Natural Disaster Detection for Smart IoT Communication using LoRA model

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Abstract

There is annual financial loss, mental pain, bodily injury, and loss of life due to natural and artificial disasters. Unfortunately, natural disasters are becoming much deadlier due to climate change. Consequently, IoT-based catastrophe detection and response systems have been developed to improve the handling of catastrophic disasters and other times of extreme urgency. As a consequence, information gathered from Internet-connected devices is utilized to aid in the categorization of several types of disasters, both natural and artificial. A determination of the nature of the crisis and notification of the relevant command center is accomplished using preexisting methods. We have shown how to modify an existing system into a particular early warning system for natural disasters using two Internet of Things (IoT) devices: the Arduino Uno and the Nodemcu. Using this data, we can pinpoint the exact position of every person whose phone is within range of the disaster and send them warnings before the situation worsens. The botmasters have shifted their paradigm away from IRC and toward an HTTP-based C&C server due to the widespread use of HTTP services. Like HTTP bots, IRC bots have a single point of failure. HTTP bots, however, are harder to stop. It is also challenging to detect HTTP botnets while keeping the false positive rate low since every service on the Internet utilizes the HTTP protocol. This chapter provides a host-based HTTP botnet detection approach that uses Hidden semi-Markov Model (HsMM) variables and the Simple Network Management Protocol-Management Information Base (SNMP-MIB). The device operates following the specifications established by the LoRa network. In this project, we used a device called Nodemcu, which was made to be configured explicitly on the receiving end to identify the users at the place where the catastrophe was detected. At that point, everyone connected to the gadget would receive a geolocation-based alert. MQTT is used to notify the right people when an issue arises. We saw better and more beneficial results from the IoT project after including LoRa.

Keywords: LoRA; MQTT; Internet of Things; Arduino Uno and Nodemcu; Machine Learning

1. Introduction and Related Study

"Natural disaster" refers to "the unfavorable impact after an actual occurrence of a natural hazard if it significantly harms a community." This definition describes "the adverse effect following an actual occurrence of a natural hazard." In the aftermath of a natural catastrophe, there is often also some economic damage, in addition to the possibility of human casualties or damage to property. The degree of damage is proportional to both the existing infrastructure and the degree of resiliency of the population that is impacted. In contemporary times, natural disasters, disasters caused by humans, and disasters hastened by humans are differentiated from one another. In 1976, many began to argue that "natural catastrophe" was too broad and may mislead people. A disaster results from a natural or artificial threat that strikes a population that is already vulnerable to such dangers. Natural

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disasters are unanticipated events that have a global impact and may hit any country. Extreme weather events, such as hurricanes, earthquakes, droughts, floods, and heat waves, are responsible for significant property damage, monetary losses, mass evacuations, anguish, and injuries and fatalities each year. For example, the tsunami that struck Japan on March 22, 2011, was responsible for the loss of 15,894 lives, the destruction of more than 120,000 structures, and projected damages of over USD 199 billion. The Internet of Things propels the field of computer science forward. The pre-Internet era has given way to the Internet of Things era, which marks the fourth commercial revolution. This shift has taken place during the course of the Internet. Increasing the efficiency of Internet-connected production while simultaneously maximizing profitability is one of the critical objectives of the Industrial Internet of Objects (IoT). This will be accomplished via the use of linked equipment and intelligent things. The adoption of IoT provides smooth company development and improved visibility, which opens up opportunities for previously unimaginable enterprises. In this section, we will discuss the significance of the Internet of Things to emergency management. To be more precise, it analyses and contrasts some of the solutions that are now available on the market and discusses IOT-based catastrophe management for various kinds of disasters. The following information is intended to be a reminder of this article. Elucidates the history of the evolution of the Internet of Things. Explains disaster management processes while also providing some illumination on reports of disasters in line with the ED data database and the disaster categorization system. Elucidates the standard procedures for issuing early warnings of impending disasters.

The actions that pertain to responding to disasters and recovering from them are often of a decentralized type. As a consequence of this, new technologies have the potential to serve as valuable instruments for local monitoring and coordination, particularly in the domain of preventative risk reduction. Because technical advances tend to occur every few, governments need to change the disaster management procedures that are to be applied by rescue teams to keep up with the latest developments. Because there are many different risks to consider when a catastrophe occurs, each component of risk must be comprehended to effectively reduce the risks associated with the possibility that disasters will occur. Both the Hyogo Framework for Action (2005-2015) and the subsequent Sendai Framework for Disaster Risk Reduction (2015-2030) presented an exhaustive list of actions aligned with the main disaster management objectives. These suggestions are implemented by the governments of different countries, who incorporate them into their emergency management strategies at the national and state levels. However, it is essential to note that the frameworks and the action plans derived from them primarily deal with vast terrains, often spanning hundreds or even thousands of kilometers. This is something that should be kept in mind. In addition, the National Disaster Management Plan (NDMP), 2016, which focuses mainly on the administration of resources on a broad scale and makes no explicit reference to catastrophes that take place within buildings, The potential for improvements in technology has not been fully used since there are no frameworks expressly created for dealing with interior tragedies. As a result, this sector is screaming for immediate attention. The management of an indoor disaster typically presents its own unique set of challenges, which are quite distinct from those involved in the direction of an outdoor catastrophe; consequently, there needs to be a particular emphasis placed on the development of tools and techniques for managing indoor rescue and relief operations. There is a significant amount of room for growth in indoor catastrophe management due to recent technological advances in the internet and cloud-based technologies, as well as the availability of Internet of Things (IoT) devices.

