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An Experimental Approach for Understanding Internet of Things (IOT) for Corporate Model and Various Platforms

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***Abstract:** Now a days Internet Of Things(IOT) based smart system has been working to reduce the manual system in various domains worldwide. Smart systems consist of various types IOT devices such as Radio Frequency Identification (RFID), Sensors(Temperature, Pressure, Ultrasonic ,PIR,IR, etc),Mobile phones, Bluetooth Low Energy (BLE), Bluetooth etc. The IOT be-comes the future of some countries such as Netherland, South Korea where maximum manual systems has been converted into equivalent smart system. This paper explains concept of connected devices which are intelligent enough to exchange data from device to device and to cloud based applications. Such devices are designed in such a way that they can employ every single bit of data that are shared in our day today life. In this paper, we are discussing a different smart system that can be used to make out simple. The smart system is like smart home/office automation, smart museum, smart gym, smart air, and sound pollution monitoring system, smart Traffic control System, smart parking system, and smart irrigation system. We also provide details of all devices that are used in systems along with their functions and architecture. Common devices that are used in all systems are Raspberry Pi-3, Arduino UNO (microcontroller), relay board and different sensors for the different purpose.*

***Index Terms:** IoT, IoT Based Research, Iot Applications*

I. INTRODUCTION

The IOT provides potentialities (capabilities) which is necessary for the development of a huge number of applications but only a very small part of these applications is currently available to our society. The new applications would likely improve the quality of our livelihood in many domains and environments such as at home, while travelling, when sick, at work, when jogging and at the gym. Such environments furnish objects with prehistoric brainpower and the communication capabilities are neglected most of the times. Such objects are enabled to communicate and elaborate the information perceived from the surrounding and it implies that different environments are having a wide range of applications which can be deployed [1]. These can be grouped into the following domains:

- Smart Interactive Office Automation Smart Museum System
- Smart Air and Sound Pollution Monitoring System Smart Car Parking System
- Smart Gym System
- Smart Irrigation System
- Smart Garbage Monitoring System Smart Healthcare System
- Smart Wild Animal Intrusion Detection System
- Smart Traffic Congestion Monitoring System

In the above-listed applications domains, we distinguish between those applications that are directly relevant or near enough to our present-day livelihood and the future domains, which can only elaborate in a short time. Since our present civilization is not organized for their deployment. In the following subsections, we dispense complete details of each application.

This paper is divided into 5 sections: Section I gives a brief concept of IOT and its application domains. Section II provides the working principle ,implementation and architecture of the above listed application domains. Section III throws light on the comparative study of each application discussed in Section

II like the Hardware components used, programming language and communication type. Section IV concludes the paper and Section V shows the experimental results and scope of future works for each application discussed.

II. APPLICATION WITH ARCHITECTURE

A. Smart Interactive Home and Office Automation System

The word automation means working by itself with little or no direct human control. A smart office automation system makes employees or customers life easy and comfort, which induce it and grow their ability to stay connected. This can achieve by using various advanced technology and different tools to improve the efficiency of users. A smart office is one that assures the effective and optimal utilization of IoT devices. The Internet can be used as a medium to connect and control office appliances under the Internet of Things(IoT) [2].

1) System Architecture: There are different techniques and devices can be used to implement this system. We can use Arduino or Raspberry Pi web-based, email-based, mobile based, SMS based, Zigbee based, Cloud-based, etc [3] [4]. In this system the IoT devices that are used are listed in Table 1:

Figure 1 shows a block diagram of a system where the main controller is Raspberry Pi which is connected with electrical appliances(fan, light, etc) via a relay module.

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The system can use Wi-Fi or Ethernet port for connection of Internet [5]. To operate this system we have a mobile application which is basically an interface between system and users. The mobile application provides facility to ON/OFF the electrical appliance, sensing camera information, etc.

As we can see in figure 1, visitor counter. This module actually counts the number of visitors entered into office.

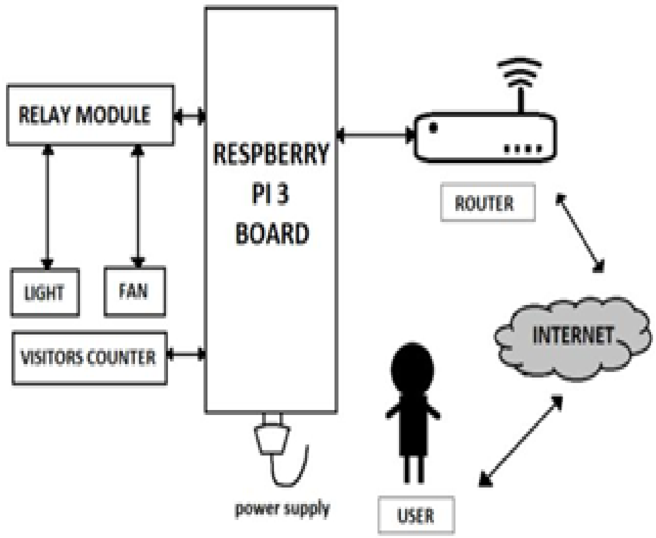

Fig. 1 System Architecture

Table. 1 Components used for Smart Office Automation System

Component	Working
Raspberry Pi-3	Used as a microcontroller and interface between all other devices.
Relay circuit	It allows low power circuit to switch a relatively high voltage or current ON/OFF.
PIR sensor	It detects movements of human being at the time, when he/she comes in contact with it.
Mobile	It is used as an interface between a user and system.

To implement this we used two PIR sensor placed at the entrance door with some distance between them. The main purpose of using the two PIR sensor is for detecting the direction of visitors. In other words, we can say to check weather visitor is entering into office or exiting from office. The logic behind this is supposed one PIR sensor is PIR1(outside) and another one is PIR2(inside). When PIR1(outside) is cut followed by PIR2(inside) that means a visitor to enter and when PIR2(inside) is cut followed by PIR1(outside) then the visitor is exited from office as shown in figure 2.

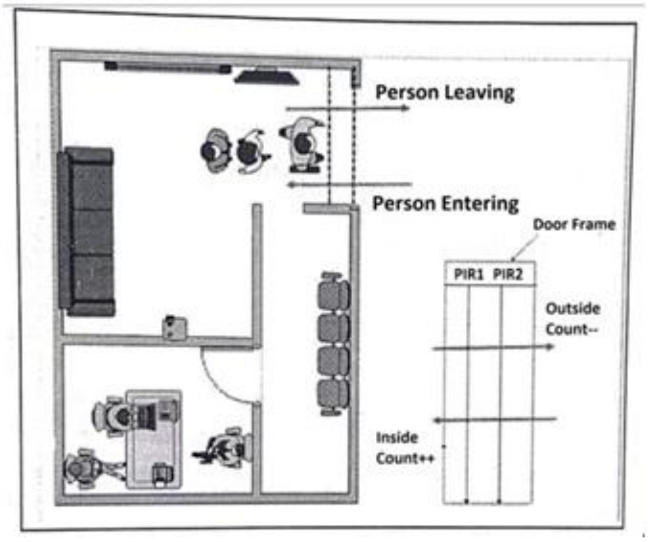

Fig. 2 Visitor Counter

The logic of cutting sensor is:

```
If ( PIR1 ) f
      i f ( PIR2 ) f
            counter;
      g
      g else if ( PIR2 ) f
            if ( PIR1 ) f
                  counter + + ;
            g
   g
```

2) Working of System: This system helps in sustainable development. If someone forgot to switch OFF fan or light or any other electrical appliances while leaving the room there is a chance of electricity wastage, hence on such situation, our system will detect whether there is anyone present in the office or not and according to that it will OFF the appliances. The system detects the availability of humans by using PIR(Passive Infra-Red) sensor which reads the movement and sends the value to Raspberry Pi(main controller). Raspberry Pi will check the value and if the value is null that means no movement then it will direct the appliance through relay circuit to switch OFF the appliances. Moreover, a user can manually check the status of his/her office via mobile application. Since System is connected with internet.

