SENSOR HACKATHON PROJECT

PROJECT TOPIC:
IoT-BASED HOME SECURITY SYSTEM USING THE MQQT PROTOCOL WITH IBE ENCRYPTION AND A CAMERA

PROJECT TEAM MEMBERS:

1. YUJIA PANG
2. JUSTICE OHENE-AKOTO

1. What are you trying to do? Articulate your objectives using absolutely no jargon.

The aim is to develop an IoT-based home security system to curb danger such as human intrusion, theft, gas, smoke and other harmful gas leakages that can ruin the safety of the home. This system will sense, create an alert and give real time visuals of the incident.

The specific objectives of this project are as follows:

1. To detect human intrusion and theft using the PIR sensor.
2. To sense the leakage and presence of harmful gasses that can ruin the home and human lives via suffocation, fire outbreaks, etc using MQ5 sensor.
3. To provide an effective and reliable functioning of the MQ-5 sensor using a DHT sensor. This gives users the real time room temperature and humidity.
4. To give an alert of danger via email to aid in increasing the response time to curb the danger.
5. To provide real time visuals of incidents for effective monitoring and evaluation using a camera.

2. How is it done today, and what are the limits of current practice?

Existing literature uses the MQTT (Message queueing telemetry transport) protocol in IoT (Internet of things) along with adopting a feasible means of encrypting the message transfers in applications. The ESP-8266 Wi-Fi SoCs, specifically the NodeMCU ESP-8266 12E and ESP-01 8266 Wi-Fi modules, are connected via MQTT. Both utilize Wi-Fi to connect to the internet and communicate using the MQTT protocol. This project also makes use of two sensors, a MQ-5 gas sensor and a PIR (Passive InfraRed) motion detector sensor, which detect human presence and various gases, respectively.

This encrypted data is then transmitted to a node in the center, the NodeMCU ESP-8266 12E, which decrypts it and uses the Blynk app to notify the user of any errors.

Limitations Of Existing Practice:

The limitation of existing practice is that there is no real time visual monitoring of incidents. Hence, existing literature gave a recommendation that this work can be extended in future as, above all the PIR sensors, a camera module can be connected so that the user can also watch, about what the PIR sensor is trying to alert. Also, there is no camera to monitor the incidents captured by the MQ5 sensor.

Secondly, the PIR sensor requires small delays as a result of the Adafruit data rate limitation which posed a challenge

Lastly, the Blynk app which was used is more complicated and suitable for those who want to write code. These does not make it user friendly to its users. It also has a small user interface and is difficult to use sometimes.

3.What is new in your approach and why do you think it will be successful?

Our new approach is an extended and an improved version of existing literature. We inculcated the blind spot of existing literature by filling in the gap of adding real time visual monitoring of what the PIR sensor and MQ5 sensor wants to alert. This gap was filled by connecting a camera module to the set-up to give real time visuals of incidents captured by the PIR sensor, that is, any human intrusion or theft. In addition, the camera also captures the real time visuals of incidents

captured by the MQ5 sensor. The success of this new approach is that, with this, the user can quickly take measures to avert the escalation of events. This gives the user the opportunity to have access to happenings before, during and after an incident had occurred. In the worst-case scenario, this will also assist other agencies such as the fire department amongst others in their root cause analysis of an incident.

Secondly, the PIR sensor requires small delays as a result of the Adafruit data rate limitation which posed a challenge. To address this, data was translated to Cayenne which uses MQTT protocol for efficient data transfer. Cayenne can send notifications to the user's email address to provide prompt warnings. Introducing, Cayenne, the delay time in transmitting data was improved. This was a major improvement since the response time of receiving notification to take action is vey imperative to prevent danger from escalating. The more one delays, the more the danger increases and becomes uncontrollable. This addition makes the new approach successful.

Lastly, the Blynk app which was used is more complicated and suitable for those who want to write code. These does not make it user friendly to its users. It also has a small user interface and is difficult to use sometimes. To fill in this gap, we used an alternative that is cayenne which is simple to use and no need for programming or writing codes. In addition, it has a good user interface and is easily configurable. This contributed hugely to the success of this new approach since the success of this project is measured by how user friendly it is for home-based safety. At the sight of danger when there is likely to be confusion all around, the user needed a simple tool to use. To complement the functionality of Cayenne, the free AtHome app was proposed for the camera to transfer collected data to the user's phone.

An overview of the reporting and monitoring platform:

Cayenne:

To ensure stable Internet connection for data transfer to the user's phone, the delay time of the system was manually set to a sufficient length for user notification. The system can operate without an Internet connection, with the red-light indicating detection of unusual movement or gas leak. However, the whole system takes approximately 1-2 minutes to stabilize.

After evaluating different options, we decided to use Cayenne instead of Adafruit for our IoT-based home security system. This decision was based on the fact that PIR sensors require small delays to ensure their effective usage, and the use of Adafruit limits the speed of the system as we try to lower the delay. A screenshot of the issue can be found below.

