An Integrated System for Smart City and Smart Home

[1]Dr. U. S. Bhadade, [2]S. J. Patil

[1]Prof. & Head, Department of IT, SSBT's COET, Bambhori, Jalgaon.
[2]Assistant Prof., Department of IT, SSBT's COET, Bambhori, Jalgaon.

Abstract-*The Internet of Things (IoT) has become a promising technology that is able to address many societal challenges by connecting smart devices to lead development of smart cities and smart home. In this paper we propose an IoT based system for smart cities and smart homes. The IoT based system includes various features for smart cities such as traffic controlling and diversion of traffic as per need, detecting the fire in any part of the city, garbage collection and routing the collection of garbage and controlling sound pollution. The paper also proposed various features for smart home such as controlling room temperature, automation of entry and exit through gate, safety measures against burglars, and automation of door bell. The proposed system for smart city and smart home is integrated thereby improving the overall performance of the system.*

Keywords-IoT, smart city, smart home.

I. INTRODUCTION

A smart city refers to an urban area that collects information through electronic media so as to manage public resources automatically.[1] This may incorporate data collected from an individual person, devices, and assets that is further processed and analyzed by some system to produce desired actions. Smart city concept integrates information and communication technology (ICT), and various physical objects connected to the network i.e. IoT to optimize the efficiency of city operations and services and connect to citizens and authorities. Smart city technology allows city officials to interact directly with both community and city infrastructure and to monitor what is happening in the city and how the city is evolving. ICT is used to enhance quality, performance and interactivity of urban services, to reduce costs and resource consumption and to increase contact between citizens and government. Smart city applications are developed to manage urban flows and allow for real-time responses. A smart city may therefore be more prepared to respond to challenges than one with a simple "transactional" relationship with its citizens. Smart city allows flow of real-time information that enables a more responsive government. Enhanced analytics allow for increased equity in the delivery of services. Different services that might be implemented in smart city are shown in figure 1.

Smart home is also referred as home automation or domotics is building automation for a home, called a smart home or smart house. As can be seen from figure 1 smart home is one of the components in smart city to provide valuable information in maintaining the harmony of smart city. It involves the control and automation of lighting, heating, ventilation, air conditioning, and security, as well as home appliances such as washer/dryers, ovens or refrigerators/freezers.[2] Wi-Fi is often used for remote monitoring and control. Home devices, as shown in figure 2, when remotely monitored and controlled via the Internet, are an important constituent of the Internet of Things. Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, mobile phone software, tablet computer or a web interface, often but not always via Internet cloud services. Due to rapid growth of India in all aspects of life numbers of users connecting to the Internet are also growing exponentially. Due to the extensive use of Internet time comes when people are searching the mechanisms by which they can command and control the things remotely. IoT is good technology solution to this. After working on individual components we need to integrate all the smart components such as smart home into one such as smart city to keep system in harmony that leads to achieve all defined objectives related to smart city.

Fig. 1 Smart city

II. PROPOSED SYSTEM

The aim of the system is to make a better use of the public resources by integrating smart city and smart home. This may lead in increasing the quality of the services offered to the citizens, while reducing the operational costs of the public administrations. This objective can be achieved by the deployment of IoT systems in smart home and the smart city projects. The other use of incorporating these systems increases transparency to the citizens. There are many services that might be implemented with number of benefits in optimization and management in societal services. These services may include city energy consumption, structural health of buildings, noise monitoring, traffic congestion, smart parking, smart lighting, automation and salubrity of public buildings, garbage collection etc. By considering some of the above mentioned services we have undertaken to implement few of them as explained below.

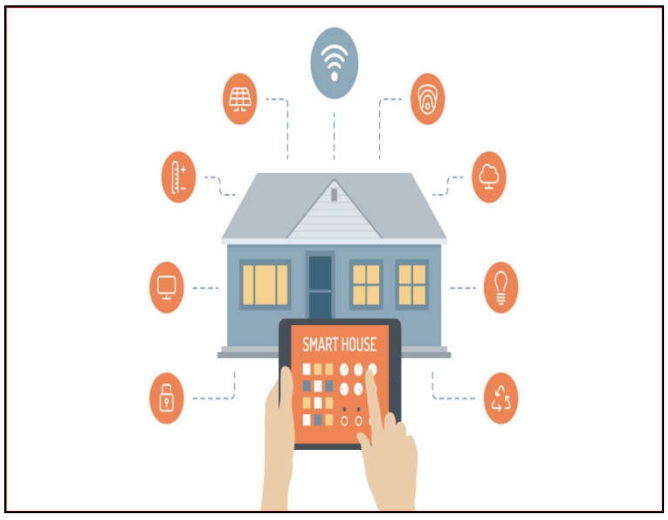

Fig. 2 Smart home

A. Traffic Control

In most of cities traffic is controlled by signal system. Often on signal square we wait for some pre-determined time as signal parameters are set based on predetermined rates. Though traffic coming from all four directions is not equal, time intervals set for four sides (lanes) are equal. This may result in keeping other lane traffic extra waiting even though traffic in one of the lanes is already cleared. This is the inability to adjust traffic to variations in traffic flow and

