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Intelligent Bin and Environment Monitoring System using IOT for Smart Cities

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Abstract: The Internet of Things is a novel cutting edge technology that proffers to connect a plethora of digital devices endowed with several sensing, actuation, and computing capabilities with the Internet, thus offering manifold new services in the context of a smart city. The appealing IoT services and big data analytics are enabling smart city initiatives all over the world. These services are transforming cities by improving infrastructure and transportation systems, reducing traffic congestion, providing waste management, and improving the quality of human life. In this article, we devise a taxonomy to best bring forth a generic overview of the IoT paradigm for smart cities, integrated ICT, network types, possible opportunities and major requirements. Moreover, an overview of the up-to-date efforts from standard bodies is presented. Later, we give an overview of existing open source IoT platforms for realizing smart city applications followed by several exemplary case studies. In addition, we summarize the latest synergies and initiatives worldwide taken to promote IoT in the context of smart cities. Finally, we highlight several challenges in order to give future research directions.
Keywords: *Internet of things (IoT), Smart City, communication technologies.*

1.INTRODUCTION

Due to the rapid growth of the population density in urban cities, infrastructure and services are required to provide the necessities of the city residents. On this basis, there is a significant increase for digital devices, e.g. sensors, actuators, and smart phones that drive to huge business potentials for the IoT, since all devices can interconnect and communicate with each other on the Internet. The IoT prototype is subject to smart and self-configuring objects that are connected to each other through a global network infrastructure. IoT is mostly considered as real objects, broadly scattered, with low storage capability and processing capacity, with the target of improving reliability, performance and security of the smart city and its infrastructures. With this knowledge, an IoT – based smart city system is proposed. Smart cities have become smarter than before thanks to the recent developments of digital technologies. The emerging IoT market is continuously gaining momentum as operators, vendors, manufacturers, and enterprises begin to recognize the opportunities it offers. A smart city is equipped with different electronic elements employed by several applications, like street cameras for observation systems, sensors for transportation systems, etc. In addition, this can spread the usage of individual mobile devices. Therefore, by considering the heterogeneous environment, different terms, such as features of objects, contributors, motivations and security rules should be investigated. In the IoT context, devices can be integrated based on the geographic location and evaluated by using an analyzing system.

Sensor services for the collection of particular data can be used with several occurring systems concerning the monitoring of cyclists, vehicles, public parking lots, etc., There are many service domain applications that use an IoT infrastructure in order to facilitate operations in air and noise pollution, the mobility of vehicles and surveillance systems. The revolution of the Internet provides an infrastructure in which many people are able to interconnect to each other. The next revolution of the Internet will make it possible to provide suitable interconnections among the objects. In 2011, the number of objects that are interconnected together was much more than the number of people. A smart city is a complex ecosystem characterized by the intensive use of ICT, aiming at making the cities more attractive, more sustainable and a unique place for innovation and entrepreneurship. The major stake-holders include application developers, service providers, citizens, government and public service providers, research community, and platform developers. Furthermore, the smart city cycle consists of numerous ICT technologies, development platforms, maintenance and sustainability, Apps for evolving citizens, and technical, social as well as economic key performance indicators (KPIs). Consequently, IoT systems will play a fundamental role in the deployment of largescale heterogeneous infrastructures. Several research efforts have been made to integrate IoT with smart city environments. Smart technology for smart cities can be implemented in sectors such as power supply, public

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transportation systems, sanitation, solid waste man
etc.

The objective of the proposed system is to desig
with automated street lights which will be energy effic
with smart garbage bins.

To measure the air pollution, upload all the parameters measured to the cloud and also to analyse the stored data in order to provide better services to the citizen.

Fig: IOT Based Smart City Applications

2. RELATED WORK

Various works have been carried out on smart city. As there is a rapid advancement in technologies, smart city project can be achieved using one of these different technologies. Architecture of an IoT based middle ware for smart city which will act as a communication layer between the heterogeneous systems in the city, giving the authorities control over the infrastructure and data. This architecture will help the authorities operate more efficiently in a vendor agnostic environment and will motivate them to implement innovative business models which will lead to autonomous self-driven cities. This IoT middle ware system consists of a messaging system, a queuing and a routing system which can route data to any analysis platform. One of the major advantages for going for a middleware for all IoT systems in a smart city is that the hardware utilization for communication will be maximized and the capex & opex cost will be minimized, compared to multiple end-to-end systems. The proposed system makes use of weather and human activity sensors for the implementation of the Dynamic street light system. In this paper they have relied on two categories of indicators which are deemed relevant to dynamic street light control. The first category is a set of environmental indicators. Sensed with a weather station, the main environmental indicator is luminosity. The second category of indicators describes the activity on the street.

