Cloud Based Automation For Smart Cities

Mr. K. Rajasekar, S. Jai Dersheni, C. Indira Priyadharshini, Jagadeeswaran

*K. S. Rangasamy College of Technology

*Corresponding Author: Indira Priyadharshini
E-mail: indiramohansweety@gmail.com,

Received: 12/01/2017, Revised: 15/02/2017 and Accepted: 17/03/2017

Abstract

This project proposes to manage the city’s aspect by building smart homes, smart parking centres, smart water monitoring systems, smart environment monitoring system, smart waste management system. This paper focuses on creating a structure for the realization of smart cities through the Internet of Things (IoT). This project uses Raspberry Pi to control and manage various sensor data and sends the data to the server. The project emphasizes on connecting people, process, data, and things to improve the ‘Liveability’ of cities and communities through internet. A Smart city monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.

Index terms – Internet of things, Raspberry pi, Smart city, Smart home, Smart parking, Waste management, Environment monitoring, Water management.

1. Introduction

The concept of Smart city embraces several definitions depending on the meanings of the word “smart city”: intelligent city, ubiquitous city, sustainable city, digital city, etc. Smart cities use Information and Communication Technologies (ICT) to be more intelligent and efficient in the use of resources, resulting in cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint, all supporting innovation and the low carbon economy. This is the concept of basically connecting any device with an ON and OFF switch to the Internet. This includes everything from cell phones, coffee makers, washing machines, headphones, lamps, wearable devices and almost any device. This also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig. All these devices or components can be controlled either using a smart phone application or using web pages designed for this purpose. The IoT is a giant network of connected “things” (which also includes people). The IoT can be applied to things like transportation networks,
waste management, item location, leakage detection, intelligent shopping and many more things thus converting an urban city into a “SMART CITY” which can help us reduce waste and improve efficiency for things such as energy use. The communication takes place between people-people, people-things, and things-things. The main objective of this project is to create an urban IoT system that helps to achieve the Smart City vision by exploiting the most advanced communication technologies to support value-added services for better administration of the city. This project also focuses on solving the domestic problems of the citizens by implementing Smart homes as one of the aspect of Smart City. The smart cities provide effective and efficient handling of resources.

2. Related Work

Andrea Zanella, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, Michele Zorzi [1] proposed a comprehensive survey of the enabling technologies, protocols, and architecture for an urban IoT. Furthermore, this paper presented the technical solutions and best-practice guidelines adopted in the Padova Smart City project, a proof-of-concept deployment of an IoT island in the city of Padova, Italy, performed in collaboration with the city municipality. In this paper, the solutions currently available for the implementation of urban IoT were analysed.

Mohanad Ibrahim, Abdelghafor Elgamri, Sharief Babiker, Ahmed Mohamed [2] proposed an approach to build a cost effective standardized environmental monitoring device using the Raspberry-Pi (R-Pi) single-board computer. The system was designed using Python Programming language and could be controlled and accessed remotely through an Internet of Things platform. It took information about the surrounding environment through sensors and uploaded it directly to the internet, where it could be accessed anytime and anywhere through internet. This approach efficiently measured temperature, humidity, light level and concentrations of the carbon monoxide harmful air pollutant.

Basavaraju S R [3] proposed a design for Smart Parking System (SPS) which enabled the user to find the nearest parking area and gave availability of parking slots in that respective parking area. This paper mainly focused on reducing the time in finding the parking lots and also it gave solution to avoid the unnecessary travelling searching through filled parking lots in a parking area. Thus it proposed a smart system to reduce the fuel consumption which in turn reduced carbon footprints in an atmosphere. This design of automatic smart parking system is simple, economic and provides effective solution to reduce carbon footprints in the atmosphere.

Thinagaran Perumal, Md Nasir Sulaiman, Leong.C.Y [4] proposed an IoT based water monitoring system that measures water level in real-time. A water level sensor is used to detect the desired parameter, and if the waterlevel reaches the parameter, the signal will be feed in real time to social network like Twitter. A cloud server was configured as data repository. The result of the proposed system clearly indicates the reliability of the system in providing consistency reading throughout the sampling period.

Sean Dieter Tebje Kelly, Nagender Kumar Suryadevara, Subhas Chandra Mukhopadhyay [5] reported an effective implementation for Internet of Things used for monitoring regular domestic conditions by means of low cost ubiquitous sensing system. The framework of the monitoring system was based on a combination of pervasive distributed sensing units, information system for data aggregation, and reasoning and context awareness. Results
were encouraging as the reliability of sensing information transmission through the proposed integrated network architecture is 97%. The key idea of the proposed method was to provide a low-cost solution and flexible connection mechanisms for integrating Internet of things with home monitoring systems.

