INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 2 - V7I2-1531)
Available online at: https://www.ijariit.com

Internet of Things Based Smart Society

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ABSTRACT

Internet of Things (IoT) is a fledgling and popular technology, which has given the provision to people for doing daily work like, at just a click or on a command. The Internet of Things has helped develop many amazing Things like, smart street where streetlight gets automatically switched on or off with the help of sensor data. Well sensor is a crucial factor in the field of Internet of Things applications. The great developers and people from the industry are working continuously to develop a system which will help sectors like healthcare, agricultural, industrial, construction, etc. A lot of researchers do research on the Internet of Things as a part of interest and as a result they end up developing amazing and unique systems. This paper produces a summary of the Internet of Things system named as "Smart Society" which consists of 5 unique modules which are Smart Street Lighting, Disaster Management System, House Safety, Smart Gardening and Healthy Environment. In the further part of the paper, the components and the software systems are discussed which have been utilized to develop this model, and at last, the challenges and future scope of "Smart Society System".

Keywords: *Internet of Things, Megatron Board, USBasp, Light Dependent Resistor, IR Flame Sensor, Moisture Sensor, Water Level Sensor, IR Proximity Sensor*

1. INTRODCUTION

The Internet of Things (IoT) is an innovative paradigm that enables the communication between electronic devices and sensors via the Internet to make our lives easier. IoT is increasingly becoming an important part of our health that is felt everywhere around us. It is a new way of life that has transformed the traditional way of life from one that is truly superior to one another. As the count of people living in the urban area is increasing, the perimeter for each residential society is also increasing and it is a bit difficult to administer for the local bodies for the sake of different works. Also, people require a lot of services few of which are efficient while others require a lot of human intervention which could sometimes get troublesome due to a lack of communication or awareness. Quite a lot has happened in the home industry since the inclusion of the Internet of Things. The home industry is the most important thing as it is one of the things that the human needs to live a life. The current way of using traditional things requires manual effort which can be highly erroneous. This traditional hierarchy includes the Secretary of the society and some staff related to a particular work. Because of this manual effort the development of an automated solution has been a viable solution for all the problems related to latency and human errors by focusing on some key areas with the service of embedded systems and the Internet of Things [12][13]. A smart society is a digital technology application with the day-to-day objects connected using digital networks and networking devices to improve people's lives. This paper proposes a smart society application in which people and equipment will work together. The existing smart society models have functions and systems which are developed to perform their respective functions only, while the system which is being proposed in the paper will integrate the below mentioned modules in one system [1][2][8]. The modern-day society functions on manual work, whereas this proposed model have an automated system which provides the following functions:

- House safety.
- Smart street lighting.

- Waste Management.
- Smart gardening.
- Disaster management.