The advanced smart lighting system framework which adjusts the intensity of the light according to needs or according to the time. The results of these proposals show that the consumption of electricity gets reduced to about 50% but the main drawback of his system was that it consumes some amount of electricity when the natural lights intensity value is not above a given value or when the street lights are stated to function according to the given time parameters even when there is no need of street lights.

Life cycle of urban data in Chinese smart cities. Life cycle consists of three phases namely data collection that is followed by data analysis

The analyzed data is then used for providing smart services to the citizens. There are various project challenges faced in smart cities project. Data is owned by government or the IT companies which is not made open to the citizen limiting the citizen participation in making smart solutions to the urban problems. Second issue faced is the top-down approach is adopted for smart cities. This approach makes services being delivered are deficient and hence preventing local innovation.

Dynamic street light control from a Hardware perspective. The work aimed at developing a low cost, low power micro–controller to dynamically adjust the light levels of LED street luminaries. Few sensors have been integrated to the micro–controller board in order to implement light control rules, based only on environmental factors. Arduino UNO At mega 328PPU has been selected as the controller in this system due to the low cost, compatibility, compact size and easy interfacing over several type of other controller including Field Programmable Gate Array (FPGA), Programmable Logic Controller (PLC) and Programmable Integrated Circuit (PIC) LCD and light intensity are the two outputs used in the proposed system and connected to the micro-controller. However, the system has been tested only in Indoor environment.

3. THE ACTUAL IOT APPLICATIONS FOR SMART CITIES

A. A. Healthcare

In the healthcare domain, IoT technologies have many advantages in smart cities. Some of those applications are tracking of people and objects including patients, staff and ambulance, identification of people, and automatic data gathering and sensing. In terms of people and objective tracking, the status of patients in a clinic or hospital is monitored in order to provide better and faster work-flow in the hospital. The location of the ambulance, blood products and different organs for transplantation are monitored to check the availability on-line. In terms of people identification, in a database, patients are recognized to decrease the risk of mistake for prevention of getting wrong drugs, doses and procedures. The staff authentication aims to improve the employee's behaviour toward patients. Regarding the data collection and sensing, it helps to save time for data processing and preventing human errors. Through sensor devices, diagnosing patient conditions, providing real-time information on patient health indicators such as prescription compliance by the patient is implemented. By using bio-signal

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monitoring, the patient condition is investigated through heterogeneous wireless access-based methods to enable getting the patient data anywhere.

B. B. Water and Weather Systems

Weather systems use diverse sensors to supply proper data such as temperature, rain, solar irradiation and wind speed, as well as to help enhance the efficiency of a smart city. Besides the electricity one, water distribution systems are essential parts of every smart city.

Conventional methods of water distribution from the water source to the customer premises are not suitable and efficient, especially for diagnosing any leakage in the pipeline or other parts of the system.

Therefore, by deploying sensors at appropriate locations of the distribution system, it becomes an intelligent one for detection of any kind of faults or other applications. Water distribution systems have some parts including a water source like a lake or a river, storage facilities like reservoirs, and distribution networks like under- or aboveground pipelines which can be seen in Figure. Detection of faults like leakage, the quality of water and the level of reservoir water can be implemented through placing sensors in an IoT-based environment. Figure demonstrates the location of sensors in different parts of water distribution systems. Accordingly, within a storage tank, the level of water is measured by placing an ultrasonic sensor on the top of the tank, and two pressure transducers at the bottom. The quality of water can be measured both after and before the storage tank at strategic locations by a glass electrode for measuring water pH. The leakage can be detected in pipelines through three different sensors including vibration (using dual-axis accelerometers), pressure (piezo-resistive sensor) and sound (ultrasonic sensor) monitoring which can be seen in the left part of Figure.

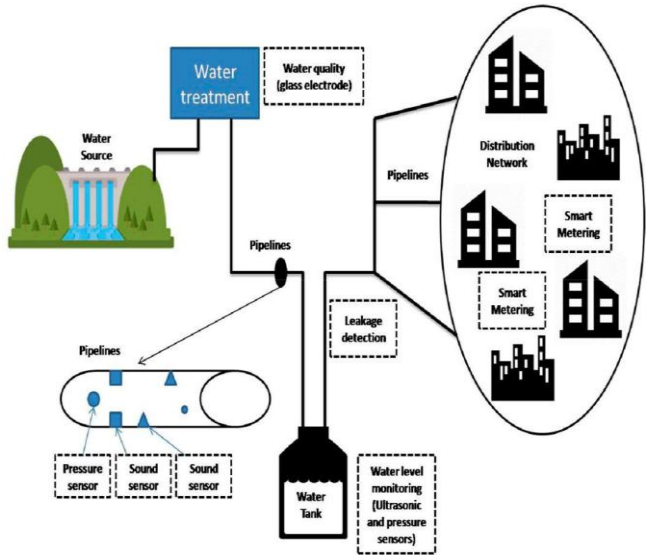

Fig: Smart water distribution.

