Automated Internet of Things for Underground Drainage and Manhole Monitoring System for Metropolitan Cities

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Abstract

The Internet of Things (IoT) consists of real life objects, communication devices attached to sensor networks in order to provide communication and automated actions between real world and information world. IoT came into existence because, without human interaction computers were able to access data from objects and devices, but it was aimed at, to overcome the limiting factors of human entered data, and to achieve cost, accuracy and generality factors. Sensor Network is a key enabler for IoT paradigm. This paper represents the implementation and design function of an Underground Drainage and Manhole Monitoring System (UDMS) for IoT applications. The vital considerations of this design are low cost, low maintenance, fast deployment, and high number of sensors, long life-time and high quality of service. The proposed model provides a system of monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. In real time, UDMS can remotely monitor current states of the manholes.

Keywords: Internet of Things (IoT), IoT applications, wireless sensor networks (WSN), WSN optimized design, WSN platform, WSN protocol, Underground Drainage and Manhole monitoring System (UDMS).

Introduction

Most of the cities adopted the underground drainage system and it is the duty of managing station (Municipal Corporation) to maintain cleanliness of the cities. If the drainage maintenance is not proper the pure water gets contaminate with drainage water and infectious diseases may get spread. The drainage gets blocked during rainy

season, it will create problem for routine life such as traffic may get jammed, the environment becomes dirty, and totally it upsets the public. Suppose if there should be a facility which would be there in Municipal Corporation (managing station) that the officials come to know immediately after blocking of drainage in which area and the exact place where it is blocked and it also informs if the manhole lid is open. Underground installed electric power lines also monitored through temperature sensors. Pressure sensors are used to avoid manhole explosions, explosions can be a result of the release of chemical and electrical energy [1]. So our main focus is monitoring manholes using sensors. If drainage gets blocked and water overflows, and if manhole lid is opens, it is sensed by the sensors, then that sensor sends information via transmitter which is located in that area to the corresponding managing station.

Related work

The drainage maintenance is necessary to keep the city clean, safety and healthy. If the drainage maintenance is not proper the pure water gets contaminate with drainage water and infectious diseases may get spread, as shown in the figure 2. 1. To overcome these problems most of the cities adopted underground drainage system. Figure 2. 2 shows the basic construction of underground drainage system. If drainage gets blocked then it will create many problems such as traffic jam, the environment becomes dirty, and if manhole lid is not closed properly there is a chance of occurrence of accidents and also people may get fall into the drainage. To overcome all these problems it is necessary to adopt a remote monitoring system in the managing station. Electric power cables are installed underground in the downtown area because of beauty and safety of the cities. Manhole maintenance by human control is very difficult because environment is poor and it is difficult to go inside the manholes for inspecting the states of the manholes. Immediately it is not possible to confirm if the person intrudes the manhole or an accident happens in the manhole.

Fig. 2. 1: Early days open drainage.

Fig. 2. 2: Construction of underground drainage system.

To solve all these problems a remote alarm system is required for transmitting current states of information detected by sensors set inside the manhole to a managing station. A system capable of easily confirming current events of a manhole are revealed in previous work entitled "Manhole state monitoring system" [2]. However the conventional system has problems that the wired PSTN, that is the dedication communication network. But current states of the manholes cannot be remotely managed by wireless. This work improved by a paper entitled "A manhole monitoring system" [3]. This invention has been made to solve the above mentioned conventional art, and it provides a system for monitoring manholes in which manhole information transmitted and received through collecting terminal and collects the information sensed by the sensors, a server and a relay terminal. This system introduces plurality of collecting terminals each including terminal unit that has at least one of an opening or closing sensor, water level sensor and temperature sensor to sense the current states of the manholes. But now a day's one more dangerous problem observed that is manhole explosion [1]. Explosion can be a result of the release of chemical and electrical energy inside a manhole. Manhole explosion events can be classified into three categories mainly smoking events, fires and explosion due to sudden raise in pressure [1]. Previous work fails to solve these kinds of problems because it increases the number of sensors, it can't provide scalability. So the present invention entitled "Automated Internet of Things for Underground Drainage and Manhole monitoring System (UDMS) for Metropolitan Cities" overcomes all these problems. This system adopts three way alert systems at the managing station, which include LCD display, route map and speaker.