B. Smart Museum System

Using IoT, we can create a smart museum where users(visitors) only have to wear a wearable device or devices that are easy to carry(like smartphones, smart watches, etc.). This wearable device will capture images for users and has the capability to do image processing and sends only the matched images to the cloud processing center where corresponding details of that image will be sent back to users. It is possible that a museum may contain two identical items and it is difficult to differentiate them using image processing, therefore in such case, we use indoor localization technique [6] [7].

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Bluetooth Low Energy(BLE) are placed in the museum which is used to get the location information of a particular antict object allowing the visitors to easily access the history and art profile through the smart devices [8].

1) System Architecture: Firstly, Images of all artworks, statues and also information content(text, audio, and video) related to those images are uploaded in a cloud. And it is updated from time to time. Each visitors(users) provided with one wearable device or smartphone. Images are captured by this device and sent to the cloud for further processes. At the same time localization is done by using BLE which is installed in the museum. Image recognition will be done by doing image processing algorithm. Then the processed image will be sent to the processing center where the image is compared with images saved in the cloud. If match found, then the information or details related to that artwork will be sent to users' smartphone/smartwatch.

2) Indoor Localization using BLE: There are two scanning phases in the BLE technology that is, active and passive scanning phase. In passive scanning phase, using the BLE it allows a device only to listen and receives data from other devices, whereas in active scanning phase, it allow the devices to send data querying for extra information excluding the listening step. [9] [10].

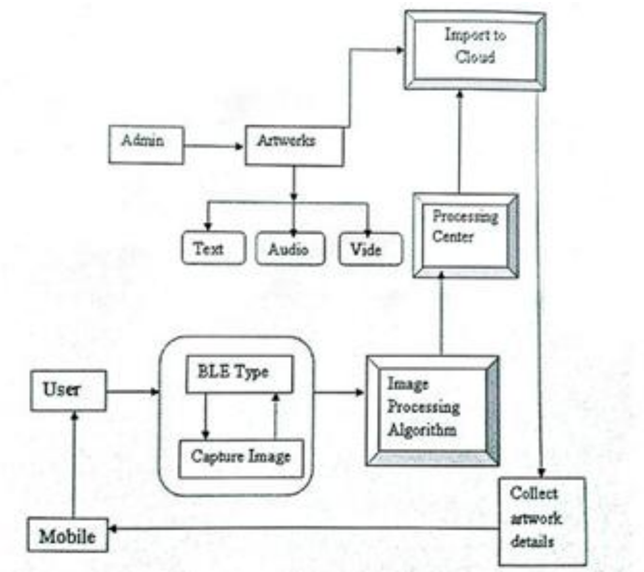

Fig. 3 System Architecture

In our case, BLEs are installed in every cells/room of a museum in a particular distance in such a way that they cover the entire area of the museum. Every gadget of the BLE frameworks sends its transmission(TX) power esteem along with area(ID).The area information is gathered using the user's wareable devices from every BLE on its range and after that decides the room/location in which it found. For this, it computes a proximity index say d, for each area, using the corresponding value of RSSI(received signal strength indicator). The equation is given as follows,

$$RSSI = (10n\log10d + A) \quad (1)$$

where A is the excluding signal strength excluding at 1m distance , n is the signal propagation constant and the distance from the sender is d.

3) Image Processing: Here, from the previous techniques, the Localization information that is stored in the cloud is used to increase the speed of the image processing algorithm. Images or videos captured by the wearable devices are swiftly examined with high precision to recognize a target object. Background subtraction algorithm which identifies moving objects from the portion of a video frame can be used to detect image from videos. It is possible that images captured by a wearable device are not good quality, it may noisy or blur. In such case, Image recognition algorithm can be used to remove noise and blurriness from images. The blur degree in a frame f can be recognized by the following equation:

$$Blur(f;_B) = \frac{q}{rS_x^2(f) + rS_y^2(f)} \quad (2)$$

where rSx(f) and rSy(f) are the x and y components of the gradient in the frame. A threshold B learned by computing the average amount of gradient in a sequence is used to discard frames with blurriness.

C. Smart Air and Sound Pollution Monitoring System

Due to the rapid growth of infrastructure and industrial plants, creates environmental issues like pollution (Air, Water, Noise), etc. Therefore, there should be some way to reduce such issues with less human effort. In such a case, we can use Smart Environment Domain, where a smart environment system inbuilt with sensors detects and controls the ecological changes influencing living beings like humans, plants, and animals. The main goal of Smart Air and Sound Pollution Monitoring System is to detect the levels(quality) of Air and Sound and if it is greater than the fixed threshold value than it will alert the authority of particular area along with all details including what amount of CO2 and other gases are present in Atmosphere and measurement of intensity of Sound in decibel(dB) [11].

1) System Architecture: The architecture contains 4 tiers. Tier 1 provides information about what type of environmental parameters to be a monitor for air and noise pollution. Tier 2 contains all the sensor devices with their suitable characteristics and features. Tier 3 provides necessary controlling and sensing actions that are required depending upon the conditions such as fixing the threshold value. It also explains the data accession from the sensor and also comprise decision making. Tier 4 deals with the intuitive domain. It fix the threshold value and identifies the variations in the sensor data depending on the threshold value of CO2 or noise levels. It will store all the data into the cloud in the form of spreadsheets and also it will show a course of the sensed parameters with respect to the specified values [12].The users can also browse the data through mobile phones, PCs, laptops etc.

The devices that are used in this system are AVR board with Wi-Fi module, sound sensor, CO sensor(MQ-7), LED(ON/OFF) indicates controlling actions, DHT11 sensor for monitoring room temperature and pressure, Xmega 2560 Microcontroller, LEDs, LCD Display, and MQ-135 dust sensor.

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2) Working of the system: The DHT11 sensor will monitor the room temperature and pressure and record it in the cloud. There will be a fixed threshold value for air and sound quality. The sensed values are transmitted to the microcontroller. MQ-2 sensor is a device which can detect combustible gases such as methane, hydrogen LPG, and i-butane . The concentration of gas detected is sent to the microcontroller which will display it in either analog or digital form. The atmosphere contains several polluting gases, but the conductivity of the sensor increases as the concentration of pollution gas increases. Therefore, here MQ-135 gas sensor can be used to detect benzene,steam,smoke and other harmful gases. It is capable of detecting different harmful gases. All the sensors are connected with the cloud through the ESP8266 module which is a Wi-Fi module that connects the microcontroller to an access point [13]. The system model is shown in figure 4.