Cayenne offers a friendly user interface that is suitable for new users and uses a similar logic to Adafruit. Unlike many articles, we did not use the Blynk app because we found that there was no need to download another app. Instead, the alarm can be sent to users directly through email and text message. We chose this approach because people are more likely to check their email and text message than the Blynk app, which can be challenging for first-time users. Overall, the decision to use CAYENNE for our home security system was based on our need for a reliable and user-friendly platform that would provide the necessary functionalities without compromising system performance.

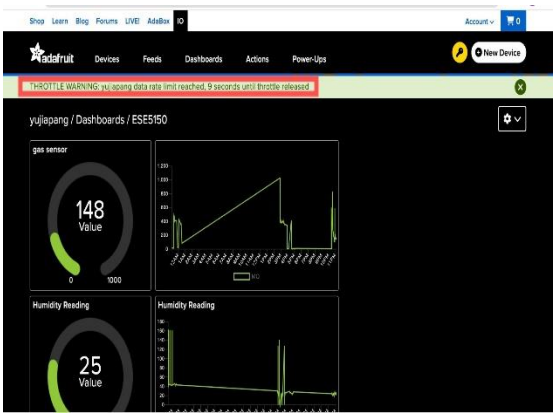


Figure 1

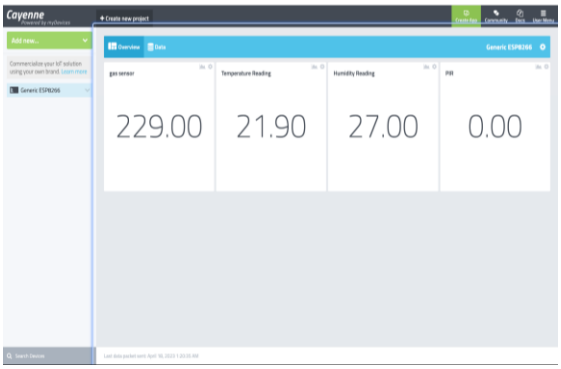


Figure 2

Fig. 1 Screenshot from Adafruit. The red box indicates that adafruit has reached the speed limit

Fig. 2 Cayenne page

Camera:

For the camera, an intermediate station was set up using a computer to transfer collected data to the user's phone. The free AtHome app was utilized to transfer data, enabling remote observation of the apartment when suspicious movement or potential gas leaks were detected. The app's record function was also utilized to provide a complete visual log of events.

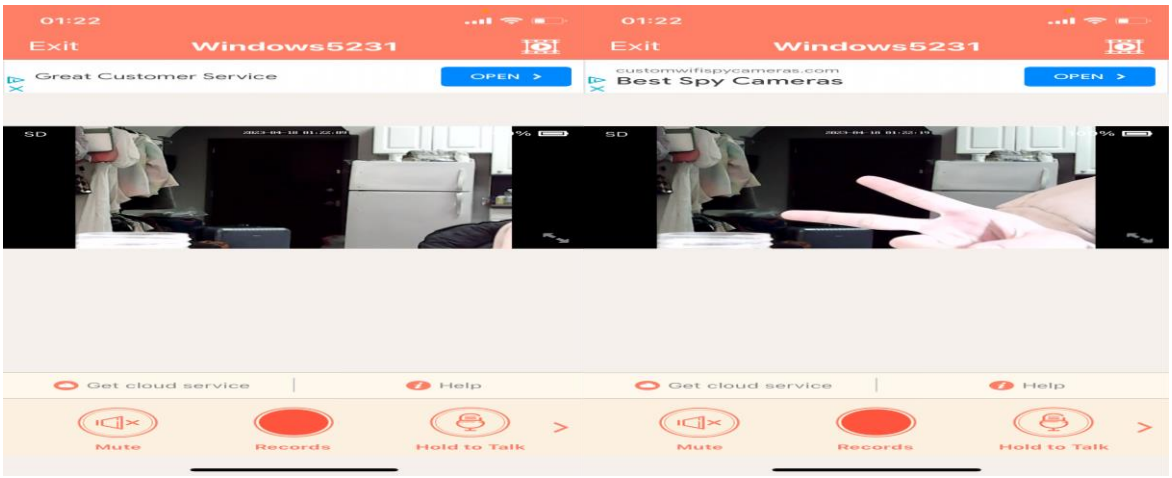


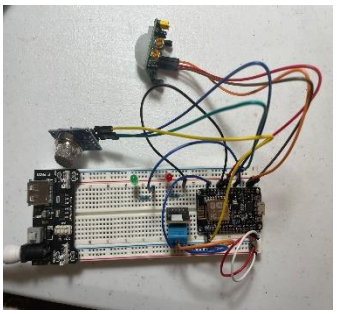
Fig.3 AtHome App

Results And Discussions:

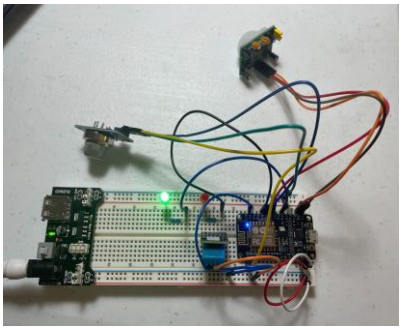
1. Make sure all the connections are correct and the code is uploaded to the board. Turn on the power supply
2. PIR sensor and MQ5 sensor need 1-2 minutes to be stabilized, thus within this time, the red LED alarm may not be accurate.