Catalin Negru, Mariana Mocanu, Costin Chiru, Aurelian Draghia, Radu Drobot [6] proposed a cost-efficient cloud-based service oriented architecture for water pollution prediction and alert system. The cost efficiency of this approach comes from the three main directions. The first way was represented by the usage of less water monitoring specific sensors due to the usage of complex hydraulic models. The second direction was represented by the construction of a knowledge-base with pre-run scenarios of pollution propagation events. The third direction was represented by the usage of cloud computing services which were proven to be cost effective. The analyzed scenarios represented only a first phase in developing the database with more complex scenarios, considering unsteady flows on Dambovita river and its tributaries for a large set of pollution events.

Ruchika Ruchi Taneja, Orlando Remédios, Artur Arsenio [7] proposed and evaluated on a real deployment of cloud-based Wireless Sensor and Actuator Network (WSAN) communication system. This solution helps to monitor and control a set of sensors and actuators, respectively, to assess plants water needs. This paper proposed a cloud-based solution for a smart irrigation system organized as a Wireless Sensor and Actuator Network (WSAN). A remote web service is employed to optimize the system with weather knowledge.

Adil Bashir, Shoaib Amin Banday, Ab. Rouf Khan, Mohammad Shafi [8] proposed a system that automates the solid waste monitoring process and management of the overall collection process. This proposal for the management of wastes is efficient and time saving process than the currently employing method in which concerned municipal employee has to look for the filled waste bins manually. The Automatic waste management system reduces the human effort and consequently the cost of the whole process. This system can be implemented at any place with ease and within reasonable amount of time. The overall method for the detection and management of waste becomes efficient and intelligent.

Keerthi.v, Dr.G.N.Kodandaramaiah [9] explained the design and implementation of an electronic system based on GSM (Global System for Mobile communication), cloud computing and Internet of Things (IoT) for sensing the climatic parameters in the greenhouse. This paper proposed a system that can monitor a variety of environmental parameters in greenhouse effectively and meet the actual agricultural production requirements. The parameters that were collected by a network of sensors were stored online using cloud computing and Internet of Things (IoT) together called as Cloud IoT.

Parkash, Prabu V, Dandu Rajendra [10] proposed a system for designing and executing the advanced development in embedded systems for energy saving of street lights. This project gives solution for electrical power wastage. The proposed system provide a solution for energy saving. This is achieved by sensing and approaching a vehicle using an IR transmitter and IR Receiver couple.
3. Methodology

This project uses Raspberry Pi (a single computer) to control and manage various sensor data and sends the data to the server. Raspberry Pi is a low power consuming, better performing, IoT supported hardware device. The project provides a user interface display device through which users can find access to the data stored at server. This project proposes to be able to manage the city’s aspect by constructing smart parking centres that reduces the travelling time of searching for a parking spot and thus reduces emission of hazardous air pollutants in atmosphere, smart water monitoring systems that helps in monitoring level of water, smart environment monitoring system that senses the temperature and humidity of the surrounding area. This project defines an effective method for waste management system in cities. The architecture of smart city is as shown in figure 1.

![Figure 1. Architecture of Smart City](image)

A. Raspberry pi

The Raspberry Pi is a series of credit card-sized single-board computers developed by the Raspberry Pi Foundation. It features a Broadcom system on a chip, which includes an ARM compatible CPU and an on chip graphics processing unit. CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 and on board memory range from 256 MB to 1 GB RAM. Secure Digital cards are used to store the operating system and program memory in either the SDHC or Micro SDHC sizes. Most boards have between one and four USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio. Lower level output is provided by a number of GPIO pins which support common protocols like PC. The B-models have an 8P8C Ethernet port and the Pi 3 has on board Wi-Fi 802.11n and Bluetooth.
**B. Node red**

Node-red is a tool for wiring together hardware devices, APIs and online services. Node-RED provides a browser based flow editor that makes it easy to wire together flows using the wide range nodes in the palette. Flows can be then deployed to the runtime in a single-click. JavaScript functions can be created within the editor using a rich text editor. A built-in library allows to save useful functions, templates or flows for re-use. The light-weight runtime is built on Node.js, taking full advantage of its event-driven, non-blocking model. The flows created in Node-RED are stored using JSON which can be easily imported and exported for sharing with others. An online flow library allows you to share your best flows with the world.