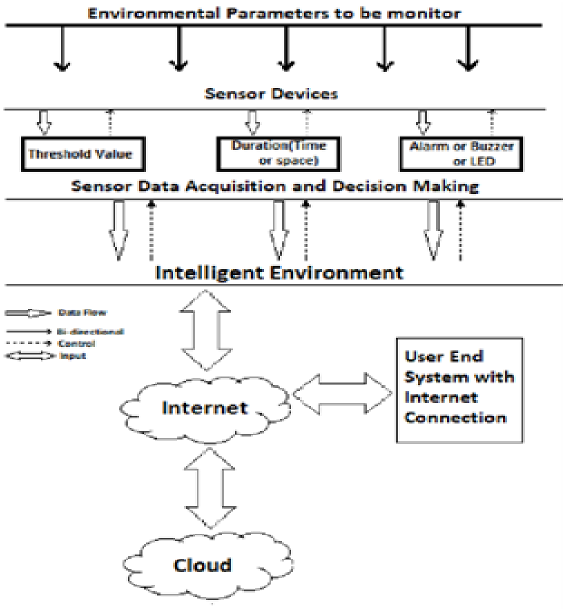

Fig. 4 System Architecture

D. Smart Car Parking System

Wireless Sensor networks are gaining importance in both academic and industrial fields. It is implemented in various sectors to monitor and collect info.

1) System Architecture: The system contains three crucial ports:

SENSOR LEVEL: The circuit has two LEDs, two ultrasonic sensors,XBee radio, Arduino Uno module.

PROGRAM LEVEL: It consists of Arduino Uno module, three XBee radius and Ar-dunno Mega module.

DISPLAY LEVEL: It consists of four LED's, XBee radio, smartphone and web page . The ultrasonic sensor senses a car arriving in the parking lot(sensor level). Arduino analyse and transfers the data to the program level via XBee radio. The data hence refers to the status of the parking lot. The program level updates the changes in web page and switches parking lot LED's respectively [14] as shown in figure 5.

The project comprises of two phases:

In the first phase the system checks to detect a car in a particular parking lot. It is done by installing a sensor at one end of the parking lot and one sensor at the height of two meters above from the ground.

Second phase involves inducting and implementing wireless nodes to allow the system communicate the occupancy of a particular parking lot to the user in the control room. The system thereby permits the admins to receive real-time data regarding the parking area.

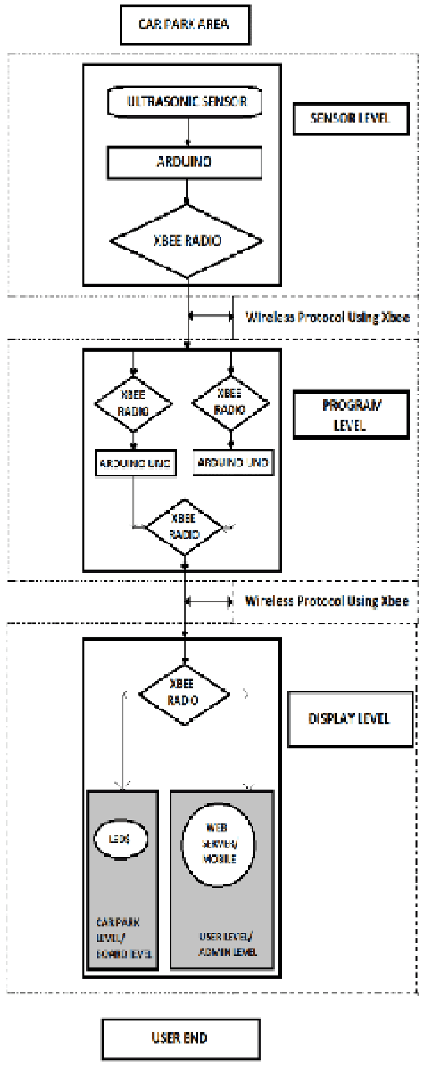

Fig. 5 System Architecture

The major aspects or goal are to easily trace the location of the car park, to easily discover its entrance and exit points, to optimize space for parking. The proposed system provides plenty of information to held drivers, find a parking lot and also powerful functions to help admins of the car park for optimal management [15].

2) Working of System: PHASE 1: The two ultrasonic sensors detect the car nearness than 155m as shown in figure 5. PHASE 2: Arduino module, Ethernet module, and XBee radio establish a communication link to the server.The Ethernet module interfaces the Arduino board and the Xbee radio is attached to it . This communication helps to initialize among the web server, field circuit and LED circuit [16] [17]. Two LEDs, one red and other green are attached to the module.

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The ultrasonic sensor transmits an echo along its path which bounces off any object and is receive back at the sensor. The sensor transmits a timing pulse to the Arduino that is identical to the distance and processes the time received from the sensor [18].

If the distance between both data given by the sensors is more than 150cm, the car parking condition is satisfied.

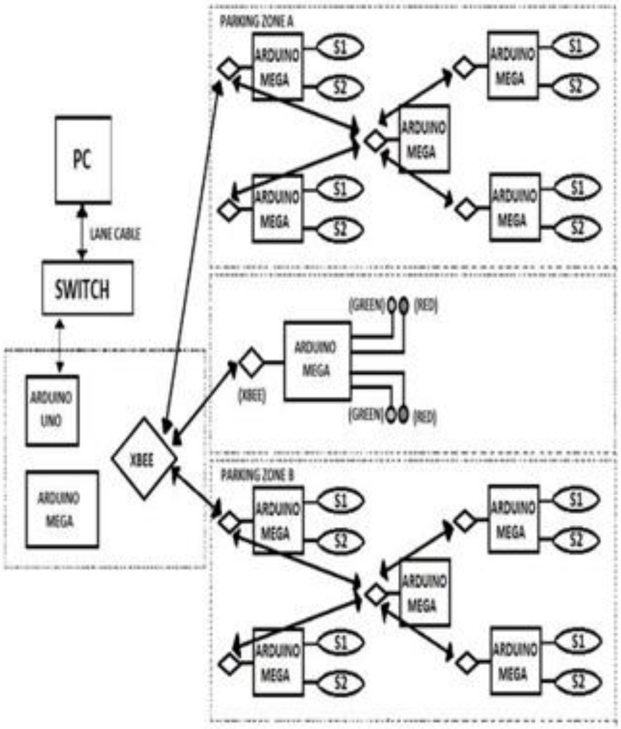

Fig. 6 System Circuit Diagram

Table. 2 List of components that been used for smart car parking system

Component's	Level	Working
Ultrasonic Sensor	Sensor Level	Detection the car during entry and exit.
LEDs (RED and GREEN)	Display Level	Display the cur-Rent state of the parking lot.
XBEE (series2)	Sensor Level	Wireless communication between router and coordinator.
Arduino Mega	Programming Level	Configuration and Programming of the main server.
Arduino Uno	Programming Level	Programming and communication Of sensor level components.

The module signals the server showing that the parking lot is empty by switching red LED OFF and green LED ON. If the distance is below 150cm, module signals that the lot is occupied by switching the red LED ON and the green LED OFF as shown in figure 6.