2. LITERATURE REVIEW

The problem for Internet Hardware Developers is (1) the pursuit of a purpose-built Internet device, or (2) the pursuit of an Internet of Things solution that is flexible enough to adapt to changing sensor needs. Internet-enabled devices can be brought to market very quickly. They often include a single integrated device that performs a dedicated function to meet the Internet needs of current objects, limiting the expansion options. What happens when those Internet needs for things change? For example, will a new type or new generation of sensors be required on the Internet of Things? If so, the need to reduce the Internet of Things tool will drastically change the timeline profile of costs and needs. Many companies are struggling with the uncertainty of Internet investment. Parkash, Prabu V, Dandu Rajendra (2016) have worked on developing a prototype of intelligent streetlights. They have optimized the power consumption by turning on the streetlights when the vehicle or the person approaches the streetlight and turning off the streetlights when vehicle or person goes away from the street light. The proposed system in this paper is based on an embedded system, PIC microcontroller and sensors that provide an economical solution. This is accomplished by detecting approaching the car using an IR transmitter and an IR receiver couple. When it senses movement, the sensor transmits information to the microcontroller, which causes the lights to flash. Similarly, as soon as a car or an obstacle moves, the lights go out. The state of the light (On/Off) can be accessed from anywhere at any time by using the Internet. It helps to save the wastage of electricity which can be utilized for other types of works. The system proposed by M. Kokilavani, Dr. A. Malathi (2017) is based on two different sensors called a light sensor and a photoelectric sensor. When the sunlight travels below the visible region the system automatically shifts to light. As soon as the sunlight appears, it automatically shuts off the light. This smart light system is provides an economical solution. The entire smart system is designed to operate using artificial energy sources. The proposed system checks for both the movement of any object as well as the available brightness in the surrounding which indirectly eliminates the chances of errors. Raju Anitha, et. al. (2018) proposed a Smart and Flexible street lighting system based on an LDR sensor, Raspberry pi 8051, IP65 CCTV camera, sensor, microcontroller. There is one camera to monitor all the activities on the road and these recordings will be stored in a server. Controlling streetlights based on solar detection using a smart embedded system. It provides flexible bright light and weather in the streetlight. The streetlight is automatically turned on in the evening and off during the day. In the event of an emergency such as harassment, robbery has a panic button located at an accessible height that anyone can press if they are in danger. Whenever a panic button is pressed, instant video recordings are sent directly to the account. Smart home safety arrangement system by Faruk Bin Poyen, et. al. (2013) is designed and examine for penetration, touch sensor, smoke, and fire sensor and for emergency changes. R. Angeline, Adithya S, Abishek Narayanan (2019) developed the Internet of Things based fire alarm alternatives for security and authentication. PIR sensor detects the location of the fire. Gas sensor detects flammable gas such as CO_2. The temperature sensor detects if there is a sudden change in the temperature. Data is gathered and consolidated at Raspberry Pi processor. Web camera attached to Raspberry Pi unit take pictures of its surroundings as soon as some abnormal activity is detected. These pictures are then sent to the relevant authorities. The authorities will ensure the presence of fire within a period of 120 seconds. A prototype for fire detection by Tri Listyorini & Robbi Rahim (2018) can detect hot spots using fire sensors, servo engines, heat sensors, buzzers, and surveillance cameras operated by the WEMOS ESP8266 microcontroller and by using a sensible method of analyzing the magnitude of the flames detected. IoT based system was used to send data from fire sensors via temperature and alarms to a cloud server. The Internet of Things based Water Level Monitoring System by Priya J, et. al. (2017) will inform users about the level of the water. Ultrasonic sensors are placed on the containers to determine the liquid level and compare it to the depth of the container. Smart Waste Management system by S.A. Mahajan, et. al. (2017) is based on ESP8266, Raspberry pi, Load Cell, UV Sensor, Humidity Sensor, and public dustbin will be provided with an embedded device that assists in real-time monitoring of garbage levels in garbage bins. The details of the waste levels that will be recorded are used to provide a well-prepared method for garbage collection vans that will reduce the required fuel costs. The loading sensor is used to increase the efficiency of the waste-related data level and the moisture sensor will be used to provide information on waste disposal. The analysis of the data collected will help the municipality and government officials to improve the system related to smart waste management.

3. PROPOSED SYSTEM

It has been observed that at present many societies are using human resources to perform their day-to-day activities that could be easily automated to save both time and human efforts. The project is mainly associated with daily activities happening in any society. Key areas of the project are: (A) House safety, (B) Smart street lighting, (C) Disaster management, (D) Waste management, (E) Healthy environment.

3.1. House Safety

Nowadays people hear a lot of news about house burglaries and break-ins. We hear of these incidents happening on every street, every city, every country but there is no system that can prevent these, resulting such events can cause a huge damage to life and property. To avoid such scenarios, this system can detect any unauthorized entrance in the house using a proximity sensor. The proximity sensor triggers an alert that will be sent to the resident on his phone with the help of Internet of Things. This way one can prevent the theft to a greater extent as, as soon as the event is going to occur it will alert the concerned person about it, and the person can take appropriate action by calling the police or the security guard at the place of the incident, so the action will be taken immediately [4][5].

3.2. Smart Street Lighting

The current electricity requirements for streetlights of present-day society are through the roof. This is because many a times the streetlights are kept on even in broad daylight to manual errors and forgetfulness. To automate this process and to avoid wastage of unnecessary electricity, the lights will be switched on or off automatically during day and night, respectively, which will be sensed using LDR. The LDR would sense the amount of daylight present and act as it crosses the threshold. This way we can save more cost-effective and, also use this saved energy in other society systems [1][2][3].