2. Communication Protocols for Internet-Connected Things Methodology

To accomplish this goal, it was necessary to investigate the potential part that CCIoT might play in collecting data in a timeframe close to a catastrophe and the value that such data would have for disaster management. In addition, an investigation was conducted to determine the different instruments and strategies for managing indoor disasters that are now accessible for usage. It does this by making use of geolocation. It is built on Arduino and uses various sensors, including piezoelectric, moisture, and vibration sensors, to monitor changes in the surrounding environment. The LoRa network, which sends and receives data from other sources, serves as the brain of this project.

Everything works as it should in line with the LoRa specifications. The tool used in this study, which goes by the name Nodemcu, has a receiving end set up in a certain way to identify persons who were present at the site where a catastrophe was found. From that point on, an alarm will be sent out through geolocation to anyone affiliated with this device. MQTT is used to convey notices. Implementing LoRa in the Internet of Things project yielded superior and more advantageous outcomes.

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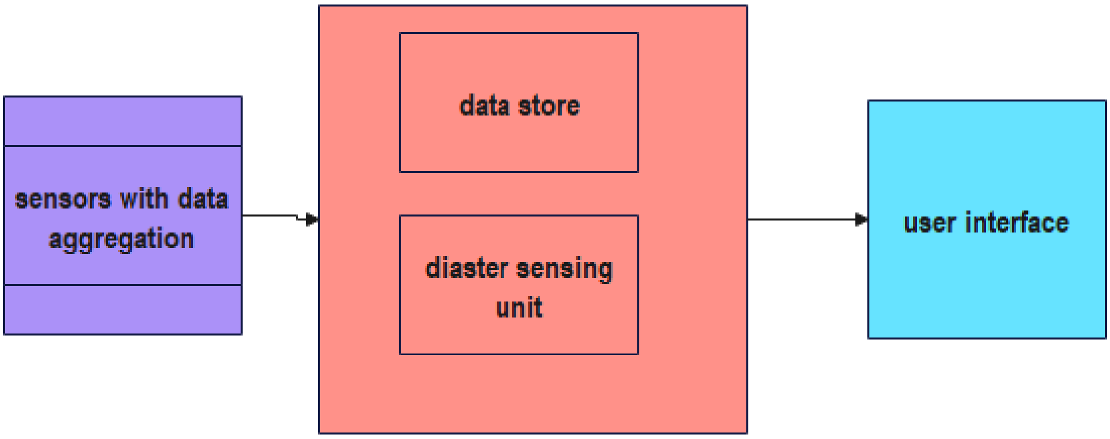

Figure 1: Block Diagram of IoT Disaster Management

The first block is made up of a variety of sensors as well as a data aggregation service. This service combines the information from all sensors into data packets that are then sent over the internet.
(ii) The second block is made up of several modules that are hosted on the cloud. These modules each carry out a separate and unique set of specific responsibilities. To determine whether or not any potentially disastrous events have occurred, the Disaster Sensing Unit examines the data to look for any values outside the norm. The Push Notification module allows the delivery of alarm messages to the members of reaction teams as well as the building supervisors. These alert messages may be sent through SMS or email. By supplying inputs to the User Interface, the Victim Localization Service makes it easier to discover people who may have been injured or killed within the structure affected by the tragedy.
(iii) The user interface is the third component of the building block set. It offers a graphical depiction of the numerous sensors and the individual distribution inside a building. It makes everyday monitoring tasks easier to do and provides visual information about the location of victims in the event of a catastrophe.

Algorithm 1: Proposed Sensing unit

Step 1: Collect data from a variety of sensors located in a variety of networks.

Step 2: Set the a value for the humidity, the b range for the moisture, and the c range for the vibration.

Step 3: The NodeMCU, which serves as the controlling unit, receives the raw data prepared by the LoRA module, which has gathered the data.
Step 4: Using the collected data, the NodeMCU will search for values corresponding to the previously determined threshold values.

5. If an is less than 990 or c is less than 1000

Step 6: If the criteria are satisfied, notify the appropriate parties that a catastrophe has been found.