**4. Hardware Used**

**A. Ultrasonic sensor**

Ultrasonic sensors are devices that use electrical– mechanical energy transformation to measure distance from the sensor to the target object. Ultrasonic waves are longitudinal mechanical waves which travel as a sequence of compressions and rarefactions along the direction of wave propagation through the medium. Ultrasonic distance measuring sensors provide information on an absolute position of a target or moving object. For glossy surfaces, transparent objects or in environments with a high degree of dust and humidity, ultrasonic technologies are often the only alternative to mechanical probing. Applications for ultrasonic distance measuring sensors include level detection, stack height control as well as absolute position feedback.

A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor.

The basic principle of operation:

i. Using IO trigger for at least 10us high level signal,

ii. The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

iii. IF the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning.

iv. Test distance = (high level time×velocity of sound (340M/S) / 2.

The hardware architecture and pin configuration of ultrasonic sensor HC-SR04 is as shown in figure.2

![Figure 2. Pin description of HC-SR04](image)
B. PIR sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects in its field of view. They are most often used in PIR-based motion detectors. All objects with a temperature above absolute zero emit heat energy in the form of radiation. Usually this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be detected by electronic devices designed for such a purpose. An individual PIR sensor detects changes in the amount of infrared radiation impinging upon it, which varies depending on the temperature and surface characteristics of the objects in front of the sensor. When an object, such as a human, passes in front of the background, such as a wall, the temperature at that point in the sensor's field of view will rise from room temperature to body temperature, and then back again. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection.

C. DHT11

A humidity sensor senses, measures and regularly reports the relative humidity in the air. It measures both moisture and air temperature. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature. Humidity sensors detect the relative humidity of the immediate environments in which they are placed. They measure both the moisture and temperature in the air and express relative humidity as a percentage of the ratio of moisture in the air to the maximum amount that can be held in the air at the current temperature. As air becomes hotter, it holds more moisture, so the relative humidity changes with the temperature. Most humidity sensors use capacitive measurement to determine the amount of moisture in the air. This type of measurement relies on two electrical conductors with a non-conductive polymer film laying between them to create an electrical field between them. Moisture from the air collects on the film and causes changes in the voltage levels between the two plates. This change is then converted into a digital measurement of the air’s relative humidity after taking the air temperature into account.

5. Proposed Work

A. Home automation

Home automation is the control of any or all electrical devices in our home or office. There are many different types of home automation system available. Home automation should provide a user friendly interface on the host side, so that the devices can be easily setup, monitored and controlled. In smart home systems, the internet is used to ensure remote control. This system can be used in several places like banks, hospital, labs and other sophisticated automated system, which dramatically reduced the hazards of unauthorized entry. The main reason to develop this system is to save time and man power along with maintaining security and convenience.

Raspberry Pi is used as a controller for various devices at home. The raspberry pi is connected to a Wi-Fi network of a local server and various devices are connected to the output pins of raspberry pi. The raspberry pi is
connected to a constant power supply. The pins of the raspberry pi are configured through Node-Red and a user interface is created using Node-Red. This system is used to monitor and control the various equipment that are connected to the input from raspberry pi model as well as from the WEB UI. Whenever the system is turned on, the current data of the home are read transferred to the user interface. So, one can easily know the current situation of rooms and change in the state of the lights. The WEB UI is used to change the states of the devices.

B. Waste management

A greatest concern of cities is solid waste management which if not attended to immediately and appropriately causes adverse effects on the environment and society. Waste management is a continually growing problem at global and local levels. To overcome this problem, waste management system must be executed. The increased dumping of wastes in the bins causes overflow which results in scattering of wastes outside the bin. Automatic monitoring system using IoT helps in finding the filled bins and sends message to authority members indicating the need of a replace.

A sensor connected to Raspberry Pi monitors the bins continuously and shows the status of the bins in a web page. Each bin is given a particular identification number to avoid confusion regarding the location of the bin. If the bins are full, the Pi switches on a lamp to indicate the attainment of allowable level and it sends a tweet message containing the information about the bin number and the capacity to the concerned authority requesting collection of waste from the particular bin. The Automatic waste management system reduces the contamination of environment. This system can be implemented at any place with ease and within reasonable amount of time. This system is used to monitor and control the level of waste filled in a bin using ultrasonic sensor that is connected to the input of raspberry pi. The ultrasonic sensor is used to measure the level of waste in the bin by sending ultrasonic waves and by reading the reflected wave. The time difference between the sent wave and the reflected wave is measured and the distance of the waste can thus be calculated from knowing time and the rate at which the waves are transmitted. The ultrasonic sensors work in any lighting condition. As soon as the system is turned on, the current level of the waste in the bin is read and the system keeps on reading the value. Once the threshold value is reached the system sends a message to the in-charge with a note clearly stating the level of waste in the bin and the bin number that needs to be cleaned.

