IoT Based Advanced Embedded Design Automation for Smart City Application

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Abstract-The concept of Smart City IoT is a comprehensive and layered framework that caters to the needs of multiple facets of projects related to smart city and thus allowing cities to utilize urban networking in order to increase economic prowess, and build more efficient, unique technological solutions to deal with the numerous challenges of the city. Smart City is the product of advanced development of the new era of information technology and smart economy, based on the mesh networking of the Internet, telecommunications network, broadcast network, wireless networking and other end-to-end sensor networking where Internet of Things technology (IoT) as its heart. The Internet of Things is modular approach to integrate sensor. Into everyday objects, and inter connecting them over the internet through specific protocols for exchange of information and communications. Also, a lot of analytical information is generated in this process which is of extreme use in determining what changes should be made in which area. However, to ensure seamless services in an IoT-enabled smart city environment, all the applications have to be maintained with limited energy resources. This paper hence provides a comprehensive survey of the enabling technologies, protocols and architecture for an urban IoT. In this paper we focus specifically to an urban IoT system that, while still being quite a broad category, are characterized by their specific application domain.

Keywords: Internet of Things, mesh, network, devices, smart city, Sensor System Integration, Wireless Technology.

I. INTRODUCTION

The IoT is a recent communication paradigm that envisions a near future in which the objects of everyday life will be equipped with micro-controllers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet [1]. The IoT concept, hence, aims at making the Internet even more immersive and pervasive. Furthermore, by enabling easy access and interaction with a wide variety of devices such as, for instance, home appliances, surveillance cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will foster the development of a number of applications that make use of the potentially enormous amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations. This paradigm indeed finds application in many different domains, such as home automation, industrial automation, medical aids, mobile health care, elderly assistance, intelligent energy management and smart grids, automotive, traffic management and many others [2].

IoT is a system comprising of physical devices, modern vehicles, buildings and even essential electrical devices which we use on a regular basis inter-connected to each other over the internet so that they can collect and exchange data among themselves. The IoT enables us to control the working of these devices remotely across an already established network infrastructure, thus enabling a more direct implementation of computer controlled systems into the physical world. This in turn caters to an increase in efficiency, reliability, precision and speed of the systems and thus leads to lesser human intervention. When augmented with sensors and actuators, it becomes a part of the cyber-physical system which is the core of implementation of a smart city [3]. Although there is not yet a formal and widely accepted definition of “Smart City” the final aim is to make a better use of the public resources, increasing the quality of the services offered to the citizens while reducing the operational costs of the public administrations. This objective can be pursued by the deployment of an urban IoT, i.e., a communication infrastructure that provides unified, simple, and economical access to a plethora of public services, thus unleashing potential synergies and increasing transparency to the citizens. An urban IoT, indeed, may bring a number of benefits in the management and optimization of traditional public services, such as transport and parking, lighting, surveillance and maintenance of public areas, preservation of cultural heritage, garbage collection, salubrity of hospitals and school [5]. These implementation of IoT are the building blocks to a much larger accomplishment, which could be achieved with the synchronization of these small automations. The mutual co relation between these individual automations can lead to the establishment of a smart city, where every unit of electrical device communicates with one another to work in perfect harmony which can potentially lead to an automated city[].The objective of this paper is to discuss a general reference framework for the design of an urban IoT. We describe the specific characteristics of an urban IoT, and the services that may drive the adoption of urban IoT by local governments. We then overview the web-based approach for the design of IoT services, and the related protocols and technologies, discussing their suitability for the Smart City environment. Finally, we substantiate the discussion by reporting our experience in the "Padova Smart City" project, which is a proof of concept IoT island deployed in the city of Padova (Italy) and interconnected with the data network of the city municipality. In this regard, we describe the technical solutions adopted for the realization of the IoT island and we report some of the measurements that have been collected by the system in its first operational days.