Step 7- Else send a notification like a Disaster not detected.

Step 8: Proceed to step 1 once again.

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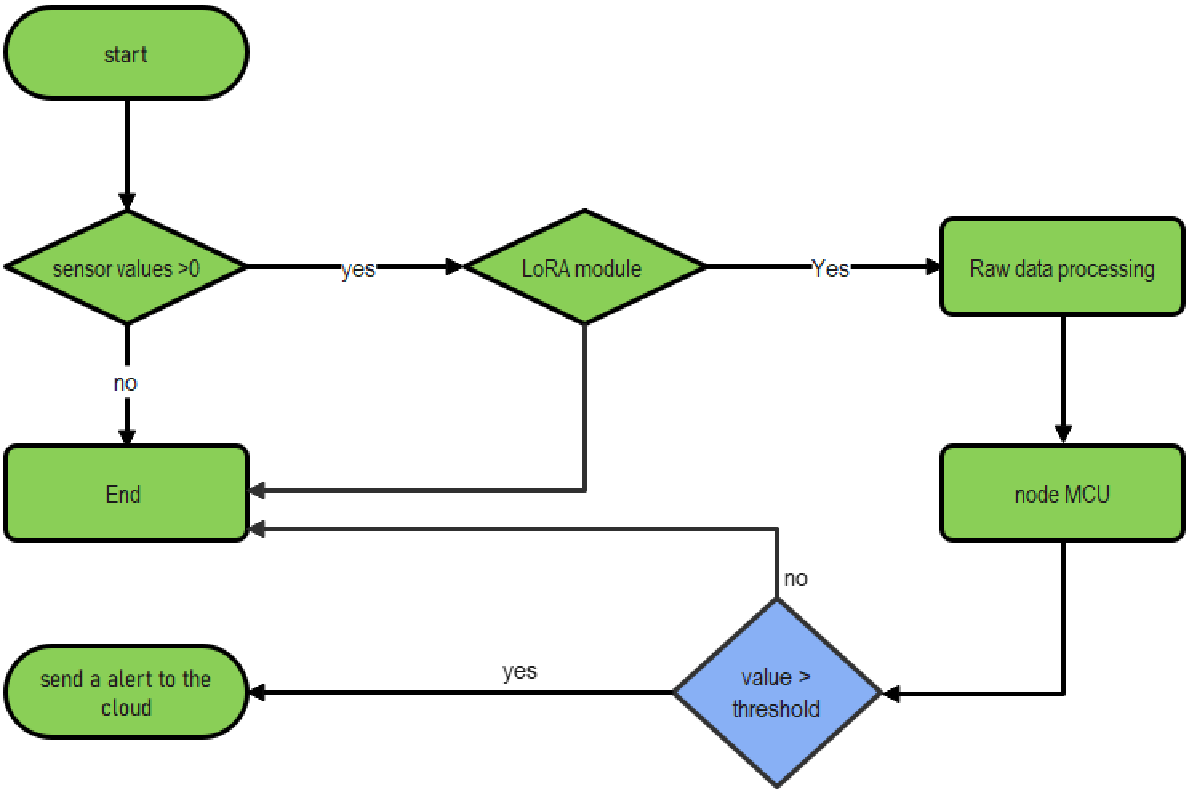

Figure 2: Flow chart of Proposed work

The Disaster Sensing Unit, often known as DSU, is a specialized service that operates on the cloud. The DSU also receives a copy of the data that was obtained from the DA in its entirety. An algorithm is used to this data to determine whether or not the potentially catastrophic event occurred inside any of the buildings registered with the system. Suppose the result of this method is affirmative. In that case, the DSU will notify the Push Notification (PN) module about it and send any other pertinent data simultaneously. The PN will send alert messages to the building supervisor via SMS or email. These messages will also be sent to any disaster response teams (RT) pre-registered and mapped in the database for that particular region. Through the user interface, the Victim Localization Service (VLS) provides the necessary data to the security personnel of the business building and the RT (UI).