3.3. Disaster Management

In many societies, parking places are in basements. So, during heavy rains, there is a high chance for the basements to be flooded, in case the drainage gets blocked or for many other reasons. This can cause heavy damage to vehicles and electronics. Hence this system reacts to this situation effectively. If the water level in the basement goes beyond a certain limit, it will generate an alert. Using the Internet of Things, notification can be sent to all members to evacuate their automobiles. This would help prevent the loss caused to vehicles due to this excessive rainwater [9]. There are a lot of cases of un-occasional fire breakouts causing heavy damage due to inefficient communication. In case of such a fire hazard, the fire suppression systems can be automated with the help of embedded systems and with the use of Internet of Things, emergency services can be contacted in time and residents can be made aware of the fire so that appropriate steps could be taken to avoid the fires. This way a lot of lives can be saved and damage to property can be minimized [6][7][8].

3.4. Waste Management

Usually, the society's common garbage bins are left unattended. Due to human errors, the garbage collector could miss the collection of garbage or the society members could fail to report the overflow of bins until it's too late. This leads to breeding of pests, which in turn can spread diseases. To counter such scenarios and bypass manual errors, the sensors in the system will check the level of garbage in the can with the help of a proximity sensor and give an indication to the waste management system and send a notification to the garbage collector's mobile. A notification can also be sent to the secretary of the society to take a follow-up on the situation [10].

3.5. Healthy Environment

Most societies have gardens, but, due to the fast moving and busy life of residents, the requirements of plants are highly ignored. During scorching heat in the afternoon, plants do not receive enough water and eventually they die. This could have negative effects on the society's atmosphere. Hence, if the sunlight and heat is too much for a specific period, the system will automatically send a notification to everyone so that the residents with awareness could water the plants and they will not die out of thirst [11] [18].

These functions of society are mainly managed by the secretary and the associated staff-related to a particular work in society. But due to manual work, there might be chances of human errors or delays in the work due to some reasons or negligence. To resolve these issues, it would be efficient to automate these processes and services by the inclusion of embedded systems and internet connectivity. This would make the job of the secretary and the staff easier and services efficient with the help of the Internet of Things. This way people can minimize and have efficient use of a society's day-to-day resources and energy requirements, irrespective of the time, and place constraints.

4. METHODOLOGY

This smart society project goes through several steps which allows the system to send the appropriate alerts to the users in case of the event occurrence. The processes start from the collecting the converted digital inputs from the hardware i.e., sensors of each module parallelly. As soon as the hardware receives the data the code running behind will send the data to the ThingsSpeak platform, which will analyze the data, and will forward it to the springboot API for further processing that will be discuss in the paper. Springboot used to create an application programming interface i.e. microservices, it is an open source java based framework. With the help of springboot API the data will updated in the database. We have used firebase realtime database, which will store the data in the following format. (Refer Fig.1).