Aside from when a city experiences too much or too little rain, many of them face severe problems with water. According to the requirements of a region, local utilities can develop innovative methods to plan and manage irrigation, solving excessive water consumption, improvement of water conservation and allocating their scarce resources more effectively, addressing flooding and wastewater management during a storm through IoT. Dumping raw sewage into the local waterways will occur unavoidably in a region without any management and plan. IoT helps teach local authorities for management and plan everything regarding water such as controlling a huge amount of raw sewage and more effective preparation for storms.

Cities through systems that monitor the weather and those that control the rainwater storage are able to gather data for determination of water supplies status. With a suitable method, cities will reduce the overflow of sewers and minimize the water contamination.

Furthermore, using a system of sensors for gathering data on the water level of groundwater sources and rivers, it is possible to anticipate flood incidents. These system sensors are based on ultrasonic range finders and placed above local waterways to measure the changes in water level and predict the flood risks. IoT through TV whitespace channels which local telecom providers made it available, enables cities to make public awareness announcements about the flood in a real-time.

C. C. Environmental Monitoring System

The changes in climate led to the increased importance of environmental monitoring. In order to determine the quality of the environment, continuous tracking of the environmental parameter is needed. .As the IoT is the most emerging technology, it plays an important role in collecting the information from the sensing unit. Generally sensing unit is composed of different sensors like temperature, humidity, moisture etc., the paper uses an Arduino UNO, Wi-Fi module that helps in processing and transferring the sensed data to the Thingspeak cloud. Thus the parameters received is stored in the cloud platform (Thing speak). The changes in the environment is updated in the form of a database through the cloud computing method. Thing speak also provide a feature to create a public based channel to analyze and estimate it through the public. An Android application is created for the direct access of the measured parameters.

a) Thingspeak

Thingspeak is an open source Internet of Things application and API to store and retrieve data from the sensors using HTTP Protocol over the internet. It is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. The main role of updating data continuously is done by Thingspeak, which has APIs for collecting data produced by sensors and APIs for reading that data from applications.

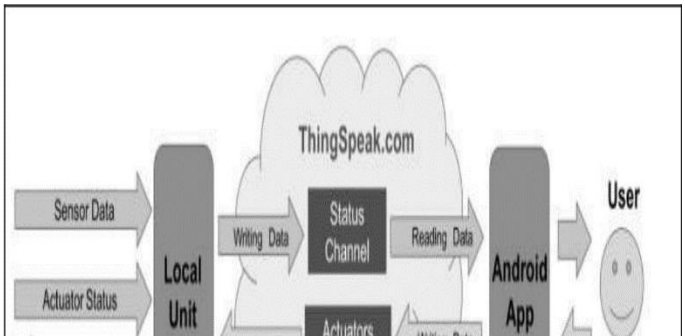

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Fig: Working of Thingspeak

The proposed system keeps track on the parameters such as moisture, temperature, humidity, rainfall, gas content and earthquake intimation with the help of the real time sensors. These parameters are continuously monitored by an open source platform called Thingspeak for an interval of every 2 minutes. The data can be viewed in any one of the three formats such as JSON, XML and CSV.

The sensors in the proposed system collect the data such as the temperature, humidity, soil moisture, pollution level, rain water level and movement in the earth surface. The Wi-Fi network helps in the process of sending the collected data to the open source platform, Thingspeak. Alternate to that, an app is made for the purpose of viewing the collected data in even more easier manner. Through the application/ Thingspeak, the user will be able to know about the status of his/her own agricultural land and counter-measures can be taken after the keen observation of the parameters of the land.

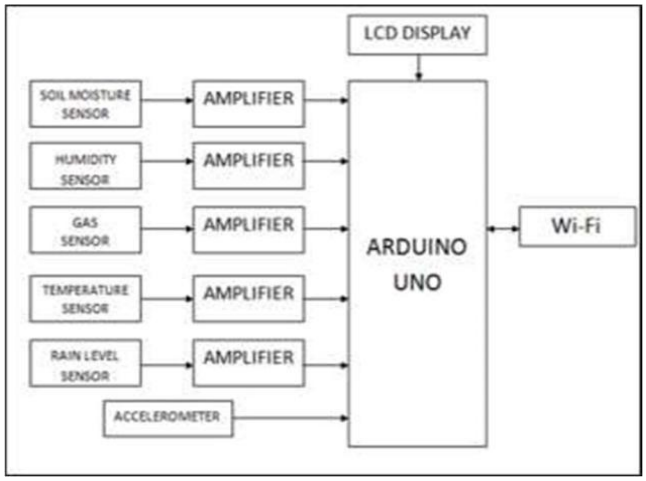

Fig: Block Diagram of Proposed Environment Monitoring System

Here we use different types of sensors for measuring the soil, humidity, gas, temperature, rain water level etc., as shown in above block diagram.