BLOCK DIAGRAM

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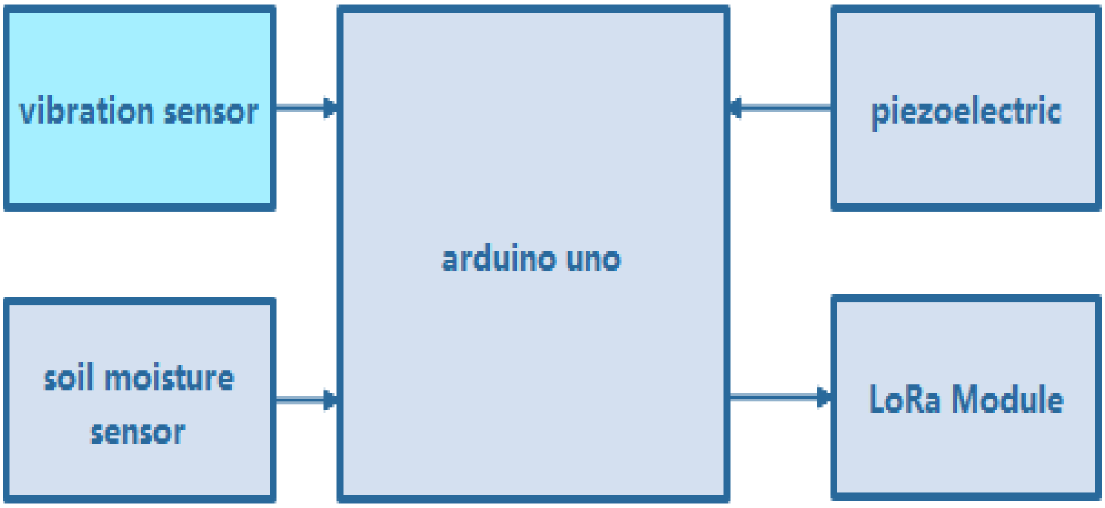

Figure 3: Transmitter

Both the transmitter and the receiver are comprised of two distinct portions each. The transmitter is what does the detecting, and it is linked to all of the sensors so that it can do so. The protocol known as Lora is utilized for communication, and a serial UART interface is used to link the devices. They might employ a GPIO or ADC interface, depending on the kind of sensor they are using. A buzzer is used there as a means of providing a local alert. The MQTT protocol is used to provide individualized notifications to each individual.

2. Experimental Results and Analysis

Many sensors (S1, S2 n), including fire sensors, accelerometers, people counters, and others, have been put in rooms and corridors throughout the structure. The sensors are in charge of collecting data linked to specific characteristics, and this information is subsequently sent to a locally installed specialized subsystem known as the Data Aggregator (DA). The Data Aggregator (DA) is the component that combines the readings from all sensors into a single data packet and assigns a unique timestamp to each package. The compiled information is then uploaded to the cloud, which is kept in the Cloud Datastore (CD), a digital archive that houses the information produced by the numerous sensors. This operation is repeated for each unique set of sensor readings obtained from various commercial facilities, and the data packets are saved in the CD's appropriate data buckets.

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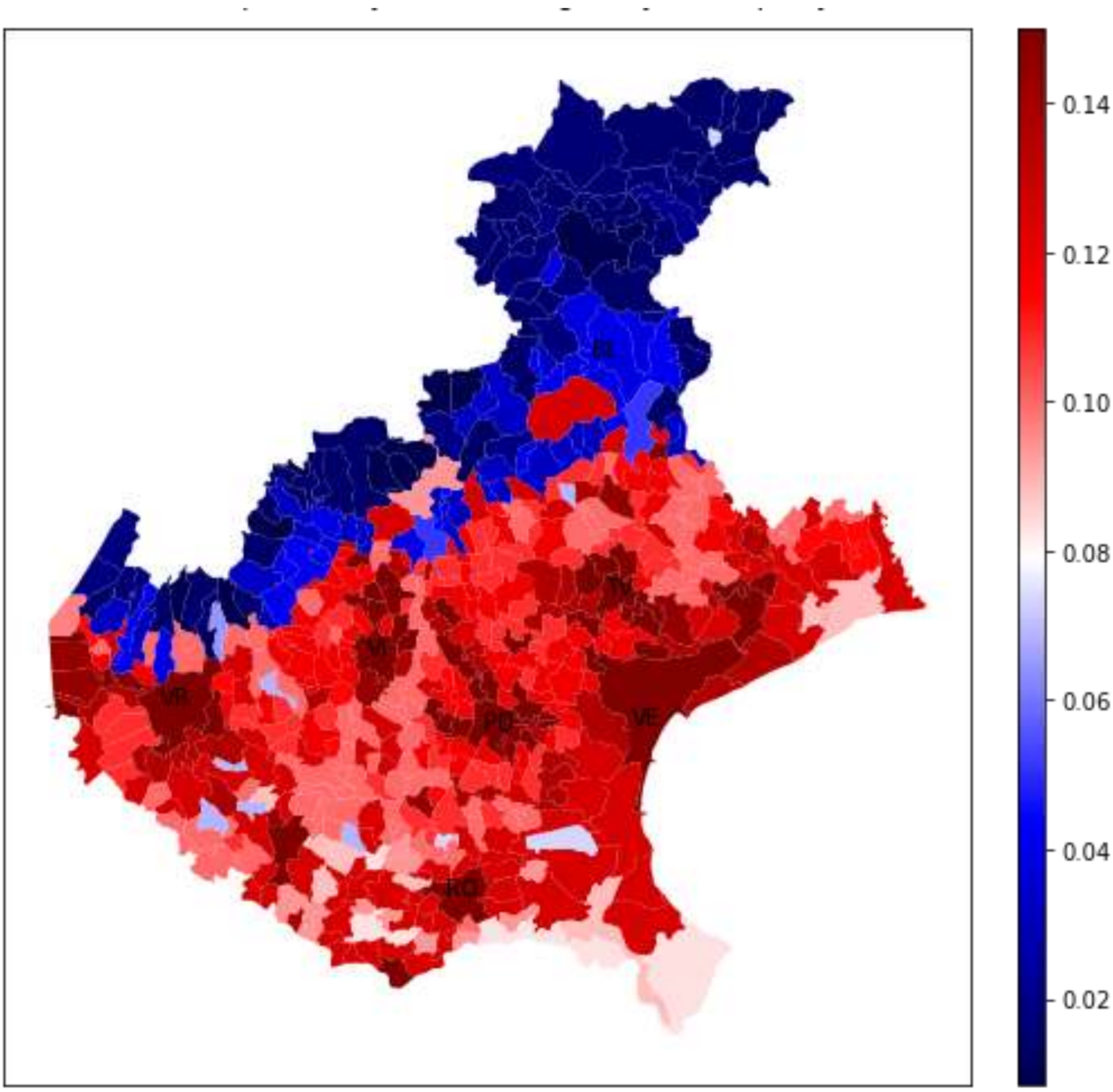