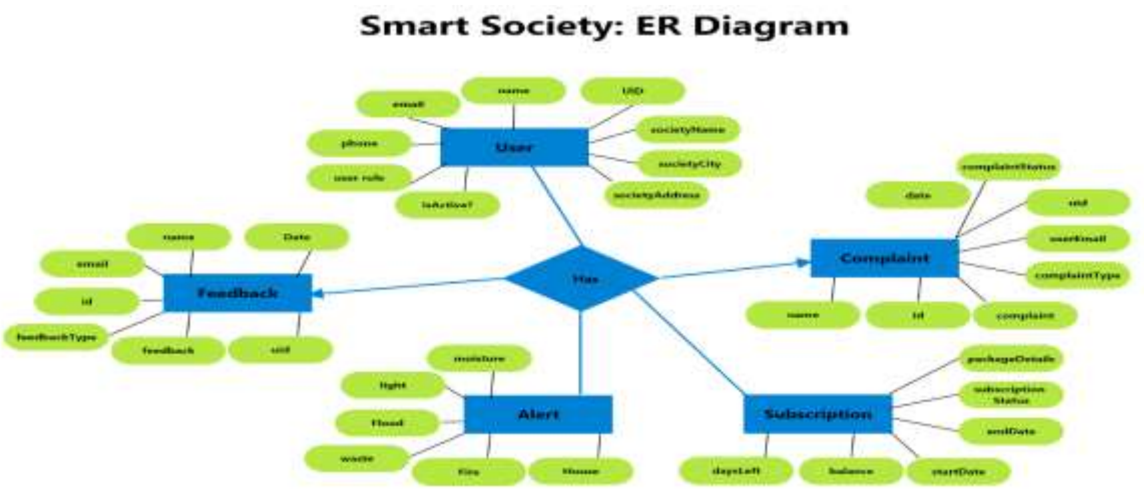

Fig. 1: Entity Relationship Diagram for Smart Society

The application will contain the multiple collections like, Alert, User, Feedback, Complaint, etc. These collections will store unique document entries for the various users across the platform. The web and the android platform will help user to register for using the product, where the user can update details of the society such as society name, society address, society city, etc.

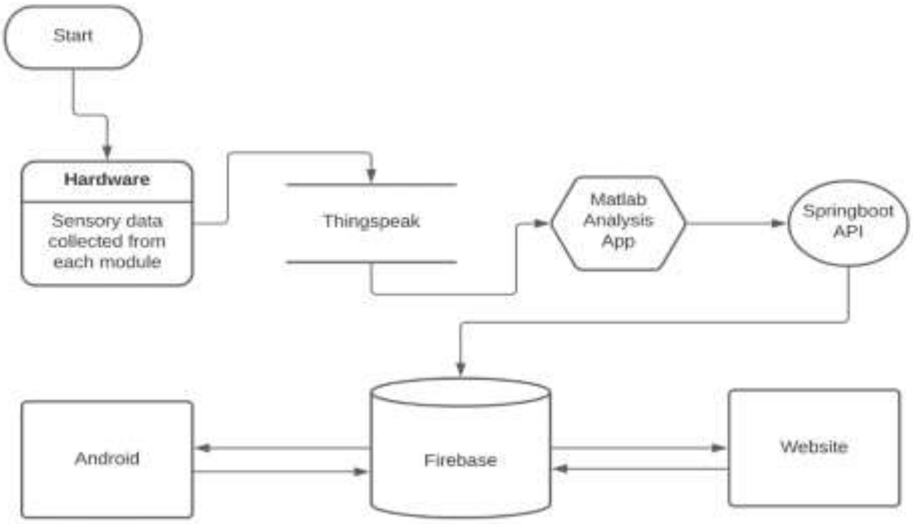

Fig. 2: Methodology & process flow

When the data is reflected in the firebase realtime database, it will use the firebase cloud messaging service to send notifications to the user.

Firebase cloud messaging is cross platform messaging service provided by the Firebase platform. It is a free service for third party app developers which helps to send notifications/messages quickly to all the users using the application.

In the Smart Society project, we have developed Android application which is used to notify the users whenever occurrence of any event is detected by the Internet of Things system. For e.g. If a fire alert is detected by the Internet of Things system, then it will send the corresponding signal to the Firebase real time database. As soon as the listener on the database detects the change in the value the notification will be send to all the users having the Smart Society Android application, these messages/notifications can be sent to a single device or group of devices or to the topics for which the application is subscribed. Firebase Cloud Messaging provides the capability to send 95% of the messages being delivered within 250ms to the connected devices across many platforms. Firebase Cloud Messaging consist of two main components for sending and receiving the messages/notification.

- A trusted environment like Cloud functions for Firebase or an application server on which we can build, target and send messages.
- Secondly, we need and Android or iOS or web client application which can receive the messages via the corresponding platform.

For Example: We will send the data to Firebase Cloud Messaging using a JSON format, to send the notification to the users.

Fig. 3: JSON format for sending alert

5. COMPONENTS OF PROPOSED SYSTEM

The following components are used to develop the Smart Society Model

5.1. Megatron Board

The development board used for this project is Megatron board. It is controlled by a 40 pin 8-bit ATmega-16 microcontroller which can work on low power. It works on an AVR based architecture.