C. Environmental monitoring

In day to day life, environmental parameters play a major role in determining the climate and the weather. The knowledge on the environmental parameters helps in preparing to the upcoming climate and weather conditions rather than leaving unprepared. The climate has effects on human health also. The temperature and humidity in air can state the weather for the day. By monitoring temperature and humidity in air, this system sends appropriate message to the user relative to the weather condition. This system proposes an approach to build a cost effective standardized environmental monitoring device using the Raspberry-Pi (R-Pi) single-board computer. The system was designed using Python Programming language and can be controlled and accessed remotely through an Internet of Things platform. It takes information about the surrounding environment through sensors and uploads it
directly to the internet, where it can be accessed anytime and anywhere through internet. This approach efficiently measures temperature and humidity and sends message to the user saying whether to take umbrella, what to eat etc. The temperature and humidity is measured using DHT11 sensor. The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It is fairly simple to use, but requires careful timing to grab data. The temperature and humidity values are continuously monitored and if there is a noticeable change in climatic conditions like possibility of rain or a storm the system sends a message to the user mentioning the requirements to be taken care of for the day. The block diagram of smart city using raspberry pi is as shown in figure 3.

![Figure 3. Block Diagram of Smart City](image)

**D. Water management**

Water is one of the essential resources for all living beings. Due to lack of monitoring, water can’t be supplied properly, some areas in city get water while other some areas don’t. This explains the need of continuous monitoring, water supply scheduling and proper distribution of water. By properly monitoring the level of water which always is faced by many challenges, the efficient use of water resources can be planned. For example, in the case of frequent overflow of water, a water monitoring system is vital, as it can give a prior alert to consumers to perform necessary actions. Internet of Things based water monitoring can give alerts to people through e-mails, text messages, tweet etc. Water is purified in treatment plants and stored in reservoirs from where they are supplied to homes. There are possibility of overflow of water in the reservoirs which must be monitored regularly to avoid wastage. By using Raspberry Pi connected to internet, the sensors can be given the authority of controlling water overflow in reservoirs. Ultrasonic sensor is used to measure the level of water and upon reaching threshold, the overflow is indicated in webpage and a lamp in switched on.
E. Parking system

Internet of Things (IoT) plays a vital role in connecting the surrounding environmental things to the network. In modern world people are facing problems on parking vehicles in parking slots in a city. This system proposes a design for Smart Parking which enables the user to find the nearest parking area and gives availability of parking slots in that respective parking area. This system mainly focus on reducing the time in finding the parking lots and also it avoids the unnecessary travelling through filled parking lots in a parking area. Thus it reduces the fuel consumption which in turn reduces carbon footprints in an atmosphere. The smart parking service is based on sensors and intelligent display that direct motorists to available parking lots. The benefits deriving from this service are manifold faster time to locate a parking slot means fewer CO emission from the car, lesser traffic congestion. The smart parking system uses Raspberry pi and ultrasonic sensor to detect the empty parking spaces and sends this data to server, this stored data is accessed by users. This enhances the user to check the status/availability of parking spaces before setting their journey. The major challenge is to use the existing resources in optimum level to reduce the searching time, traffic congestion in the city. The Smart Parking System is designed by making use of raspberry pi board which is an IOT supportable hardware. Raspberry Pi helps to develop a system with less cost and with more performance. The services offered by smart city and their applications are shown in figure 4.

![Figure 4. Applications of Smart City](image)

6. Conclusion

A city can be transformed into a Smart city by integrating various aspects of technology, communication, cloud computing and by providing advanced and easy user interface systems through browsers and mobiles. To manage various parts of the city, a network of sensors must be made to monitor the relevant parameter continuously and data from the sensors must be stored and processed. In addition to this, cost and power consumption must be made as low as possible. To achieve this, highly efficient micro controller called Raspberry Pi can be used which can connect to various sensors and provides internet connectivity that can be used to implement Internet of Things.
REFERENCES