II. SMART CITY CONCEPT AND SERVICES

In this world of information and assets are provisions of being on the top of millions of real-time interacting and communicating devices, these are systems based on Internet of Things (IoT) technologies which are aimed at exploiting these assets in quintessentially resilient and sustainable way which allows them to reach their full potential. According to [], the Smart City market is estimated at hundreds of billion dollars by 2020, with an annual spending reaching nearly 16 billions. This market springs from the synergic interconnection of key industry and service sectors, such as Smart Governance, Smart Mobility, Smart Utilities, Smart Buildings, Smart Environment.

Wireless sensor actuator networks are sensors whose main purpose is to oversee environmental and other external factor. All the data generated during monitoring is then stored to generate relevant information. Many environmental sensors help to detect environmental factors such as temperature, pressure, humidity etc.

M2M communication means the communication between two machines without involvement on humans. The devices may communicate with either wired or wireless methods. The data which is being generated by this communication is then further analyzed by humans to extract necessary information. Smart cities wouldn't be possible without machine to machine communication. A M2M communication system generally composed of sensors, RFID's and a network system.

III. PROPOSED METHODOLOGY

a. Waste Management: Waste management is a primary issue in many modern cities, due to both the cost of the service and the problem of the storage of garbage in landfills. A deeper penetration of ICT solutions in this domain, however, may result in significant savings and economical and ecological advantages. In this framework dustbins are arranged at different locations. The Smart clean dustbins are related with the web to get the ongoing status. Two ultrasonic sensors are settled at the highest point of the dustbin to avoid inaccurate level measurement and is interfaced with PIC microcontroller. Weight sensor is placed at the base of the dustbin and is additionally interfaced with controller to recognize over weight of the junk filled in the dustbin. Both sensors send the signals to the controller. The RF-transmitter encode the information originating from PIC and send to Arduino unit which acts as receiver, it sends the information to RF-collector which is associated with the Arduino Ethernet shield. Arduino collects information received by the collector and transfer on website page through the Ethernet shield.

Figure 3.1 Block diagram of proposed system

Ultrasonic sensor is used to check the level status of dust bin so to determine if it is full or empty, while Load cell senses the weight of the garbage present in the dustbin and to determine if the threshold limit is reached or not. Algorithm has developed which checks filled level continuously and if dustbin is filled to its maximum limit then there is indication on LCD display at the same time the encoded signal will be transferred by RF transmitter. RF receiver receives the data which is then transferred to the arduino modem connected with the Ethernet shield. Active status of dustbin is shown on web page using connections through Ethernet shield. Simplified flowchart of proposed system is shown in figure (3). Monitoring the webpage will help the garbage collection department to track for the exact location and amount of the garbage. The garbage vehicles can then unload the garbage from a particular location. The function of GSM module is to send a message to the garbage collection department.

Figure 3.2 System flowchart

Air quality**:** The targets call for a 20 percent reduction in greenhouse gas emissions by 2020 compared with 1990 levels, a 20 percent cut in energy consumption through improved energy efficiency by 2020 and a 20 percent increase in the use of renewable energy by 2020. To such an extent, an urban IoT can provide means to monitor the quality of the air in crowded areas, parks or fitness trails [17]. In addition, communication facilities can be provided to let health applications running on joggers' devices be connected to the infrastructure. This system senses four parameters. They are carbon di-oxide, LPG gas, colour of Water and fire. These pollutants when released from industries or when fire is detected the system gets activated. When carbon di oxide goes above the defined level or threshold value the system gives an alarm to the authority. If the authority does not take any actions system automatically stops the motors. Similarly when _re is detected an alarm is given and if no actions are taken by the authority automatically exhaust fans will get on. Waste water from industries is checked based on the colour of the water. If the colour of the water is darker it means it is more polluted. This system senses the colour of the water and when it gets too dark the alarm is given and if no actions are taken the motors get off. The LPG when leaked is detected and after the alarm if no actions are taken the boilers are switched off. This system is also monitored using IOT the internet of things. Whenever the parameters cross the limits the values are updated. These updated values can be viewed anywhere and anytime by opening the link given through internet. The inputs from sensors given are interfaced with IOT and made available online all the time so anyone who has the link can view the condition of the parameters.