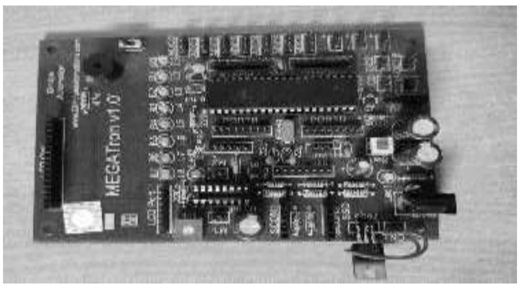

Fig. 4: Megatron Board

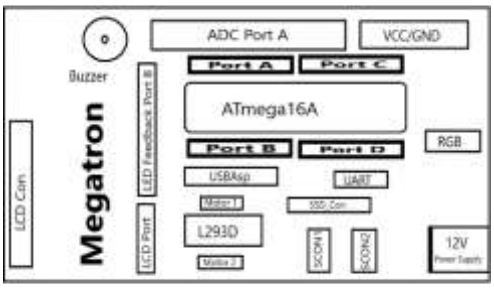

Fig. 5: Working of Megatron Board

Megatron Board has 32 digital GPIO pins distributed over four ports, namely Port A, Port B, Port C and Port D. Port A also has support for analog to digital conversion. A buzzer is present which is mapped to ADC pin7. Port B has an LED feedback system, each LED mapping to 8 pins of Port B. The board can be provided upto 12V power supply. It also has an LCD and RGB ports. There is also a slot provided for L293D and ports to connect 2 motors.

5.2. USBasp

USBasp has been used to upload the underlying working code to Megatron, since it is the recommended for AVR controllers.

Fig. 6: USBasp

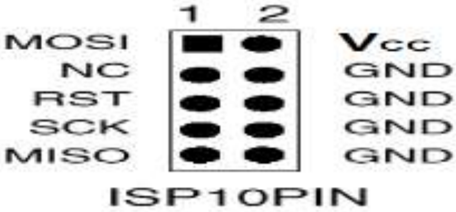

Fig. 7: Pin diagram of USBasp

The project uses a 10-pin USBAsp programmer. The communication works on a master/slave model with USBAsp as the master and ATmega16 as the slave. USBAsp sends data with the MOSI (Master Out Slave In) and receives data through MISO (Master In Slave Out). The SCK is a mutual clock shared between master and slave.

5.3. ESP8266 Wi-fi Module

ESP8266 is used to communicate to other devices as well as the internet, for data distribution to servers. The board sends sensor data to this Wi-Fi module through UART communication.

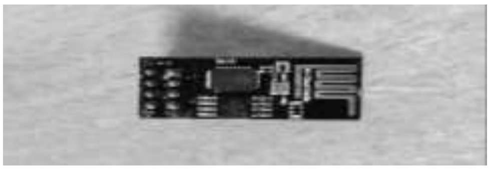

Fig. 8: ESP8266 Wi-Fi module

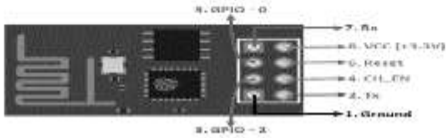

Fig. 9: Pin diagram ESP8266 Wi-Fi module

ESP8266 works on 3.3V supply. The Tx pin transmits data to the Rx pin on Megatron and Rx receives data from the Tx. The UART port on Megatron serves this purpose. The ch_en pin on ESP8266 is active high for chip enable.

5.4. Fire Sensor

The fire sensor is used to distinguish the infrared rays emitted from fires and flames.

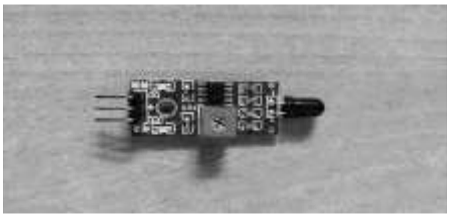

Fig. 10: IR Flame Sensor

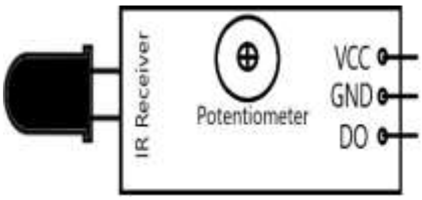

Fig. 11: Pin diagram of IR Flame Sensor

The fire sensor is equipped with an infrared receiver that senses the flame and emits digital values on pin DO. The potentiometer is used to calibrate the sensing distance. The fire sensor is also used in many places like industrial gas turbines, hydrogen stations, industrial heating, firefighting robots, etc.