actual traffic demand. This problem can be solved by measuring the density of traffic in terms of queue length on the road the traffic acquires. Once the traffic is measured the signals will be programmed to change timing as per the density. Of course the initial values of timers have to be fixed and time for each approach can be varied between a minimum and maximum.

With change in time, traffic variations results in updation of timer values. The traffic will be diverted to an alternate route, in case of heavy traffic. Also if heavy rainfall is detected in particular area, the traffic may be diverted to an alternate route based on certain parameters measured. The system is shown in figure 3.

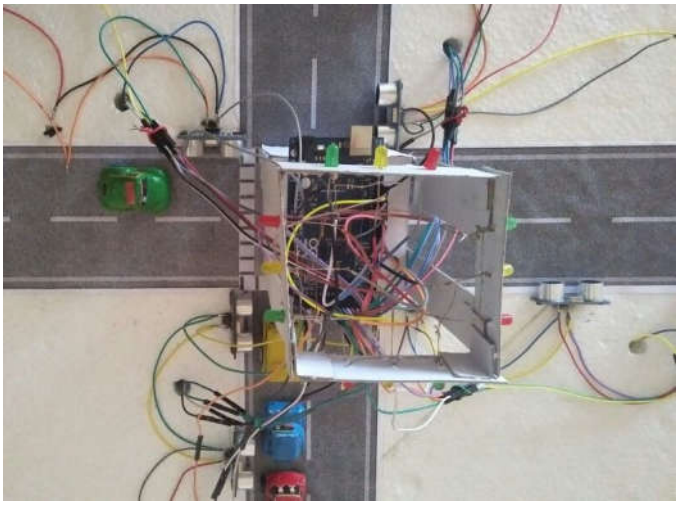

Fig. 3 Traffic control system

B. Garbage Collection

In this module, our aim is to detect the level of garbage bins placed at different locations in the city and inform the municipal authorities about the status of the garbage bins and to provide efficient routing algorithm for collecting the bins thereby saving the time and fuel consumption of local Municipal Corporation. The system is shown in figure 4.

Fig. 4 Garbage collection module

C. Sound Pollution

India is the country which celebrates the festival throughout the year such as Ganesh Festival, Navratri, Holi etc. During these celebrations the level of the sound is more than the threshold which adds fuel to the sound pollution. It is found most annoying to the public places such as hospitals and schools. In this module the sound level is detected and

through IoT mechanism, the sound level readings are sent to controlling authorities that can take appropriate action immediately after the sound level crosses the permissible limit.

D. Fire detection

In this module, the temperature at various places of the city is monitored by locating the sensors at some places. The sudden rise in temperature may indicate the alert of fire.

E. Controlling room temperature

This module aims towards the comfort zone of the person at home. In summer if a person reaches home and then turns AC ON, it will take 2 to 5 minutes to cool the entire room, but if he could turn AC ON when he starts from his office then he will enjoy cool room when he reaches home and this is possible through this module. The module turns AC ON/OFF through the webpage. The person will interact with this module through client-server architecture provide by nodeMCU.

F. Automation of house gate

If we arrive home by car, then we need to get off the car and open the gate and again move back to car to enter the home premises. The gate can be open or close by the person in the similar way he turns AC ON/OFF. With the help of stepper motor module, it is possible to open and close the gate.

G. Burglar alarm system

Home safety is very important from the owner's perspective. If unknown person try to enter the house at night then this event must be noted and informed to owner either through buzzer or visual alarm. The sensors in this module will detect the presence of person by weight/load sensor or infrared sensor and the same will be recognized by the module and further it will be notified to the owner.

H. Door bell automation

Similar to above modules this one will be able to detect the person just before entrance of home. As soon as the person approaches near the home the module will rise the alarm and people inside are notified about the presence of a person waiting outside who is just about to push the doorbell button.

III. System Integration

To integrate smart home and smart city it is necessary to identify the services that are integral in purview of smart city. This is because not all services are of prime interest to be maintained under smart city project laid down by authorities. E.g. one of the feature of smart home i.e. controlling room temperature is not necessary to integrate in smart city as it has nothing to do with other public services and of course city officials may not make it part of smart city. However fire detection is an important component that has to be integrated in smart city as safety and security of citizens is one of the objectives of smart city mission like our India. Similar problems can be identified from society to encompass in smart city. Burglar alarm is another module in our proposed system that can be directly integrated in smart city. During night, police personnel on patrolling are notified presence of burglar trying to enter house resulting safety of house.