Figure 4: Flood Probability in the particular Region

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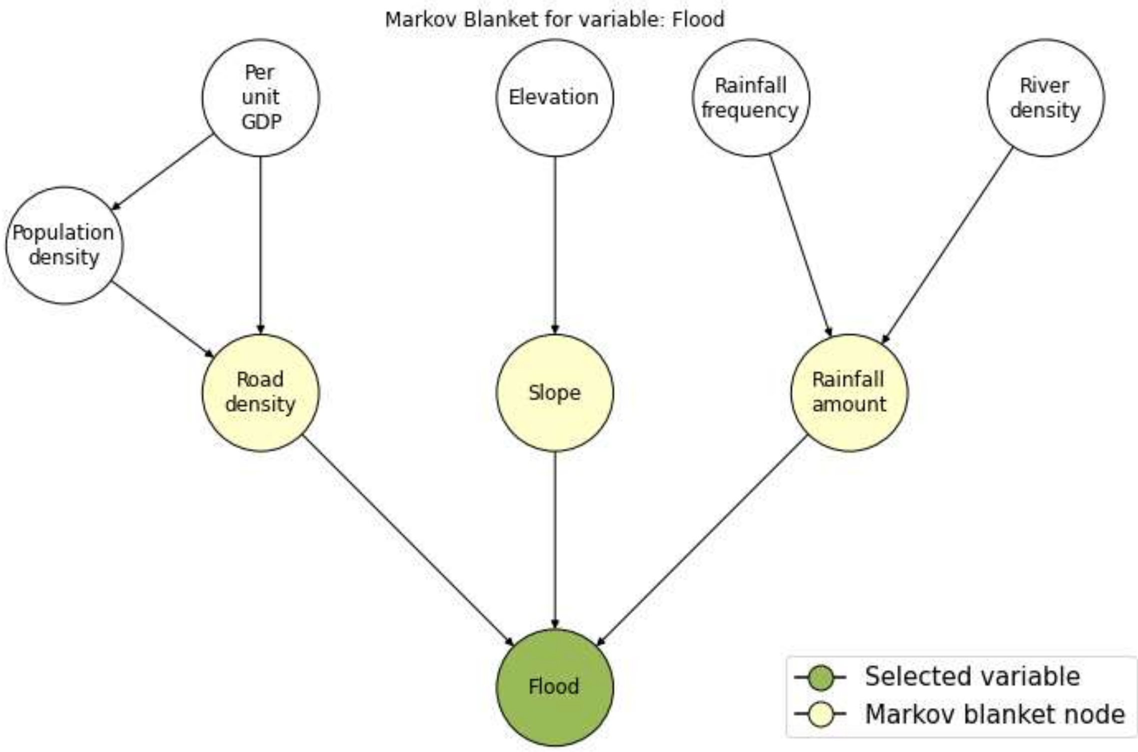