5.5. Moisture Sensor

To detect the level of moisture in the soil, the system uses a digital moisture sensor.

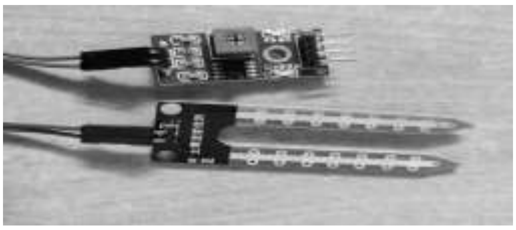

Fig. 12: Moisture Sensor.

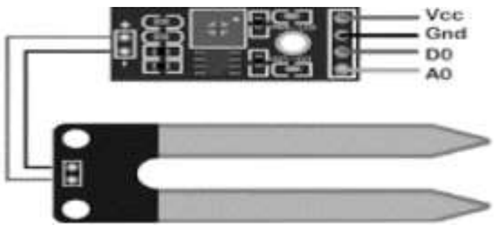

Fig. 13: Pin diagram of Moisture Sensor

The moisture sensor consists of a fork-shaped probe that goes into the soil and acts as a variable resistor. The module has a potentiometer to control the sensitivity and a comparator to convert analog values to digital. This module can provide both analog and digital output on pin AO and DO respectively. Moisture sensor can also be used in agriculture and irrigation.

5.6. Light Dependent Resistor
The LDR is used to sense the darkness around the system, to generate digital values for street lighting decision.

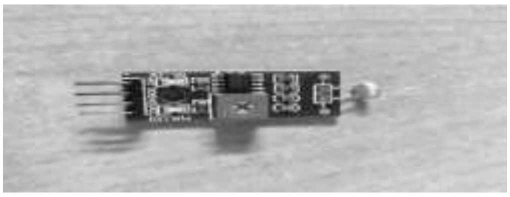

Fig. 14: Light Dependent Resistor

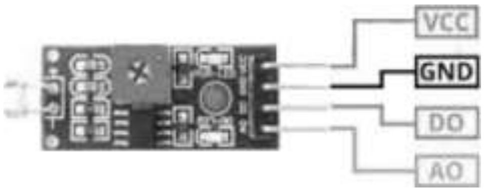

Fig. 15: Pin diagram of Light Dependent Resistor

The LDR module used in this project can provide analog as well as digital output on pins AO and DO respectively. The potentiometer can be used to control the sensitivity towards light. The onboard comparator converts the analog values to digital available on DO. LDR is used in infrared astronomy, smoke detection, camera light meters, etc.

5.7. Water Level Sensor
The water level sensor detects the level of water in particular area and sends a digital signal if it crosses a threshold value.

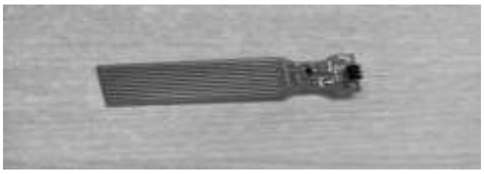

Fig. 16: Water Level Sensor

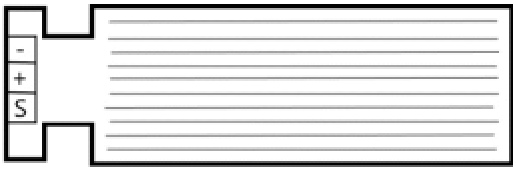

Fig. 17: Pin diagram of Water Level Sensor

Water level sensor consists of 10 lines of alternating power and sense traces. These exposed parallel conductors act as variable resistors which return analog values depending on the submerged level of the sensor in water. This sensor can also be used in tanks to identify its capacity.

5.8. IR Proximity Sensor
The Proximity sensor is used for the detection of garbage level in the garbage can and to detect burglar entry.