IV. System Components

A. Arduino Uno

Arduino/Genuino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable. In Arduino Uno, "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and

version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform.

B. DHT11 (Temperature & Humidity Sensor)

As disussed earlier in fire detection sudden rise in temperature indicates fire. Let's discuss this sensor. This sensor features a complex and calibrated digital signal output. By using the exclusive digital signal acquisition technique and temperature and humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programs in the OTP memory, which are used by the sensor's internal signal detecting process. Following figure 5 shows how we can connect Arduino board module DHT11.

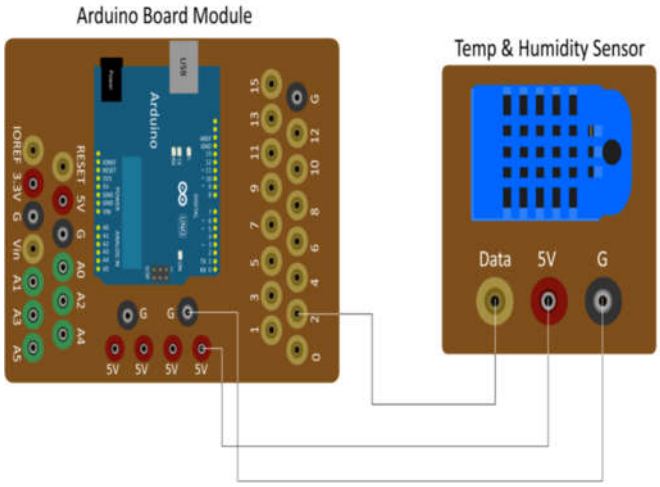

Fig. 5 Interfacing Arduino & DHT11.

Following is the program to interface DHT11 to Arduino and print the temperature sensed by the sensor on the serial console.

```
/*
Interfacing Temperature and Humidity Sensor (DHT11)-using One Wire Protocol
*/
#include<DHT.h> //define library for sensor
#define DHTTYPE DHT11 //define macro
int SensorPin =2;
DHT dht(SensorPin, DHTTYPE);
//pin initialization
float t, h;
void setup()
{
Serial.begin(9600);
}
void loop()
{
```

```
delay(2000);
t=dht.readTemperature();
//object to read the sensor value h=dht.readHumidity();
//object to read the sensor value Serial.print("Temperature="); Serial.println(t);
Serial.print("Humidity=");
Serial.println(h);
}
```

Load this program onto the Arduino through IDE and then make connections as shown in the above figure. Once complete we can see the temperature on the monitor.

C. Stepper motor

A stepper motor or step motor is a DC electric motor that divides a full rotation into a number of equal steps. The motor's position can then be commanded to move and hold at one of these steps. This motor is useful in opening of house gate as we discussed in automation of house gate. Figure 6 shows the connection of stepper motor & Arduino board.

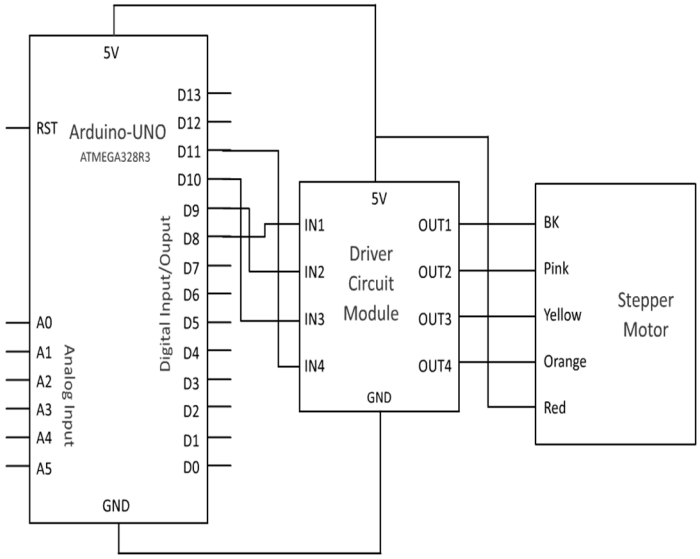

Fig. 6 Interfacing Arduino & Stepper Motor

D. Buzzer module

A piezo buzzer can be connected to arduino as shown in below figure 7 to alarm an event.