3. GreenLED will turn on and RedLED will turn off if there is no gas leak or suspicious movement. DHT sensor to collect temperature and humidity and send it to the Cayenne. During this time, no notification will be triggered.
4. If there is a sudden movement detected by the PIR sensor, or potential gas leak detected by the gas sensor, the red LED will turn on. The data will also be collected by Cayenne and send notification to users via email or text message.
5. After get notification, user could log into the AtHome App, and watch live surveillance of their home (with sound) and use the record button in the app to record suspicious behavior Green LED and red LED could work without the Internet and send live visible alarms if the user is at home.

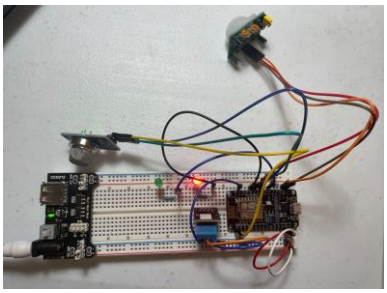
Images of results:



Hardware connections



Green light on, Safety mood



Red Light on, danger: potential gas leakage or theft

4. Who cares? If you are successful, what difference will it make?

This project offers an easy and affordable solution for individuals who want to set up a home alarm system, providing numerous benefits such as enhanced security, prevention of theft and burglary, and detection of life-threatening gas leakages. Additionally, the IoT-based system allows for remote access and monitoring, which is particularly useful for those who travel frequently, have young or elderly family members at home, or need to protect valuable assets. Overall, the successful development of this system will address the issue of home security and safety, benefiting homeowners and their families. This is also accessible via the app which can be viewed at any place at any time to help expedite response time to curb danger. Once there is a trigger, the individual can have real time information to monitor and help prevent it escalating. This will also help save lives and properties which makes it a necessity and imperative for all to have.
On a larger scale, governments, safety agencies, fire departments, police, insurance companies and relevant authorities can adopt this to save lives and properties.

5.What are the risks?

The risks to this project are as following:

1. An interrupted supply of electricity. Since the sensors are powered by electricity to work, its operation will be haltered when there is no supply of electricity.
2. A weak and an interrupted internet connection. The sensors transfer information to the adafruit via the internet to sound the alert. With a weak and interrupted internet connection,

this will be hindered. Without the Internet, the red LED and green LED are still able to send visible warnings, but this will limit its usage.

3. An ineffective maintenance and calibration of the sensors. The sensors will be out of shape and not be as sharp as it is to sense and transfer data.

Recommendations to curb the risks as following:

1. An alternative and standby supply of electricity to the sensors with a fast change over time.
2. Having a conscious and adhering to a strict maintenance and calibration schedule for the sensors.

Future recommendations to this project:

1. Adding a decoy alarm to the PIR sensor to produce the sound of wild dogs or police sirens to scare off human intruders and thieves.
2. Adding a coil that can trigger a fire extinguisher automatically as soon as danger is sensed and an alert is blown. This trigger can also be added as a feature to the mobile app and given a few minutes to reset (that is preventing the trigger of the fire extinguisher if there are other alternatives to curb the danger) or trigger the fire extinguisher after there is no response on the app for a few minutes.

6.How much will it cost?

The whole project includes ESP 8266 board, PIR sensors, MQ5 sensors, DHT sensors, and cameras. All the sensors including camera are around $5, and the price for the ESP 8266 board is around $10. Thus, the whole cost is around $30.

7.How long will it take?

Based on the level of experience and exposure of the operation and functionalities of IoT, adafruit, cayenne, PIR sensor, MQ5 sensor and the DHTI, it should take about ten to fifteen days to complete this project.

8.What are the midterm and final "exams" to check for success?

Midterm Evaluation:

1. Functionality of the PIR sensor in detecting human intrusion and theft.
2. Accuracy and reliability of the MQ5 sensor in detecting harmful gases.
3. Integration of the DHT sensor for monitoring room temperature and humidity.
4. Effectiveness of the system in giving alerts via email and notification to the user.

Final Evaluation:

For the final evaluation, the following criteria could be used to assess the success of the project:

1. Real-time visuals provided by the camera for effective monitoring.
2. Overall effectiveness of the IoT-based home security system in detecting and preventing danger.
3. User-friendliness of the system, including ease of use and setup.
4. Reliability of the system in providing real-time alerts and visuals.
5. Overall contribution of the project towards improving home security and safety.

The final evaluation could also include a demonstration of the system's functionality and a report detailing the design, implementation, and results of the project.

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