The two sensors are used by the server node to update automatically. The car detection event is actuated when both the sensors have the xyz=1 and conversely, status=0 signifies the parking lot is empty.

It has been programmed to identify the two events and alter status of the parking lot automatically via Zig-bee.

The webpage displays that event has occurred or not by the use of red and green LEDs respectively, as shown in figure 8.

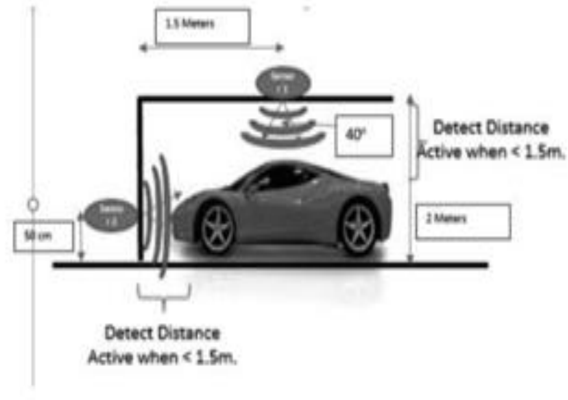

Fig. 7 Sensor Installation

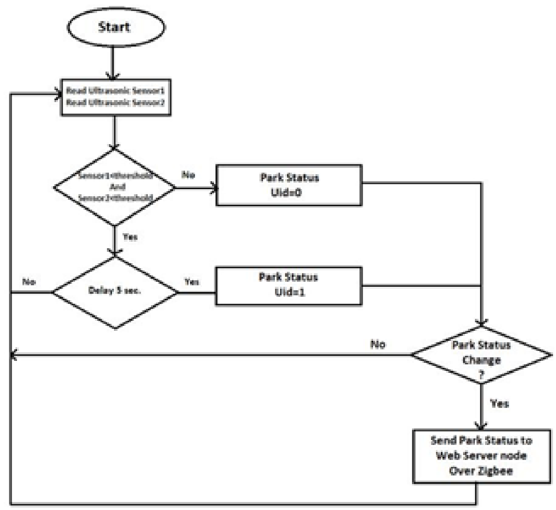

Fig. 8 Sensor node circuit flow chart

E. Smart Gym System

This system consists of a simple model and prototype that can be execute in a gym using IoT. The main purpose of this system is to provide users with well organized utilization of the resources present in the gym.

Personalized workout regimen: This field provides a user personalized suggestion based on vital statistic, feedback from users/machine and user workout history so that to achieve optimal result according to users fitness goal [19].

Personalized bookkeeping and inclusive tracking: This field is responsible for tracking activities of a user in an inclusive manner and also maintains users history records [20].

Improve user involvement: It is required to modify the workout regimen according to available resources so that user can involve with the neighbouring domain.

The main components required for the system are: Fitness Devices: These devices are communication interface or medium between a user and the system. These devices act as a guide recommend users about the set of exercises he/she need to perform one after another. Along with this, the devices also keep track of the users vital states like blood pressure, pulse rate, body temperature etc. using sensors.

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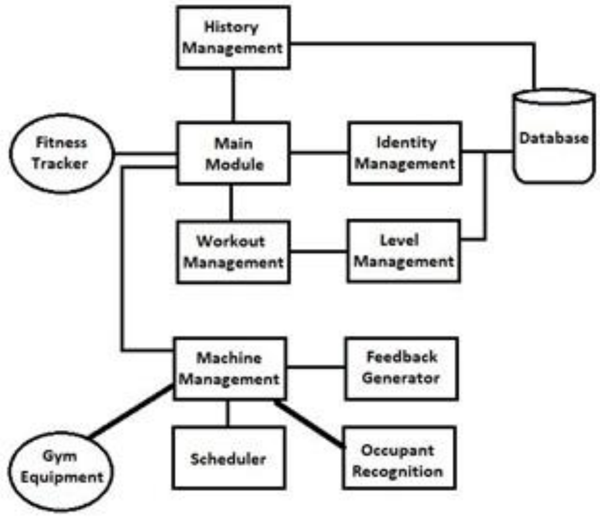

Fig. 9 Class Diagram

Gym Equipment: This represents the smart equipments that are available in the smart gym. The function of this smart equip-ments is to create an interface between the workout equipments and the system and to record the activities performed by the users. The information concerning the tenure of the equipments or the response of a equipment with respect to the user can be obtained by other components by interacting with a smart machine using this interface.

History Management: Whenever a user performs any kind of activity on particular equipment all the information concerning that activity are stored in the database by the system. So that it can be used in future for personalized bookkeeping. This records can be used by the system for analyzing which helps system to generate suggestions and overall for a user.

Identity management: It is common that different users can use the same machine, therefore there should be some mechanism to distinguish each user from others, which can be done by using a module assigning unique ID to each users. Whenever a user infiltrate into the smart gym, this module identifies the user by matching their IDs and retrieves the required information form the server of that particular user.

Level management: For each exercise, there are different levels, which are achieved by users as they continue the exercises for more optimum result. This module manages levels that are available in the system. So, that according to that system can guide the users. In addition to this, the module also promotes or demote the users to different level according to their performance for the set target.

Workout management: The level management module put the user to a particular level and provide information related to this level to workout management. Work-out management uses all the information and creates a dynamic workout for the user.

Occupant recognition: It recognize whether an equipment is active or inactive. If it is inactive. The occupant is recognized using unique user IDs and since when the equipment is active that particular user is also identified.

Feedback generator: This module generates feedback based on the number of activities performed by a user.

Scheduler This module schedules the workout since it is common that the number of users is greater than a number of machines, therefore, this module manages the multi-user with each user providing efficient time to each workout and efficiently occupy the exercise proceeding another as a necessary constraint [21].

Machine management: This module interacts with the equipments directly and retrieves information which is further used by occupant recognition, feedback generator, and scheduler module. This module also arranges the information according to their requirement and sends the information to the main module when required.

Main module: This module directly interacts with users through fitness devices. This module renders the recommendation along with dynamic workout to the users. Also, it manages several informations from other elements.

1) Implementation: For implementation the framework is divided into three different parts:

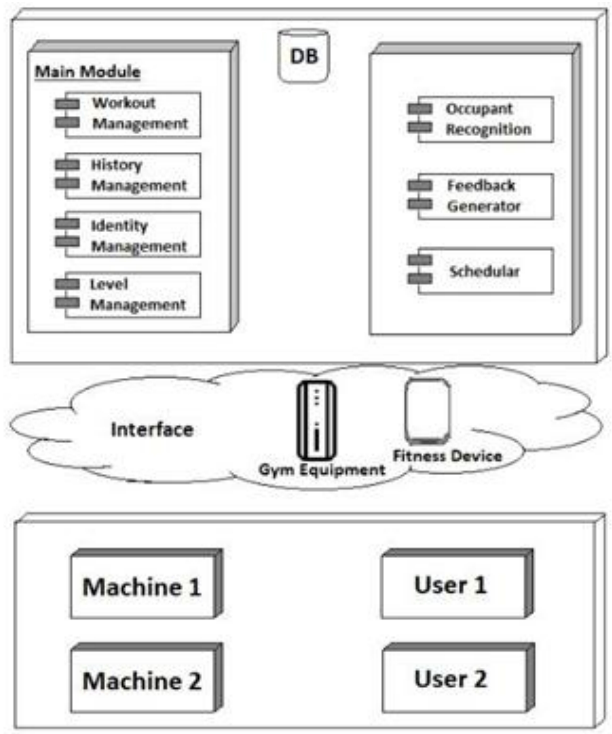

Fig. 10 Connectivity Diagram

Interface

This includes gym equipment and fitness device, the fitness device interact user to perform an exercise which he/she needed, along with suggested repetition and sets. If one equipment is occupied already than the system suggest another equipment based on a workout schedule.