Figure 3.3 Block diagram of proposed system

Smart lighting**:** This project provides a better solution for streetlight control and automation. The system consists of LDR, relays, microcontroller, temperature & humidity sensor, and some electronic components. LDR Light Dependent Resistors are light sensitive devices. They are made up of semiconducting materials with high resistance. LDR works under the principle of photoconductivity in which conductivity of the material gets reduced by the absorption of light. . Arduino microcontroller is used to control the relays and to fetch the data from the sensors to the database through Wi-Fi module. The entire system can be monitored and controlled by a central system through a web interface. A central database is created to fetch data from all individual systems which can simultaneously control up to eight lights. The conventional lamp is replaced by smart LED light technology which consumes low power and provides high-intensity light and effectively illuminates the surrounding.

Figure 3.4 Architecture of smart street light

All the LEDs (Street lights) are used to connect with the relays which enables the LEDs for their switching ON/OFF according to the instructions given to it. And the instructions are carried out through ULN2003 relay driver from Arduino by sensing the data from LDR connected to it. Using the DHT11 temperature and humidity sensor, the data of the specific area is sensed and send it to the server using the ESP8266 Wi-Fi module which is connected to internet. And sends the weather and status of the street lights to the server which is controlled by a central control and monitoring system. Fig.1 explains the architecture of the system.

Traffic congestion**.** The system design uses IoT and wireless Technology addresses real-time traffic monitoring application. Array of ultrasonic sensors used to detect traffic level which mounted at road sides. It is road side infrastructure which interfaced with controller which data sends to server through Wi-Fi module. Here shown at the intersection, road side sensors equipped to detect traffic level at signals. If first lane detect high level traffic then priority gives to this lane means more time to pass vehicles. Road side sensors interfaced with Road Side Unit (RSU).Road side unit consists of controlling and monitoring unit, web server unit and Wi-Fi module. At signals traffic signal control method used to detect traffic level at lanes by ultrasonic sensors. Signals controlling by microcontroller according to sensing data at lanes, which is processes and sends to server by Wi-Fi module. This entire system equipped at road sides using wireless sensor network. The Overall architecture of proposed system is shows in

Figure 3.5 Flowchart of traffic monitoring system

Road side sensors are detecting vehicles and find traffic levels, such as low, medium and high which equipped at particular distance gap. The sensing data continuous sends to controller for detecting traffic levels. If any lane detects traffic level is high then controller controls signal timing at that lane and gives more time to pass vehicles. If low traffic level detects then controller controls signal timing at that lane gives less time to pass vehicle. So this system controls traffic congestion at intersection. The monitoring data displays on the Liquid Crystal Display (LCD) unit. The information about traffic levels and its time and date sent to server, which is authorize open source. This data analyzed by IoT analytics and stored in the server database for future analysis. The block diagram of proposed system is shows in

Figure.3.6 Block diagram

Block diagram of proposed system shows interfacing of ultrasonic sensors to ARM 7 controller, which is input side of system. ARM 7 also interfacing with LCD display unit for output, LED's signal for controlling signal display time a Wi-Fi module to transfer data to server.

Smart parking. The transitions indicate the flow of the data between the database and the rest of the components. As the fig. suggests the user has to first register himself through the mobile application which indeed stores his information onto the server. This data is useful to track the user later if he tries to breach the system policies. After registering into the parking system his user has the privilege to go into the application and checkout for a free parking space available and then he can actually go and park his bike there. The application is updated each time when the bike is detected on the parking area with the help of IR sensors. IR sensors are responsible to detect if a particular slot contains bike or not. Vehicle identification is done with the help of RFID tags which are present on each bike which in deed helps us in calculating the amount to be paid by each user separately. RFID readers are present on the parking area which captures the RFID information of each user. Before generating the parking bill, IR sensors and RFID tags work together to know which vehicle is being parked and depending on the time and the amount the corresponding bill is generated. Raspberry PI3 is a processor which performs all of the above functions through the use of Internet. Payment of the parking bill is done through online banking which will be done using the mobile application. All of the data generated above is stored and retrieved from the database. The tracking system is an integration of several modern embedded and communication technologies. To provide location and time information anywhere on earth, Global Positioning System (GPS) is commonly used as a space-based global navigation satellite system. The location information provided by us GPS systems can be visualized using Google Earth technology. The implemented tracking system can be used to monitor various parameters related to safety, emergency services and engine stall.