D. INTELLIGENT BIN FOR SMART CITIES

The method of connecting the objects or things through wireless connectivity, Internet called Internet Of Things. Nowadays a variety of tasks are based on IOT. Cities in the world are becoming smarter by implementing the things around using IOT. This is a new trend in technology. Smart cities include obstacle tracking, object sensing, traffic control, tracking of our activities, examining the baby, monitoring home lights and so on. One of the objective of smart cities is keeping the environment clean and neat. This aim is not fulfilled without the garbage bin management system. Hence the paper "IOT Based Intelligent Bin for Smart Cities" has been developed. Bin management is one of the major applications of IOT. Here sensors are connected to the all the bins at different areas. It senses the level of garbage in bin. When it reaches threshold a message is sent via GSM to the concerned person to clean it as soon as possible. The completed task is done in LabVIEW environment.

For detecting the garbage, many sensors like weight sensors, IR sensors, etc can be used.

Weight sensor is the one which gives the information about the weight of garbage. But using this is not efficient because it doesn't identify the level of waste in the bin. Hence Infrared sensor (IR sensor) is used which is a multipurpose sensor, which can detect the level of garbage. IR sensor emits the light, which is invisible to naked eye but the electronic components can detect it. It consist of IR transmitter and IR receiver. Both analog and digital output is produced by IR sensor. This sensor produces the output a logic "1" at the digital output when it senses the object and a logic "0" when it doesn't senses any object. Depending on the distance between the object and sensor, sensor produces the analog output voltage between 0 and 5V. An LED is present on the IR sensor board. It is used to indicate the presence or absence of an object. IR sensors are highly sensitive to surrounding lights.

The output of IR sensor is acquired by The National Instruments myRIO-1900. It is an input output device which is portable and reconfigurable. This can be used by the students in the design of robotics, controls and many other designs. The NI myRIO-1900 has a ZYNQ chip. This ZYNQ chip is a combination of processor (ARM Dual core) and FPGA (Xilinx). The NI myRIO-1900 consists of analog input, digital input, analog output, digital output, power output, non-volatile memory and audio input and output in an embedded device. USB acts as a connector between the NI myRIO-1900 and host computer. It has connectors A and B that acts as an expansion port and a connector C that act as a mini-system port, they carry the signals and these signals are distinguished by different connector names. Here the mostly used connector is mini-system port connector C. This device can even connect to the wireless network and create wireless network. It has inbuilt option to connect to Wi-Fi.

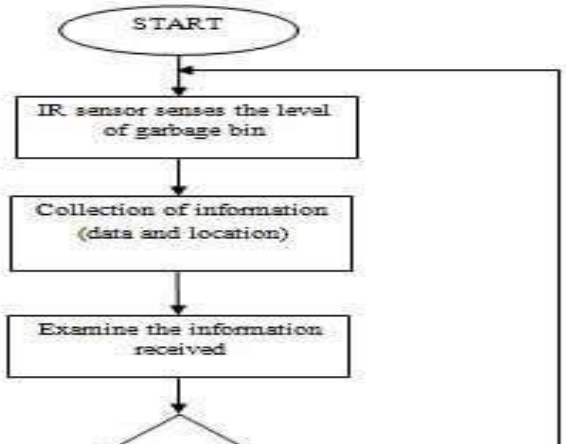

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Fig: Flow Chart of the Working of Intelligent Bin

4. ADVANTAGES

- Production: It provides organic food, safe products and reduces cost of delivery.
- It helps in controlling water, environment and conservation of animal populations.
- It helps in smart waste management, recycling and reuse.
- It makes mobile payments easier and creates online ordering apps.
- It has delivered intelligent rail and other transit solutions. The asset tracking, smart roads, fleet management has become possible due to smart city solutions.

5. CONCLUSION

This paper has presented recent trends and advancements in IoT enabled smart cities paradigm. We devised a taxonomy for IoT based smart cities based on communication protocols, major service providers, network types, standard bodies and major service requirements for the understanding of the reader. Based on the conducted study, we concluded that smart city applications rely on several wireless technologies. Furthermore, we studied major open IoT platforms for the ease of researchers. In addition, a number of reported case studies of several newest IoT deployments and research projects are presented to reveal an increasing trend of IoT deployments. In the end, we unearth several open research issues such as multi-vendor interoperability, low cost, low power consumption and security which demand considerable attentions from our research community.

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