is this IOT?

Internet of things (IoT) is proposed development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data.
Typically, IoT is expected to offer advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices, is expected to usher in automation in nearly all fields. Our project incorporate most of these characteristics allowing us to call it a device which can be used in Internet Of Things.

Description

Our project helps everyone who wants to know about whether Professor/Professors is/are in their room or not. And if they are not present in their room then we provide their location by localizing them near to another Professor's room. We are hosting all of this data on our website which can be seen in the photos attached and the video too. With their current whereabouts in the department we are also storing all there location's history which can be used by anyone who wants to work further over this project. We have implemented MQTT service using HiveMQ server, which publish the data of professor's location to device subscribed to any professor's topic. We have used various sensors and device to make these tasks possible.

Working

We have placed an arduino with HM-10 bluetooth low energy sensor, an Xbee and a PIR motion sensor in every professor's room.We assign an HM-10 ble sensor to each professor with their name set it in. Whenever any professor comes in the range of an HM-10 ble sensor, the arduino has code in it which sends this data to Raspberry Pi through an Xbee which is received by another Xbee connected to RPi. RPi has a python script running in it which parse this incoming data. This parsed data is getting updated in our database and also getting reflected on our webpage. If professor comes inside the room, the motion sensor detects his presence and motion sensor data is also sent as post request to our website. All this data is stored in our database. We have created a MQTT broker by making a server (HiveMQ) and when the data is getting updated on the database it is also sent to MQTT broker, which publish this data to every one subscribed to that professor's topic. A user can subscribe to more than one professor and whenever that professor/professors is/are present in the department the notification to sent to the user.

Hardware/Software used:

Hardware specifications

1. Arduino- Arduino mega 2560 r3 development board
2. Xbee- Xbee 6.3mw Wire Antenna- Series 2c (Xbee Mesh)
3. Xbee Shield- Xbee Shield V2.0
4. BLE (Bluetooth Low Energy) Beacon- HM-10 Wireless Bluetooth RF
5. Transceiver Module Serial/TTL/RS232 for Arduino
6. PIR Motion Sensor
7. Raspberry pi- Raspberry Pi 2-Model B,1GB
8. Xbee Dongle- Xbee USB Adapter with FT232RL