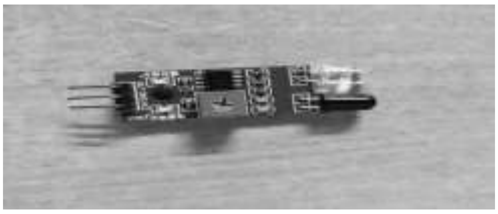

Fig. 18: IR Proximity Sensor

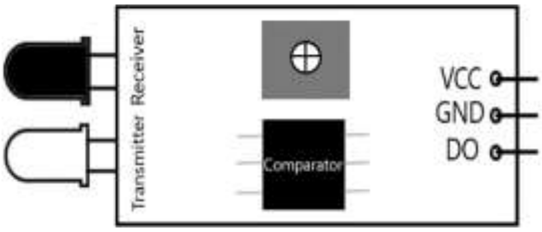

Fig. 19: Pin Diagram of IR Proximity Sensor

The proximity sensor is equipped with an infrared transmitter and receiver. If an object gets close enough the receiver detects the infrared signal reflected from the object. The comparator is used to provide digital output on pin DO. The potentiometer helps to change the threshold distance.

6. SOFTWARE USED IN PROPOSED SYSTEM
6.1. Atmel Studio
This project is developed with the service of an embedded system and the Internet of Things. The code has been written in C programming language with Atmel Studio 7 as the Integrated Development Platform for developing and debugging all AVR (Alf and Vegard's RISC processor) microcontroller application. The Atmel Studio IDE gives an environment to write and debug code for the microcontroller applications.

6.2. ThingsSpeak
ThingSpeak is an analytics platform service that enables users to compile, analyze, and visualize live data streams in the cloud. ThingSpeak provides a graph format where as soon as the system gets the signal or indication from the sensors, it plots the graph, these graph values are further used to process data value and after processing it sends appropriate messages to the user. In this way ThingSpeak gives a platform for Internet of Things devices to communicate through Things to its users, by sending alert messages via mails, text messages, etc. This enables users to keep track of their society and the activities which are being carried out in society.

As per the specifications of this system, we would need six fields to record data from each sensor. We have used a single private channel for this project, since one channel in Thingspeak can support eight fields. Six of these fields are used for each module, namely fire, water level, moisture level, garbage level, burglar detection and light intensity.

Thingspeak provides API keys that can be used to read or write data in the fields. Each channel has separate API keys. This API key is provided to the code in the Megatron board, where ESP8266 module uses them to call the REST API and send the sensory data. This information is recorded and visualized in the form of a line chart.

The sensory data should be made available in the Firebase Realtime Database to be later used by Android and web application. The data from Thingspeak cannot be directly sent to Firebase Realtime Database. For this purpose, we have created a microservice using Springboot. This microservice simply collects the data from the API call, creates a connection to database, does the required calculations and stores them in their respective locations in the database.

To call the microservice from Thingspeak, we have created a Matlab Analysis App that collects data from each field of the channel, builds the microservice API call and sends a GET request using the webread() function. We have also created a React App in Thingspeak that triggers the Matlab Analysis App subroutine. This React App is set to trigger the subroutine on data insertion.

Hence, as soon as the data is sent by ESP8266 to Thingspeak, the data gets recorded and React App triggers the Matlab Analysis App which builds and calls the Springboot microservice API thus storing the data and making it available to Android and web application to set off notifications and perform further tasks.

7. WORKING MODEL

The following diagram demonstrates the flow of Smart Society's Working Model of the smart society system, the table specifies the threshold values for each of the sensing unit. All the sensing unit provides the digital output.

Table 1: Threshold values for sensing units.