The gym equipment furnish other information about the users' such as the equipment response about the performance and load used etc. by the user.

Server

The server part is responsible for the management and various computation required to arrange a user-centric workout. It includes main module and machine management and function of each of this are explained earlier.

Client

This part consists of the user and the gym equipments. Equipments which are furnished with sensors count the number of activities perform by a user such as the elapsed and force exerted by the users and the information is sent to the equipment management module. This is applied by response generate and occupant recognition to calculate their respective outputs.

F. Smart Irrigation System

Generally in our country farmers needs to visit their respective agriculture field time to time in order to inspect the moisture level of soil and according to the moisture level required amount water from the tank is pumped out through the water pump to irrigate their fields. Here, the problem is farmer needs to wait for switching OFF motor until the irrigation is complete, takes a longer time and effort especially when there are multiple fields distributed across different places. Hence, there must be something which can automatically identify the soil moisture level and allow that much quantity of water needed, the smart irrigation system can be the solution [22]. If the area of the farm is large more number of pipes are required in different direction for watering the plants from the motor. Previously, the farmer manually changed it from time to time. But in the smart irrigation system, the electromagnetic valve is used to change the direction of pipe automatically to the required area which is controlled by the Raspberry Pi. When the valve is open, the motor automatically starts and at the same time a message is sent to the registered mobile or email account of the user(farmer). By which farmer far away from the field can get the status of their respective fields.

1) Working of System: Sufficient water quantity is flow in the respective field.

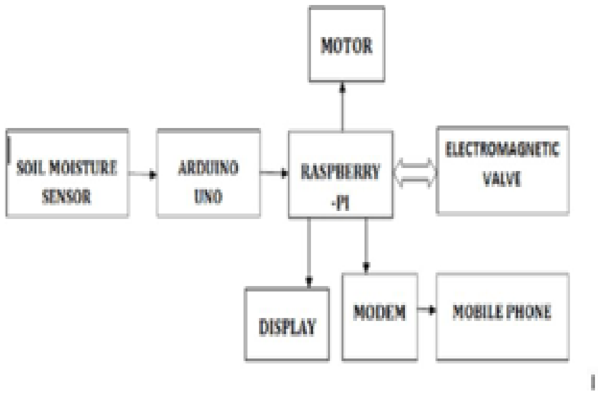

Fig. 11 Functional Block Diagram

Therefore, The system runs using two nodes that is, the control and sensor node. Sensor node is placed in the field for sensing the moisture level of the soil and the moisture value is sent to the controller node. Control node contains Raspberry-pi which is also connected with an electromagnetic valve. It also contains GSM facility to connect with smartphones and internet. On receiving the moisture value from sensor node the controller node compares the revived moisture value with required threshold value. If it is less than the required value than control node switch ON the water pump to irrigate the field and at the same time it sends alert message to user's(farmer) smartphone or Email [23] [24].

G. Smart Garbage Monitoring System

As we know dustbin is considered as a basic need to maintain the level of cleanliness in our environment, so it is very important to clean the dustbin periodically as soon as they get filled. But in existing system people(labor) manually do these at a fixed period of time. Therefore, it is commonly observed that dustbin is overflowed in maximum cases, which result in an unhygienic environment. So, there should be some type of system that cares about this situation. Smart Garbage monitoring system can be used to solve this problem. This system is for immediate cleaning of the dust-bin [25].

1) System Architecture: For implementing this system we need an ultrasonic sensor, microcontroller, wifi mod-ule(ESP8266) and breadboard as an interface which connects all the mentioned devices together using some jumper wires.

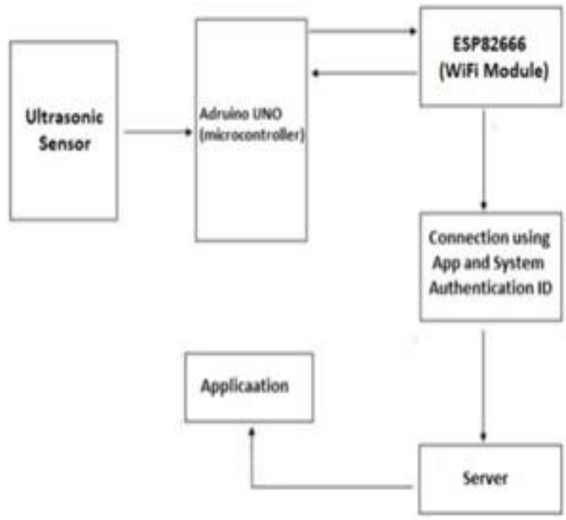

Fig. 12 Proposed model - Architecture Diagram

The ultrasonic sensor this sensor usually works by emitting an echo along its path and bounces off any object and the echo is received back to the sensor. The time taken to transmit and received the echo back to the sensor is used to calculate the distance of the object an. it can be given by:

Distance = Time sound speed=2 (3)

Microcontroller We can use either Arduino UNO or Raspberry-pi as a microcontroller. The microcontroller controls and regulates all other devices connected with it, just we need to flash our program to it.

wifi module ESP8266 is a Wi-Fi module which will give your projects access to Wi-Fi or internet.

The breadboard is an interface which is used to connect all other devices with each other. Typical breadboard includes top and bottom power distribution rails.

2) Working of System: Steps are as shown in figure 13. The first step for this system is to configure an app. Since the system uses the Internet hence, there is an app which acts as user and system interface.

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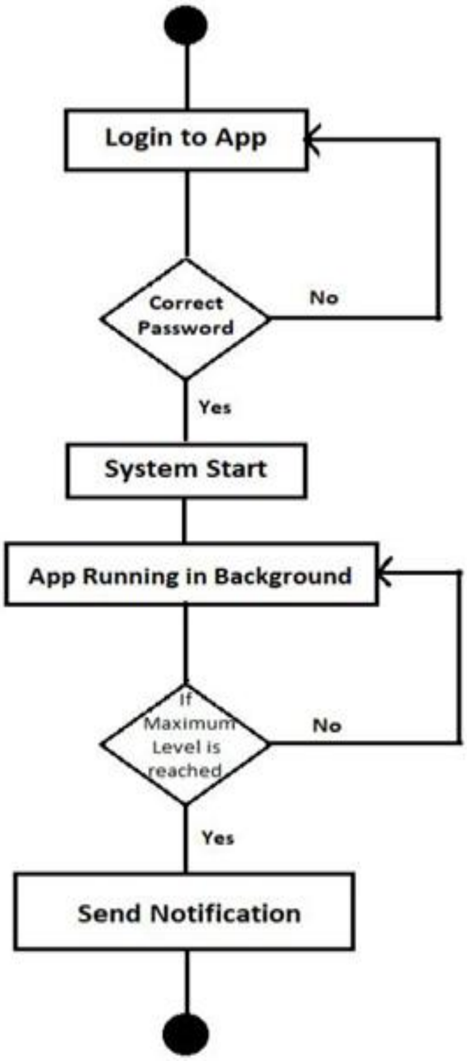

Fig. 13 Working process of the proposed model

The user needs to install this app in his/her smartphones or other Internet enable devices. Then they have to create their own unique account with a password for security purposes. Once the account is created they can use the system. The system containing the microcontroller that read the value coming from the ultrasonic sensor, installed in smart dustbins all around the city [26]. And maintain the table for every smart dustbin along with their garbage levels and their location and send the details to corresponding users.