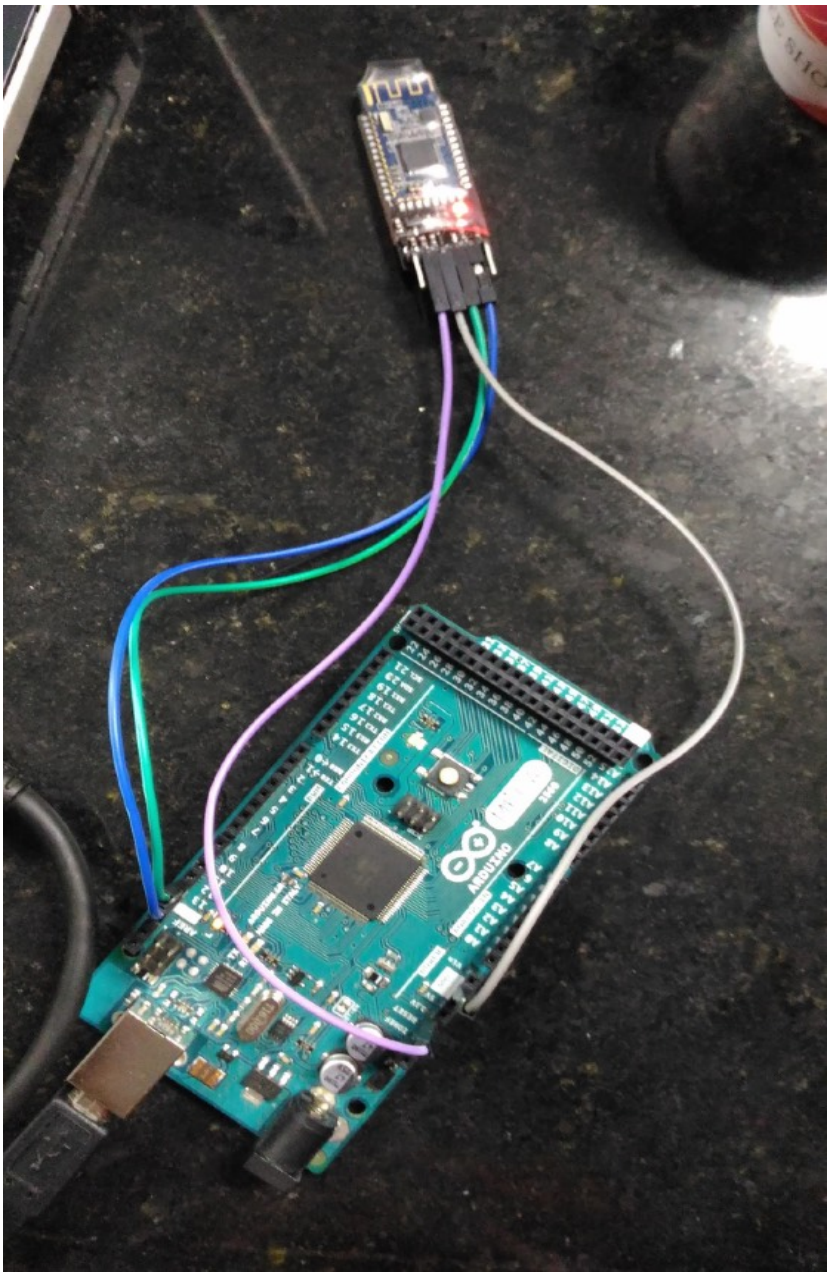
Software

1. Arduino – For interacting with the Arduino Uno/ and Mega.
2. XCTU – For interacting and programming the Xbee.
3. PostgreSQL – Database for storing professor's data
4. HiveMQ – MQTT server and publish, notification functionality
5. Django – Web framework to host the website

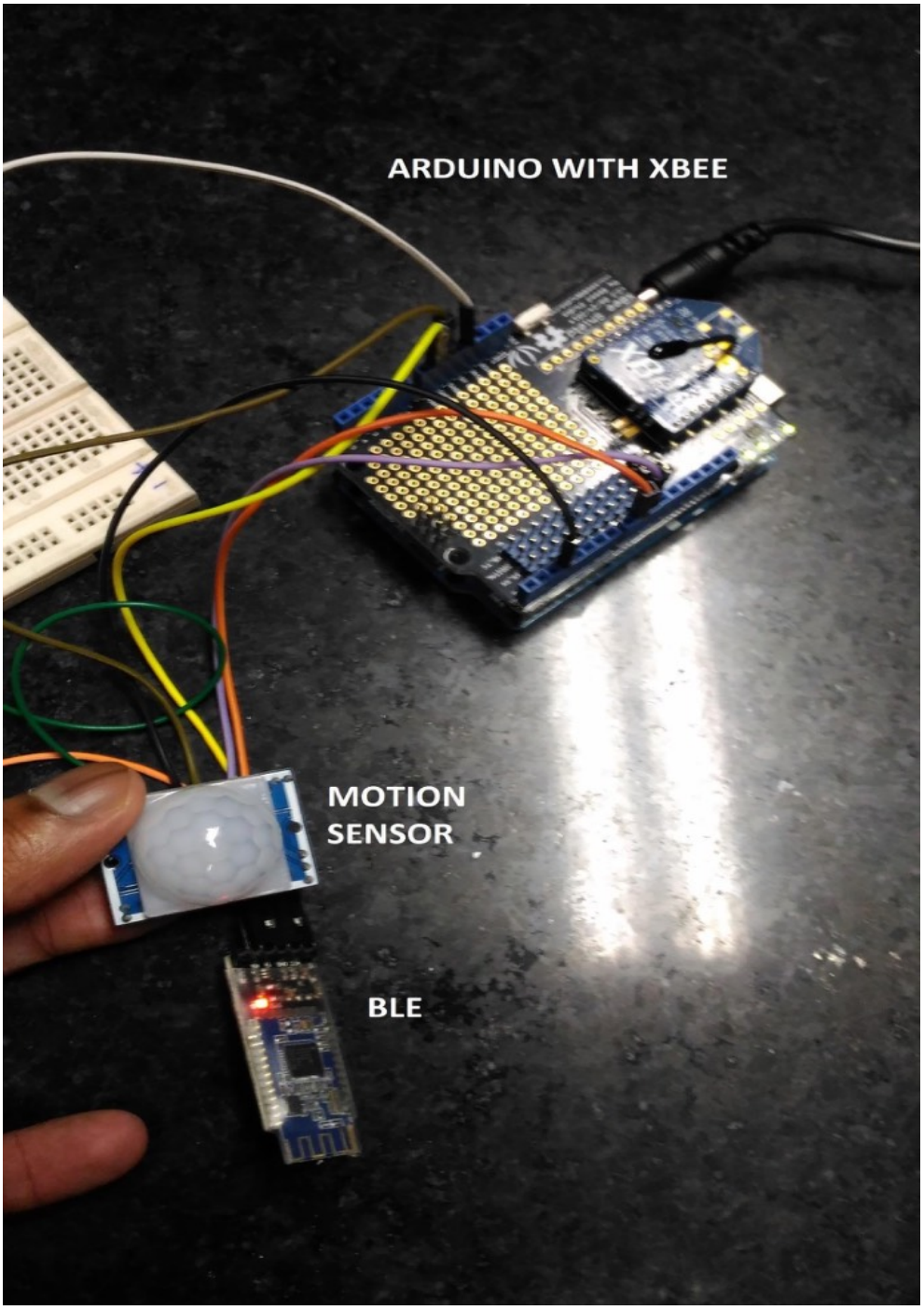
How to Assemble:

Every room will have an Arduino with a ble (receiver) and motion sensor attached to it. Also every floor will have a raspberry pi which will communicate with those Arduino's. The pi also communicates wth the server over the internet to update the location of the people being tracked. These pi act as server to which an Xbee is attached using a dongle which collects data from the other Arduino and updates on the server. The person to be tracked will have a ble (transmitter) which they will carry with them. The Arduino in the rooms will also have an Xbee shield on them with an xbee attached so that they are able to send data to the concerned raspberry pi on that floor. Once the pi receives data from the Arduino's it parses it to collect information on which person was detected by which of the pi's. The data then gets updated on the server database. This data is then displayed on the webpage hosted on the server. The displayed data is updated regularly (after every 5 sec - 10 sec) so as to give the most recent activity. If the person leaves the building, then the last time remains as it is and does not get updated to show the last time any activity was detected by him in the building.

The transmitter with the professor (In practical the BLE should be attached to a 3V battery to get power instead of the Arduino for ease in carrying around).



Receiver in the rooms



IoT Device Salient features of our device include:

1. It is the inter-networking of professor's room embedded with electronics, software, sensors, and professor that enable these rooms to collect and exchange data with the central server.
2. Each professor is uniquely identifiable through its embedded computing system but is able to inter-operate within the existing networking infrastructure.
3. We can view that whether the professor is in his room or not and if he is in the department then where he/she is.
4. Central server receive location of all professor through Xbee attached to it and each of the professor's room and will store it.
5. Bluetooth transmitters with professor does the indoor localization of professor with respect to the various rooms.

Future Work

1. **Indoor positioning on Map :** The data which we are getting from these devices can be very useful as we all know GPS doesn't work inside buildings so by using accurate indoor maps, we can use this data to track exact location of a person and showing it on map.
2. **Automation/ Energy saving**: A large part of home automation relies on knowing where you are in your house. GPS cannot do this. So now we can save a lot of energy by detecting that if a person is there or not in a room.
3. We can use the data for taking out the predictions that around what time a professor is most likely available and which is the most likely place, using Machine learning technique.
4. **Smart Suggestions :** We can suggest professor that which is the nearest washroom, conference room or exit and what will be the shortest path.

Cost

Unit of currency is Indian Rupee for the below cost.

For each professor room, we will use the following hardware and their cost are mentioned:

1. Arduino - 950
2. Xbee - 1600
3. Xbee Shield - 800
4. BLE (Bluetooth Low Energy) Beacon - 650
5. PIR Motion Sensor - 200

Total price for each room set hardware is 4200.
Note : We can use Ethernet shield instead of Xbee and Xbee shield. But due to unavailability of Ethernet shield we didn't use it other wise its price will come down to 2300.

For each professor

1. Power Source for BLE - 20
2. BLE (Bluetooth Low Energy) Beacon - 650

Total price for each transmitter hardware is 670.

Central server has below cost for their hardware specifications other than the terminal:

1. Raspberry pi - 2800
2. Xbee - 1600
3. Xbee Dongle - 600

Total price for central server hardware is 5000.
Note : If we have used Ethernet shield then central server hardware cost will be 2800.

For total cost, say there are n bluetooth transmitters in professor room, m professor and central server system.

Total cost will be (n*4200) + (m*670) + (5000)
Or (if ethernet shield is used)
Total cost will be (n*2300) + (m*670) + (2800)

Code

All commented codes are included in the rar file. This comprises of code that has to be uploaded in arduino, code to run Django web server and Python script to update database.

We also have to configure Xbee's using XCTU, by making their PAN-ID same, and assigning major and minor of Xbee connected from RPi to the major and minor values of another Xbee present in each room.

Two ble's are also configured using serial terminal.
AT+NAMEPARA1 to change name of ble to PARA1.
AT+IMME0 to set parameter to zero.
AT+MODE0 to set mode to zero.
AT+RESET to reset ble in case any problem is faced.
Refer to HM-10 Data sheet for any more AT commands.

Conclusion

Our project is very easy to implement and is very useful in day-to-day basis. Though the cost is a little high but it can be reduced by using some cheap and particular hardware used only for the purpose of indoor localization. It still requires further efforts to utilise it up to its full potential. As we have mentioned in our future work, this project can be taken in many different directions and can be implemented in not just our department facility but in schools, hospitals, prisons and many more.