Figure 5: Node Allocation and data management

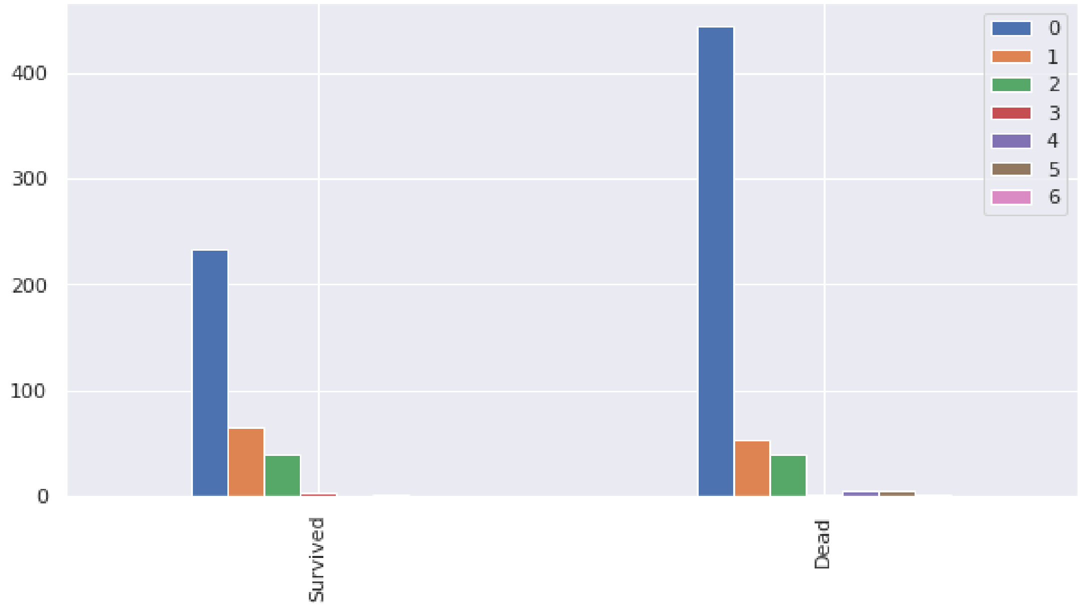

Figure 6: Survival and Death Rate Prediction

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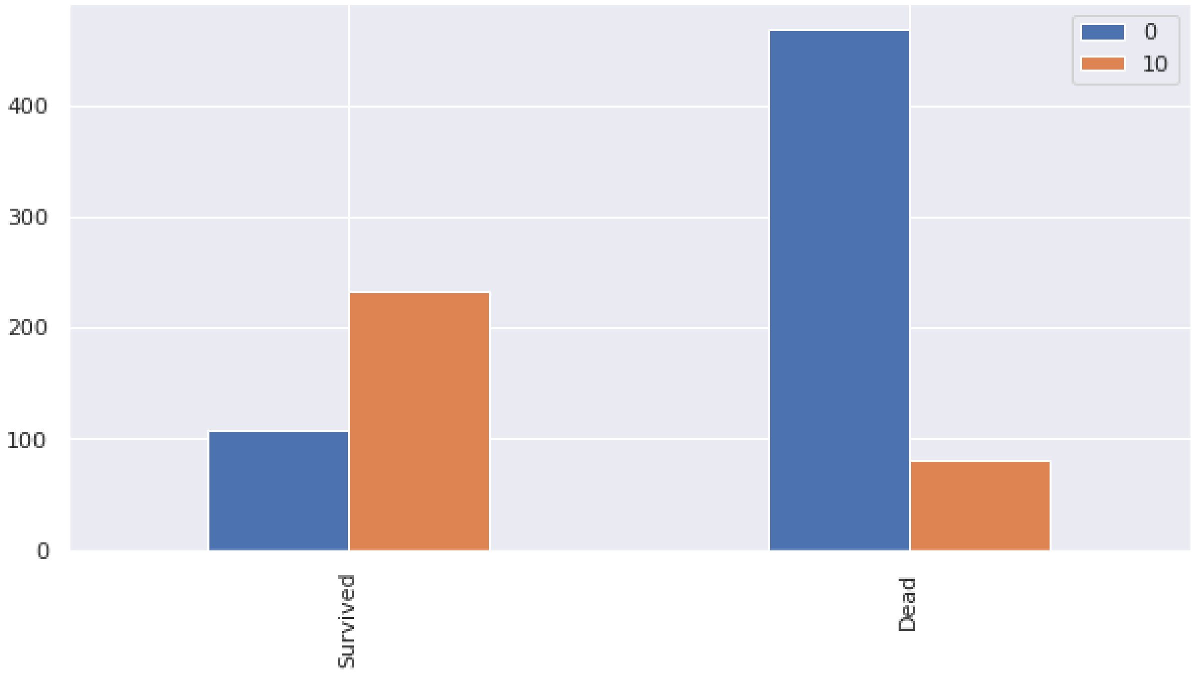

Figure 7: Survival and Death Rate based on Alert Indication

The suggested system is intended to provide information to rescue teams on the emergence of any disaster-like circumstance, such as fires breaking out in buildings or the partial collapse of a massive commercial structure (RT). This would save a significant amount of time previously squandered before RT could be notified and mobilized, increasing the likelihood that persons trapped within the damaged building may have their lives saved. The proposed cloud-centric Internet of Things (IoT) architecture not only tackles the concerns of delay in the commencement of rescue activities, but it also has the potential to address the non-availability of crucial real-time metrics inside the building struck by the tragedy.