H. Smart Healthcare System

In IOT based smart healthcare system healthcare devices are used to collect medical information, analyze it and store the information to the server. The server is capable for storing several different formats of data and can activate alarms when required. This medical information allows incessant and ubiquitous access any devices connected through the Internet. There are limited number of IOT devices that are powered using a battery, therefore our goal is to minimize power consumption inorder to boost the durability of the system.

Components Used

1) Intel Galileo 2G board (Used as a gateway in this system)
2) XBee S2 Sensor node
3) XBee adapter
4) The temperature sensor (Body temperature).
5) Pulse sensor
6) ECG sensor (Echocardiograms):- EVALUATE HEART HEALTH
7) EEG sensor (Electroencephalogram):- measure brain ac-tivity
8) ADC pins

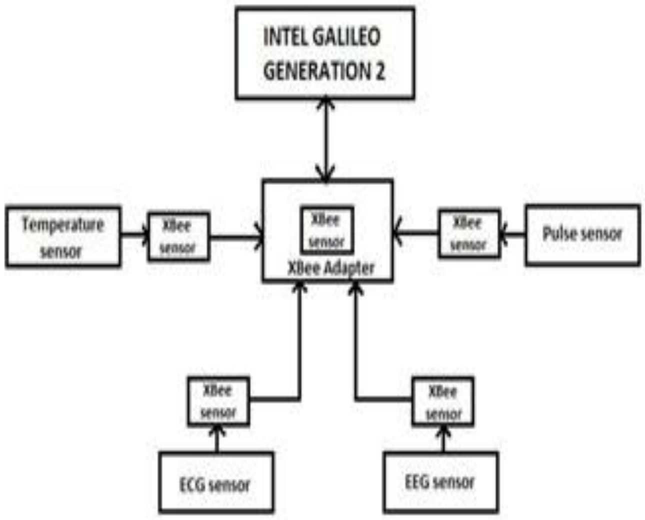

Fig. 14 Block diagram of the system

2) Working of System: XBee module is connected with the temperature sensor, ECG sensor and EEG sensor using the ADC pin. The samples from all devices are retrieved by XBee sensor according to the configured sample rate and at every 5 seconds these samples are transmitted to the gateway as shown in fig14. These samples is received by the gateway and the required calibrations are conducted to retrieve the actual values equivalent to the cloud server and store in the database in order to analyze them by professional and take optimal step for the same. Hence, this system abolish the need for the healthcare professional to visit the patient regularly after certain intervals. Moreover, a physician can check the data of the patient from anywhere using ant internet enable device like PC, smartphone, etc. to analyze it and can prescribe appropriate medical management.

I. Smart Animal Intrusion Detection System

The human animal conflict is a major problem in the forest zone and agricultural field leading to loss of huge quantity of resources and also a threat to human life. In consideration of this problem, an IoT based animal intrusion detection system can be used to solve this problem. In this system wireless sensors and camera's are used where the sensors are used to detect the movement of the animal and the camera capture's the image and the image is sent for classification using image processing via a microcontroller, then a suitable action's are performed by the system based on the type of the intruder. A GSM module is used to send SMS notifications to the forest officials or the owner of the farm. Buzzers are used to make a loud acoustic sound in order to scare away the animals [27] [28].

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Components Used

1) Hardware requirements.
PIR Motion Sensor(HC-SR501). Web Camera
Arduino Uno Microcontroller. Bright Light Emitter.

GSM module

2) Programming tools.
Microcontroller- Arduino IDE.
Image processing- MATLAB 2017a.

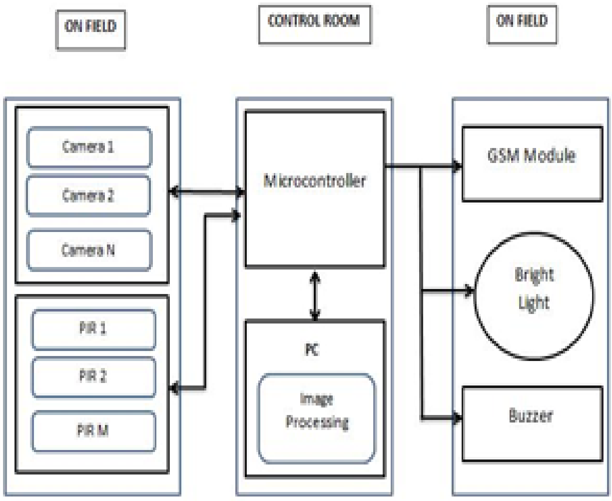

Fig. 15 Block diagram of the system

2) System Architecture: In the proposed system, PIR sensors and the camera's are pole mounted on the boundaries of the farm. The number of PIR motion sensors is twice the number of cameras because of the range of PIR sensors are less than that of the range of the camera. That is, the range of the PIR sensor is around 20-30 meters and the range of camera around 40-50 meters. An Arduino UNO is used as a microcontroller to control the operations of the system. MATLAB 2017a is used for image processing to classify the image sent by the camera by comparing the image with the sample images stored in the database. A database is created to store the sample images of different types of animals. Buzzers and light emitters are used as a repellent system to scare away the animals.

3) Working of System: In the proposed system, the PIR sensors, and cameras provides the first level security. Once the PIR sensors detect a movement, it gives a signal to the camera through the microcontroller to capture the image in that area where the signal came from. The camera then sends the captured image to PC via microcontroller for image processing. PC receives the captured image for classification of animals where samples of images stored in the database is compared with the captured image sent by the camera to detect whether it is threat or not. If the object image is identical with the object in the stored image and the object is classified to be a threat the microcontroller signals the GSM module and an SMS notification is sent to the farmer regarding the location and type of the animal that is trying to intrude the farm, simultaneously the repellent is applied based on the type of the animal, where the bright lights are emitted and irritating noise is made from the buzzers for scaring the animals after every 4 seconds. If the image is not matched then no SMS is sent and the repellent system is avoided.