Sensors	Safe Value	Danger Value
Fire	1	0
LDR	1	0
Water Level sensor	0	1
Moisture sensor	0	1
Burglary	0	1
garbage	0	1

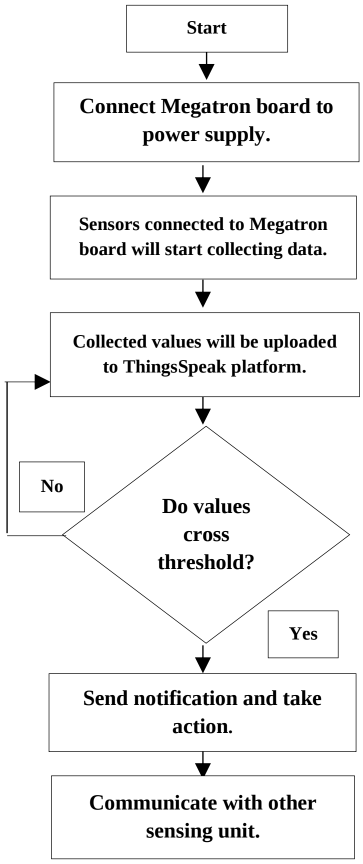

Fig. 20: Flow chart of working model

The Smart Society Model will go through the 6 different stages which are:

7.1. Connection

In this process the connections will be done with each unique module that will be connected to Megatron Board. Each unique module which is house safety, disaster management, smart street lighting, waste management and healthy environment will be integrated to the Megatron Board along with USBasp and ESP8266 wifi module. As soon as the supply is provided the system will continue its function.

7.2. Reading Values from Sensors
Once the connections are done, the process will move forward to reading the data from sensors, each sensor will keep on collecting the data. This is one of the crucial stages as this data will be further used for processing.

7.3. Uploading Values on ThingsSpeak
The values which are read from the sensors will be uploaded to the cloud in every 15 seconds using ThingsSpeak API keys. This will store the values of a particular sensor to the cloud and these values will be used to plot the graph for analysis.

7.4. Processing
The values which are uploaded on cloud will be monitored and analysed here. Using MATLAB analysis app, we will send this values to the springboot API and this data will be reflected in firebase realtime database. The applications will check if the values crosses threshold if yes then it will take the necessary action and will send notification to the user, else it will compare the received value with threshold value again.

7.5. Sending Notification
Once the processing will be done and values will be compared to threshold it will send the notification to the users using firebase cloud messaging.

7.6. Communicating with Other Sensing Units
This phase will ensure that the model communicates with all the sensing units to check their working status and eventually will keep working in a loop.

8. TESTING
The module has been tested in the environmental conditions, which ensures the performance of the system under various circumstances. The following table refers to the different sensors used for various sensing units, what is its safe value, danger value and parameters required for each sensor to function properly.

Table 2: Parameters for sensing units.

Sensor	Safe	Danger	Parameters
Fire	Return value: 1	Return value:0	Should be kept away from sunlight or should be kept inside tainted glass. 5V min requirement
LDR	Return value: 1	Return value: 0	Should be kept in direct daylight, need safety from environmental aspects like rain, birds, etc. 5V min requirement
Water Level sensor	Return value: 0	Return value:1	Detects danger when more than 75% submerged. Should be protected against falling water (Since sensor should detect rising water) 5V min requirement.
Moisture sensor	Return value: 0	Return value: 1	Sensor should be completely dug in the ground. 5V min requirement.
Burglary and garbage	Return value: 0	Return value: 1	Should be kept away from sunlight. 5V min requirement.
ESP8266	3.3V	5V	Should be kept in a cool and dry place, Internet connection always required. Voltage regulator mandatory. 5V min requirement.
Megatron	12V 1A	<9V <1A	

9. CONCLUSION & FUTURE SCOPE
The smart society system is beneficial for coping up with the modern society where the internet is a part of their day-to-day life. In this study, work has been done in development of Smart Society Model. The System we developed will be helpful to track activities of the society and will allow us to take the necessary action when in need with the help of smartphones, tablets, and laptops. Future research can be done for Adding actuation and multi-verification of sensor data for more quick and effective measures. This system can introduce more modules like parking management, automatic door opening, sound system controller, etc. in the smart society model. This work can provide an Android application for Model tracking and controlling which will monitor efficient utilization of energy, the safety of the house from thefts or strangers, disaster management like an overflow of water level, solid waste management, eco-friendly system for plants, etc. In all, using a single Android application one can build a trustworthy and sustainable system. The Smart Society System can have its own web portal where it can store the sensor data.

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