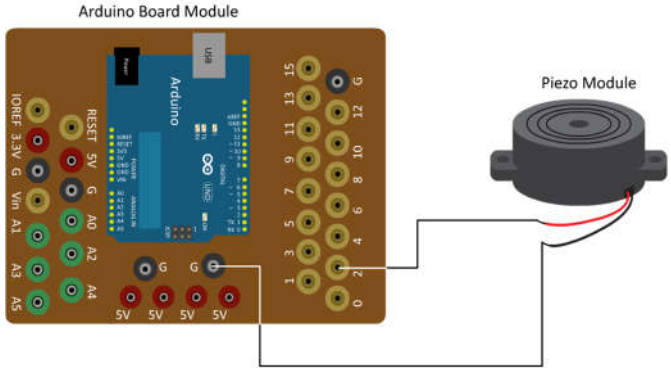

Fig. 7 Interfacing Arduino & Piezo buzzer

E. SD card module

Many applications involve monitoring parameters and storing the data at local places particularly at places where there is no internet connectivity or lack of reliable network. The data collected may be synchronized for later analysis. SD card module can be useful in this case. Following figure 8 shows how to connect SD card module to Arduino board. Though our proposed system is not required this module, it has many applications in smart cities and smart homes.

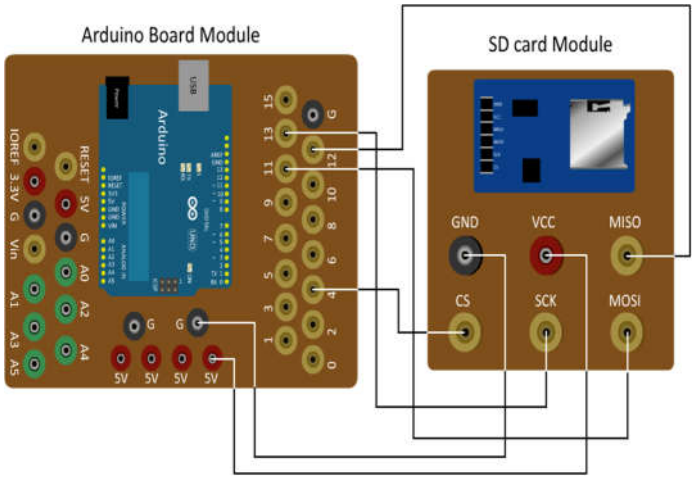

Fig. 8 Arduino board & SD card module.

F. NodeMCU

This module is heart of the integration system without which it is not possible to call individual components as an IoT system. IoT system is the one that makes the system to interact with other nodes involved in other systems through Internet. NodeMCU also called as ESP8266 module that is responsible to collect the information from all the sensors through the Arduino board and send it to the server. Also if the user wants to control the peripheral devices at home or present at some other location, it is the NodeMCU which receives the signal from the user via WiFi and activate the peripheral devices as per the choice of the user. In other words NodeMCU can be made to act as client as well as server as shown in figure 9.

G. Integration of smart city and smart home

So far we had seen dedicated system for smart city and dedicated system for smart home. In this paper we have integrated both the system for the betterment of mankind. If we consider the traffic control module (part of smart city) and a person (sitting at his smart home), then before getting out of the home, he can know the traffic scenario at different locations and accordingly he may choose his route to go to his destination. The people need to register themselves for this system. In case the house owner update his status that he is leaving city for 2-3 days, in that case if a try to theft occurs then this incidence will be immediately recorded at controlling station and the patrolling police of that area to take further care of that house.

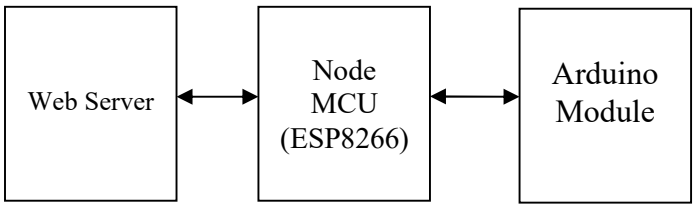

Fig. 9 NodeMCU communicates with web server and Arduino board

The integrated system consists of all the components we discussed earlier via NodeMCU as shown in the figure. As discussed NodeMCU can function in two ways. First it may receive the data collected by Arduino board and supply data to the web server for further processing and retrieval. In another case user can connect to the NodeMCU through the web page and issue commands to perform operations such as turning AC ON/OFF. Thus NodeMCU works as interfacing component to convert things to IoT in true sense.

CONCLUSION

In this paper we have integrated smart city with smart home. The whole idea was to ensure that the resident of the city will get the information at a single tip about the city along with its home. Thus using this system the resident will be able to monitor room temperature, home security and at the same time he can monitor different parameters of the city such as air pollution, garbage level in dustbins, sound level, pollution and traffic of various places of the city.

ACKNOWLEDGEMENT

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