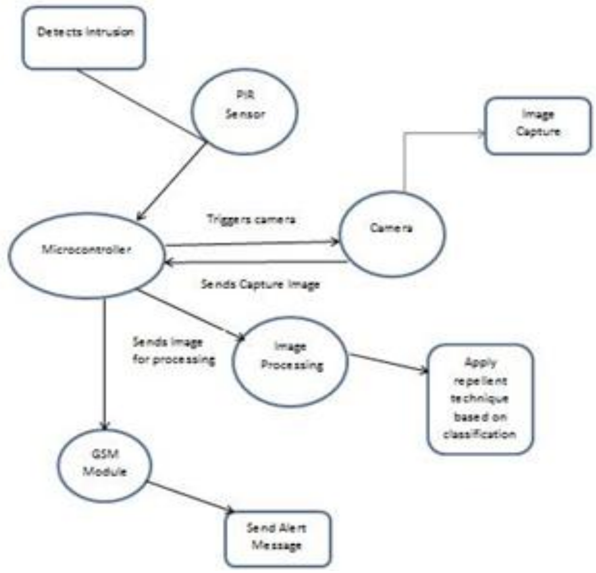

Fig. 16 Flow diagram of intrusion detection system

Figure 16 shows the flow diagram of system performing the respective steps. Figure 17 shows simulation output when elephant is found as an intruder. Figure 18 shows simulation

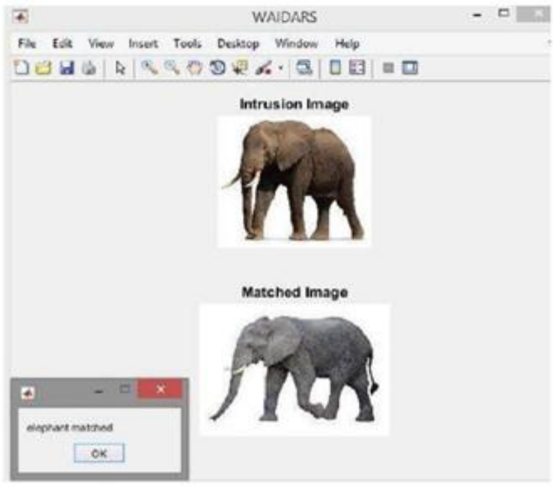

Fig. 17 when the elephant detected as intruder

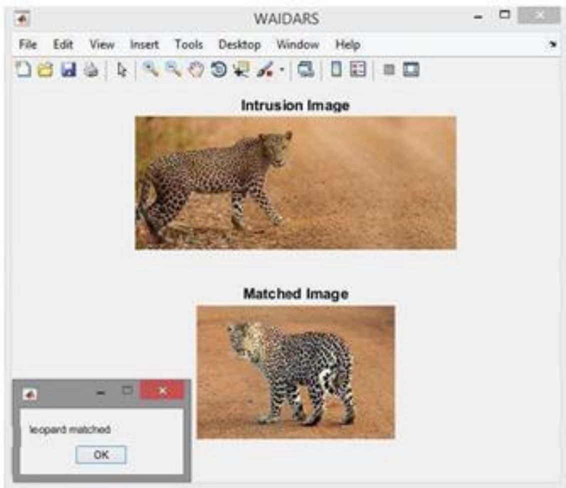

Fig. 18 when the leopard is detected as intruder

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J. Smart Traffic Control System

An IoT based automatic smart traffic controlling system using sensors and a website with live update of the traffic density is helpful in optimizing the busy interplay of the traffic pattern flow. This automatic model can reduce the problem of traffic congestion in throng cities [29].

As we know that a typical traffic system consists of four/three lanes and at the end of each lane it comprises of a traffic lights/signal and timer display that operates in a sequential manner. The difficulty of this system is that the level of the traffic in each lane cannot be detected by the system and as a result of the when the lane is empty the time is wasted. Along with time loss, it also fails the restrict the vehicles that blocks the zebra crossing used by the persons to cross the road. Many adaptive methods for traffic controlling has been implemented such as, using GPS for tracking vehicles [30], RFID technology [31],CCTV cameras and image processing algorithms [32], VANET technology [33], by collecting social media data and applying text mining algorithms can also be used for building well organized traffic management system [34] [35] [36].

1) Components Used:

1) Raspberry Pi 3:- It is a mini computer with a UNIX based operating system installed for processing and controlling other microcontroller connected to it.

2) Buzzer:- It is used as a warning alarm for the safety of the pedestrian crossing the road.

3) Ultrasonic Sensor HC-SR04:- It is used to detect the presence of an object/vehicle within its range. It has a range of 2-400 cm.

4) MCP23S17:- It is a multiplexer with 16 bit I/O extended IC which is used for adding more devices to the system that are required.

5) Dual 7-Segment Display:- It is used to display the time counting down in each lane.

6) Light Emitting Diode (LED):- It is used as traffic signal lights in the system.

Table. 3 List of number of components used for smart traffic congestion monitoring system

Component's	No of components used
Buzzer	4
Ultrasonic Sensor HC-SR04	16
LED	12
Dual 7-Segment Display	4
MCP23S17	2

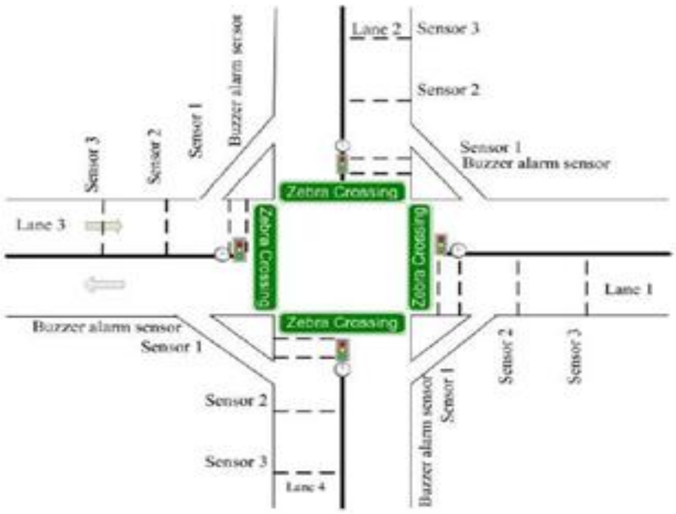

Fig. 19 Model of the system

2) System Overview: Figure 19 shows the overall system design. In the proposed model each lane consist of 4 ultrasonic sensors are placed equidistance to each other to detect and compute the level of the traffic in each lane and the result is sent to the Raspberry Pi. According to the level of the traffic Pi uses the computed information to set the signal timer and updates the information it on the website.

3) Connections: A total of 32 I/O pin are required by ultrasonic sensors. We can reduce the number of pin to 17 I/O pin by making the trigger pins common for all the sensors. The Raspberry Pi has only 26 I/O pins that are used for I/O pins. This problem can be solved by using the MCP23S17 IC. In this system, 2 MCP's are used to extend the number of pins .Each MCP adds an extra 16 I/O pin to the system. Figure 20 shows the connections from Pi to the MCP's and the sensors. The sensors of each lane are connected directly with the Raspberry Pi. Figure 21 shows the connection from the frist MCP to the 7-segment display and figure 22 shows the connection from the second MCP to the LEDs.

4) Working of system: The proposed model uses the sensors of each lane to measure the level of the traffic in a particular lane. When the sensor is triggered an echo from the sensor is transmitted along its path and bounces off any object and the sensor receives the echo. The time between the transmission and reception of the echo is used to evaluate the distance of the object and the sensor by applying the following given formula.