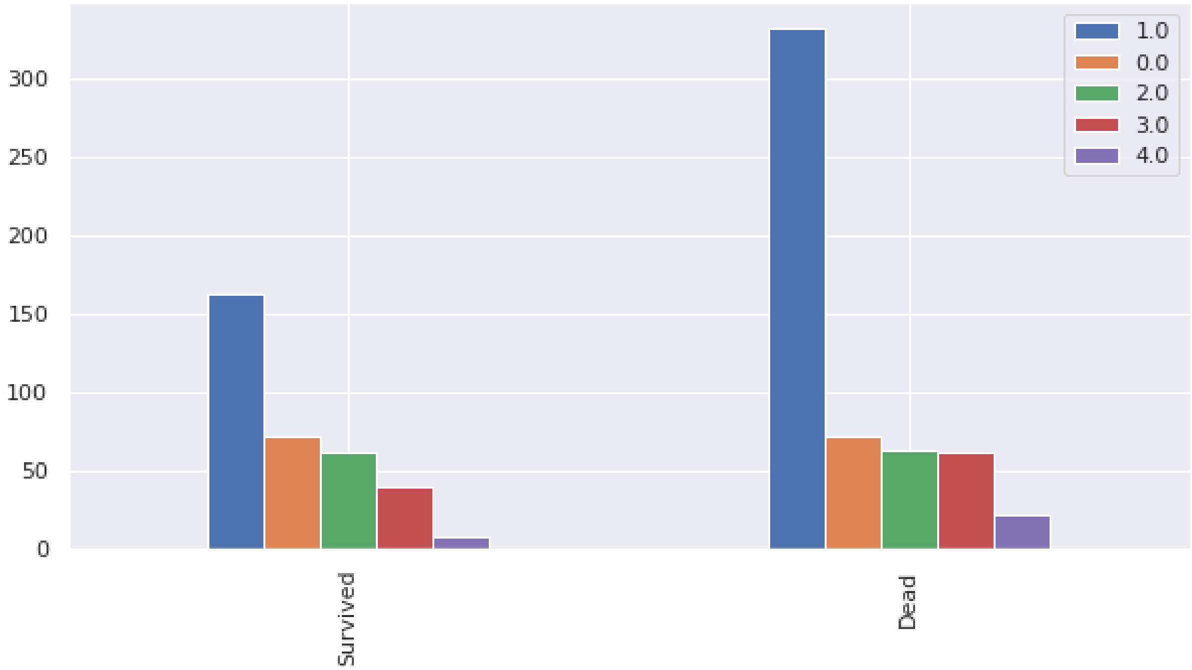

Figure 8: MQTT setup in mobile

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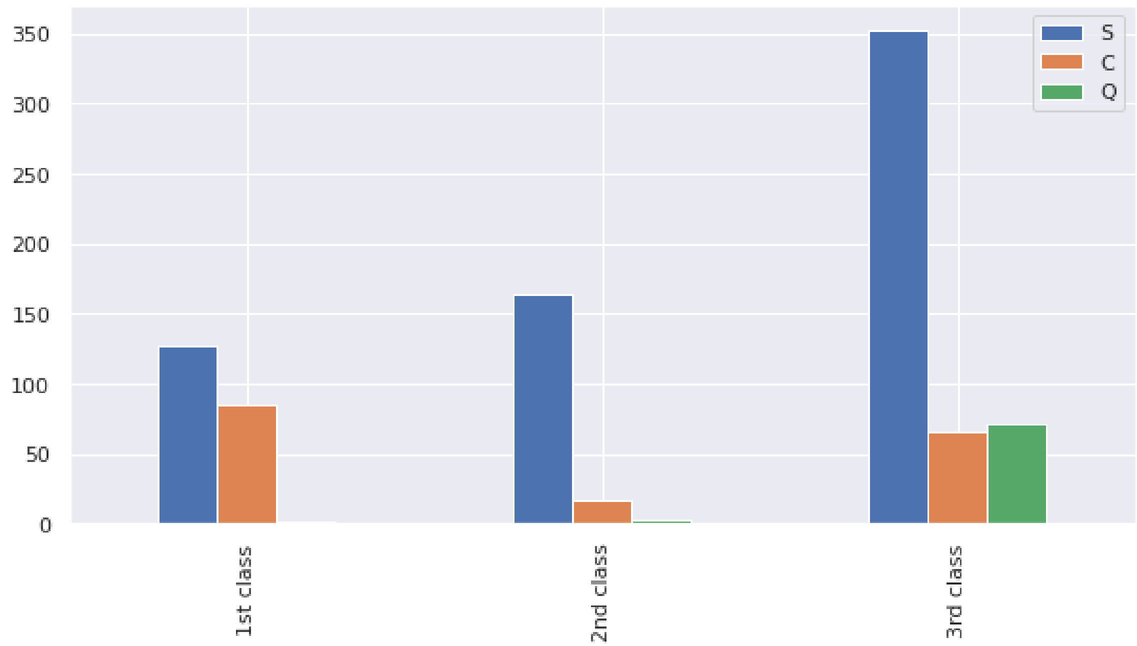