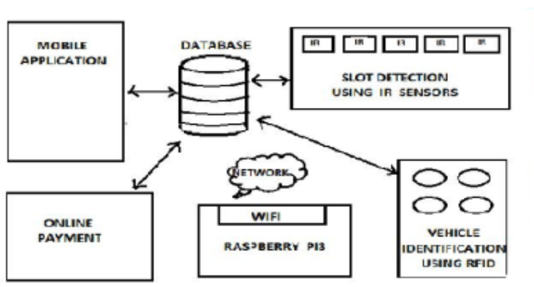


Fig 3.7: Architecture of Proposed System

Structural health of buildings**.** Guided wave techniques are widely used to detect damage in structures due to its sensitivity to different changes in the structure. Damage localization is based on determining the time for the signal to travel from the source to the damage and reflected back i.e. Time of Flight (TOF). There are two basic active sensing techniques used to detect damage in structures; Pitch-catch and pulse-echo. In the pitch-catch technique, two PZT sensors are used; one as a transmitter and the other as a receiver. The received signal from the transmitter is used to determine the location and/or the extent of the damage. On the other hand, the pulse-echo technique relies on the reflected wave from the damage, and one PTZ sensor is used for both transmitting and receiving the signal. A combination of Pitch catch and pulse-echo techniques is proposed to check structure health in this proposed work, and will allow for determining the damage location and size. Fig. 1 shows the proposed technique.

IV. SIMULATION/EXPERIMENTAL RESULTS

Prototype analysis of smart city components

A. Waste management system.

Table (1) .Experimental data from several tests run of the prototype of smart bins.

Test No.	Level sensor A (cm)	Level sensor B (cm)	Weight (Kg)	Status
1	0.32	0.51	0	Almost empty
2	1.28	1.04	0.30	Partially filled
3	3.81	4.15	0.42	Partially filled
4	8.37	8.94	0.75	Partially filled
5	-	-	1.6	Overload
6	22.30	23.47	1.5	Almost full
7	15.93	11.59	1.24	Partially filled
8	15.92	9.84	0.95	Partially filled
9	15.95	10.29	1.1	Partially filled
10	0.75	0.85	0.15	Almost empty

B. Traffic monitoring

FIG :4.1 First Lane Traffic Level.

FIG:4.2 SECOND LANE TRAFFIC LEVEL

C. SMART STREET LIGHTNING

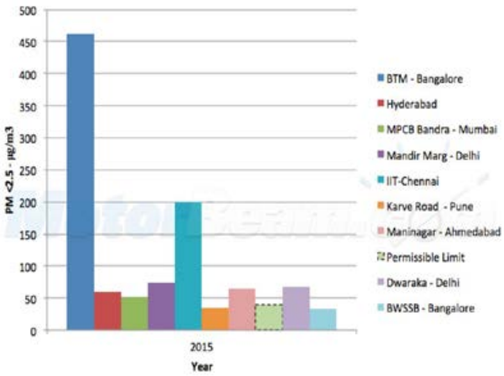
FIG: 4.3 EXPLAINS THE RESULT OBTAINED FROM THE SMART SYSTEM.

D. SMART PARKING SYSTEM

Fig: 4.4 Booking of a parking slot

FIG: 4.5 Selecting the amount of time

E. AIR POLLUTION MONITORING



V. CONCLUSION

As we have observed that number of smart devices is increasing exponentially due to which the implementation of smartness in the cities can be achieved more easily. In the coming days we will see more and more of smart cities and also digitization of various public and private sectors Internet of things is to create a panorama where the world of objects will be digitally sensed and located simultaneously reducing all barriers and paving the way of new aspiration of smart cities.

Smart city challenges can be changed into chances to create a techno ocean by formulating innovative ideologies just by accepting the involvement with the local sublime.

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