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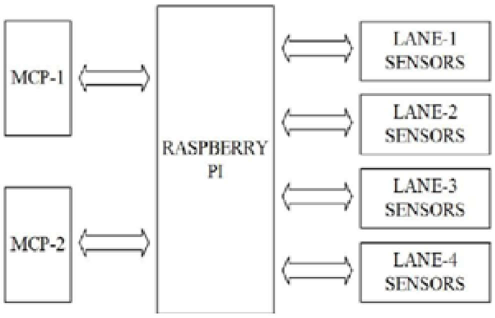

Fig. 20 Connection of MCP and sensor with Raspberry Pi

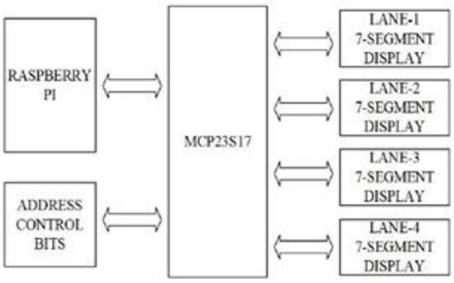

Fig. 21 Connections from first MCP

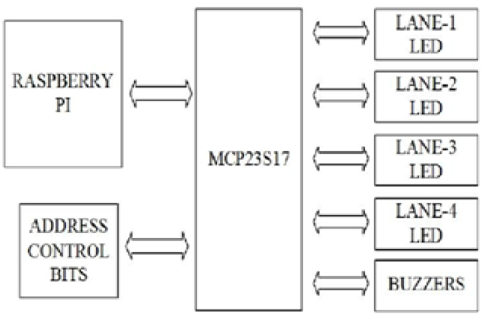

Fig. 22 Connections from second MCP

Distance = (Time between Echo 34000)=2 (4)

The width of each lane is used as a threshold value in order to sense the presence of a vehicle. The system computes the density of the traffic into three fixed levels Low, Medium and High. The information from the three sensors are used to calculate the level of the traffic in each lane. The distance of the vehicle calculated by using (4) ,if it is less than the threshold value, the sensor gives an output 1 else output is 0 such that output 1 signifies the presence of a vehicle in that location and output 0 it signifies an empty lane. The density of the traffic for each lane is allocate based on the conditions as followed:

Low: (S1=0,S2=0, and S3=0) or (S1=1, S2=0, and S3=0)
Medium: (S1=1, S2=1, and S3=0)
High: (S1=1, S2=1, and S3=1)

Based on the following conditions the timer is set for each lane as:

Low: 10 seconds.
Medium: 20 seconds.
High: 30 seconds.

While the timer is counting down for a lane, The system monitors each lane with red signal continuously to check weather the zebra crossing is blocked by and car which is checked using the buzzer alarm sensor if the sensor detects the presence of a vehicle or it is too close to the zebra crossing, the system sounds the alarm giving the warning to move back and keep safe distance. This whole process is applied in a loop for each lane. The traffic data collected at each step is updated to the website so that the users can access and see the level of traffic in each lane.

III. EXPERIMENTAL RESULTS WITH ENABLE TECHNOLOGIES

Table IV shows experimental results of each application by comparing the components used, IOT devices required, programming language used and the communication type.

Appications	Components	IOT Devices	Programming Languages	Communications
Smart Interative Home and Office Automation System	Raspberry Pi, Relay Board	PIR Sensors	Python 3, Arduino Programming Language	Wireless
Smart Museum System	Raspberry Pi	BLE	Python 3, Arduino Programming Language	Wireless
Smart Air and Sound Pollution Monitoring System	Arduino UNO, LED	MQ-2 Sensor, MQ-135 Sensor	Python 3, Arduino Programming Language	Wireless
Smart Car Parking System	Arduino UNO	Ultrasonic Sensor,	Python 3, Arduino Programming Language	Wireless (Xbee)
Smart GYM System	Arduino UNO	Ultrasonic Sensor	Python 3, Arduino Programming Language	Wireless(Xbee)
Smart Irrigation System	Raspberry Pi, Arduino UNO, Relay Board	Soil Moisture Sensor, Temprature Sensor, Water Level Sensor	Python 3, Arduino Programming Language	Wired/Wireless (GSM)
Smart Garbage Monitoring System	Arduino UNO	Ultrasonic Sensor	Python 3, Arduino Programming Language	Wireless (ESP8266 Wifi Module)
Smart Healthcare System	Intel Galileo	Temprature Sensor, Pluse Sensor, ECG Sensor	Python 3, Arduino Programming Language	Wireless (Xbee)
Smart Animal Intrusion Detection System	Arduino UNO, Buzzer, Light Emmiter, WebCam	PIR Sensor	Python 3, Arduino Programming Language	Wired
Smart Traffic Control System	Raspberry Pi, MCP, Buzzer, LED, Dual 7-segment Display	Ultasonic Sensor	Python 3, Arduino Programming Language	Wired

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Fig. 23 Results shows the exceptional growth of IoT and absorbed by the World Population

IV. CONCLUSION

In this paper, the concept of IOT and its different application domains are studied. The paper addresses how IOT can be implemented in our day to today life in different domains with its implementation and working with the least minimum cost. Various IOT devices like Raspberry pi, Arduino UNO , etc. can used as a micro controller to make the other devices like Temperature sensor, Ultrasonic sensor, PIR sensor, BLE devices etc. to communicate with each other over the internet, thus making our surrounding intelligent enough to handle tasks that are being done manually. This paper also addresses the future works for each applications that are required and can be implemented in future making the system more efficient giving minimum cost estimation.

V. FUTURE WORKS

A. Smart Museum System

The system is totally based on image recognition. Therefore if camera to not able pick image clearly, it will be hard for system to identify the image and therefore may produce wrong result. If structure or paintings are placed nearby such that they all adjust in one single image than system will only produce information of any one image .In other words the system is able to detect multiple structure at same time.

B. Smart Traffic Control System

By increasing the number of sensors in each lane we can make the system more precise computer operated cars can access the website to sight the level of traffic in each lane and make the decision to pick the fastest path avail-able. Classification algorithm of data mining technique can be used on the traffic information collected in longer term in order study the patterns of the traffic in each lane at different time intervals of the day such that different timing algorithm can be applied at different time interval of the day based on a particular traffic pattern.

C. Smart Irrigation System

A Raspberry Pi can be used as a microcontroller instead of ATmega328 which requires Zigbee Transceiver for sending and receiving data from nodes and the cloud server as Raspberry Pi consist of inbuilt Wi-Fi module and BLE module for wireless transmission of data. The sensors can be effectively interfaced with Raspberry pi and remote correspondence is accomplished. Usage of such a framework in the field can enhance the yield of the harvests and helps to deal with the water assets viably decreasing the wastage. The proposed system can be extemporized by utilizing a sensor to evaluate the measure of water utilized for water system and in this way giving cost estimation.

D. Smart Animal Intrusion Detection System

The tracking of animals using a camera involves a large amount of image processing from live feed video. If an animal is moving fast the camera might capture a blur image which may not be suitable for classification as the system cannot identify whether the intruder is a human or and animal as a result the system may fail to perform further operation. Using cameras increase the cost in large area. The proposed system can be extemporized by utilizing a sensor to detect the presence of intruder and in this way giving cost estimation.

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