Figure 9: Dumping code into NodeMCU Wi-Fi module

It is necessary for the positional data of each sensor in the building to be registered and then created based on the pre-defined locations (latitude and longitude) of each sensor and camera to count the number of people located in various parts of the building at any given moment. On the map in addition to the heat maps, the numerous sensors that are situated on the multiple levels of the building are also represented. The sensors that have detected a hazardous scenario will appear in a unique shade of red on display. The suggested architecture is dynamic, and it is possible to map several major commercial sites into the cloud datastore of a single application.

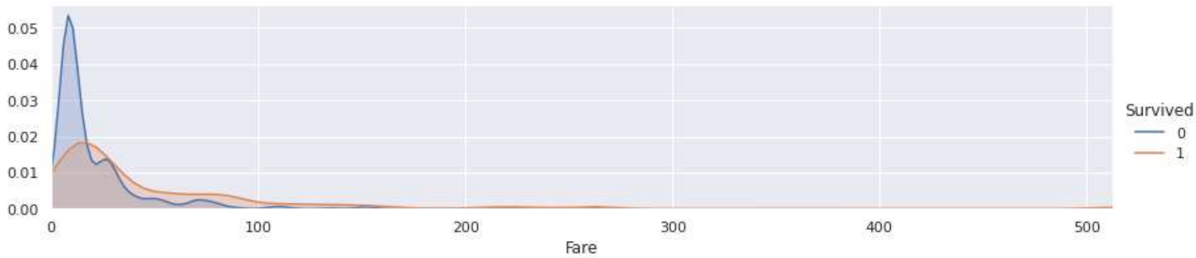

Figure 10: Alert display in the computer when disaster detected.

For each level of the building, several logical and virtual sensors have also been given significant thought in addition to the physical sensors. These conceptual sensors were registered with the system analogous to how physical sensors are registered. The logical collection of sensors includes smoke detectors, which can identify whether or not a fire is occurring, and person counters, which can determine the number of occupants present in a particular area or room of the building at any one moment. A simulation program was developed to populate the data store with the various logical sensor readings. This software creates a stream of sensor data, which is then sent to the DA, which transmits to the CD. In addition, the simulation software adds some randomness to the count (of people) that the different human counting devices will report. One terminus of a communication route is what is meant to be understood by the term "endpoint." Continuously monitoring the CD is accomplished via an application hosted on Google App Engine and offered as a service. The endpoint and any response teams that are associated with that building are notified immediately if it comes across sensor readings that are interpreted as reflecting a potentially hazardous or disaster-like scenario. The SMS also includes a link that may be used to see the situational data in real-time on the browser screen of any device capable of connecting to the internet. JavaScript is

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used to construct a user interface accessible in any web browser. The user interface is lightweight and can generate results without putting additional computing strain on the client devices. The data is presented understandably inside the browser of the computer or mobile device by superimposing heatmaps and representative sensor photos on Google Maps.

5. Conclusion

There is no mention of any system having the capability to determine the number of people who are trapped at a particular location and communicate that information to rescue teams without the need for any human intervention, even though early warning systems are designed to be able to generate alerts in a variety of ways depending on the specifications of their construction. If such technologies are available, the response teams might be directed toward the sections of the city where there is a greater likelihood of discovering the casualties. The many organizations dedicated to assisting in the event of a natural disaster or artificial catastrophe have collaborated to design and produce a wide range of disaster management tools and systems. Most of these technologies are centered on providing advanced warning of impending calamities. On the other hand, it has become abundantly evident that none of the countries now use any technology capable of providing interior situational information on buildings affected by a catastrophe. This project will send notifications to the general public during natural disasters. Our project has passed all of its tests with flying colors. This disaster detection system will use LoRa to send notifications to surrounding mobile phones to obtain more fruitful results. The model's findings were consistent with what we had predicted. Consequently, going shopping is an option for everyone. We are looking for such a catastrophe detection system as affordably as possible so that we may get warnings about impending disasters. This indicates using a wireless sensor network, with an application on a mobile phone as the controller for the system's functional sensors. The administrator keeps an eye on all the sensors and generates warning signals for things like temperature, humidity, and water levels. Both the gas and vibration sensors register excessive readings. Because of this method, folks can locate the safest place to take shelter before a disaster.

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