Methodology
3. 1 Introduction:
Most of the cities adopted the underground drainage system to maintain the cleanliness of cities. If the drainage maintenance is not proper the pure water gets contaminate with drainage water and infectious diseases may get spread. The drainage gets blocked during rainy season, it will create problem for routine life. The traffic may get jammed, the environment becomes dirty, and totally it upsets the public. If the manhole lid is not closed properly there is a chance of occurrence of accidents and also people or animals may get fall into the drainage. This problem is solved, suppose imagine if we should have a remote monitoring system to monitor the internal states of the manhole, and then we can solve this problem efficiently. These problems occur due to environmental changes like rainy season etc. Figure 3. 1. 1 shows the transmitter block diagram in which sensors senses all the parameters and converts it into electrical quantity.
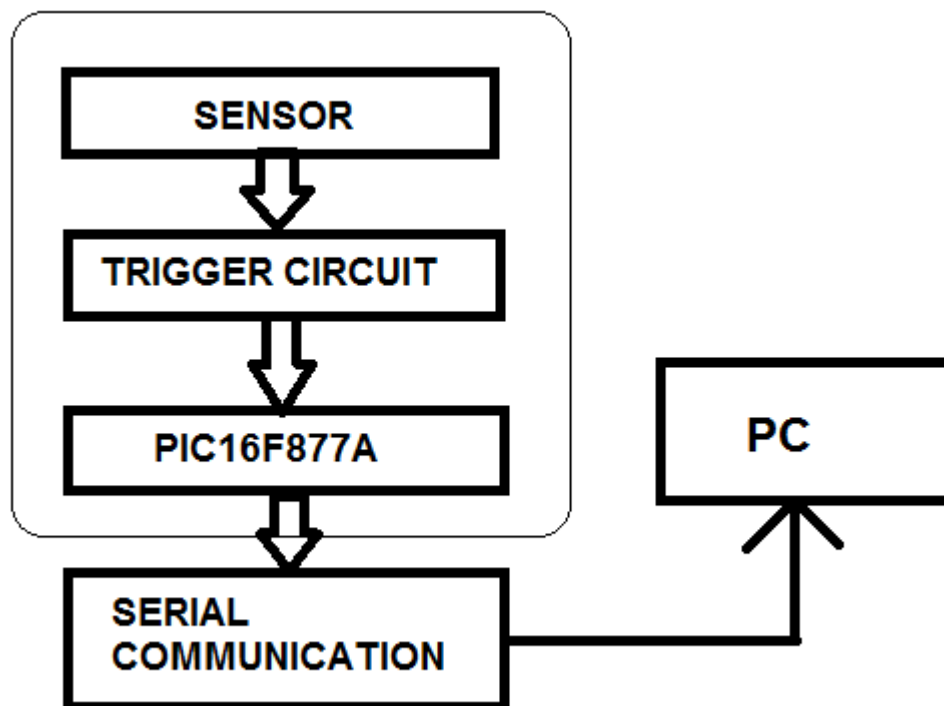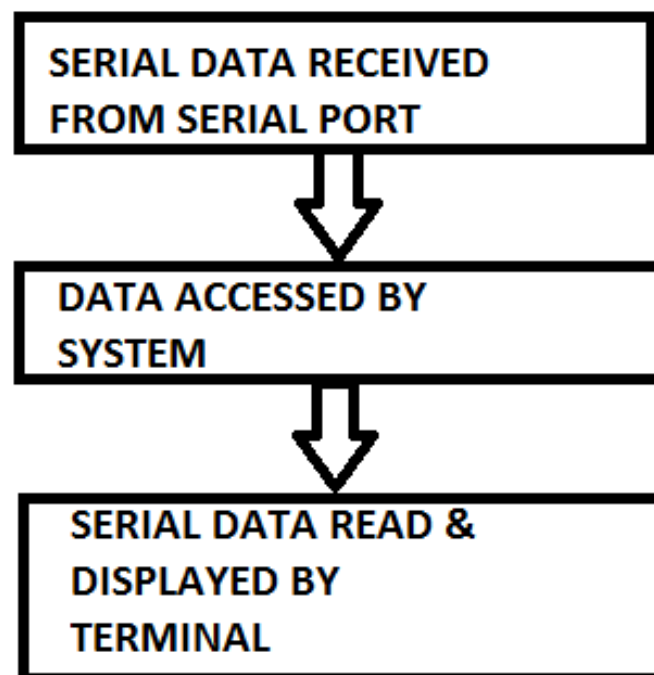
Fig. 3. 1. 1: Transmitter

Fig. 3. 1. 2: Receiver.

To overcome the problem of open drainage system, most of the cities were adopted the underground drainage system to keep the city clean, safety and healthy. This is a design of monitoring manholes through internet. Previous system fails to provide low cost, low maintenance, fast deployment, and high number of sensors, long life-time and high quality of service. This design provides three way alert systems, which include Route map, LCD display and Speakers. Figure 3. 1. 2 shows the block diagram of receiver which collects the serial data from the serial port and displayed it on the monitor using terminal emulator program.
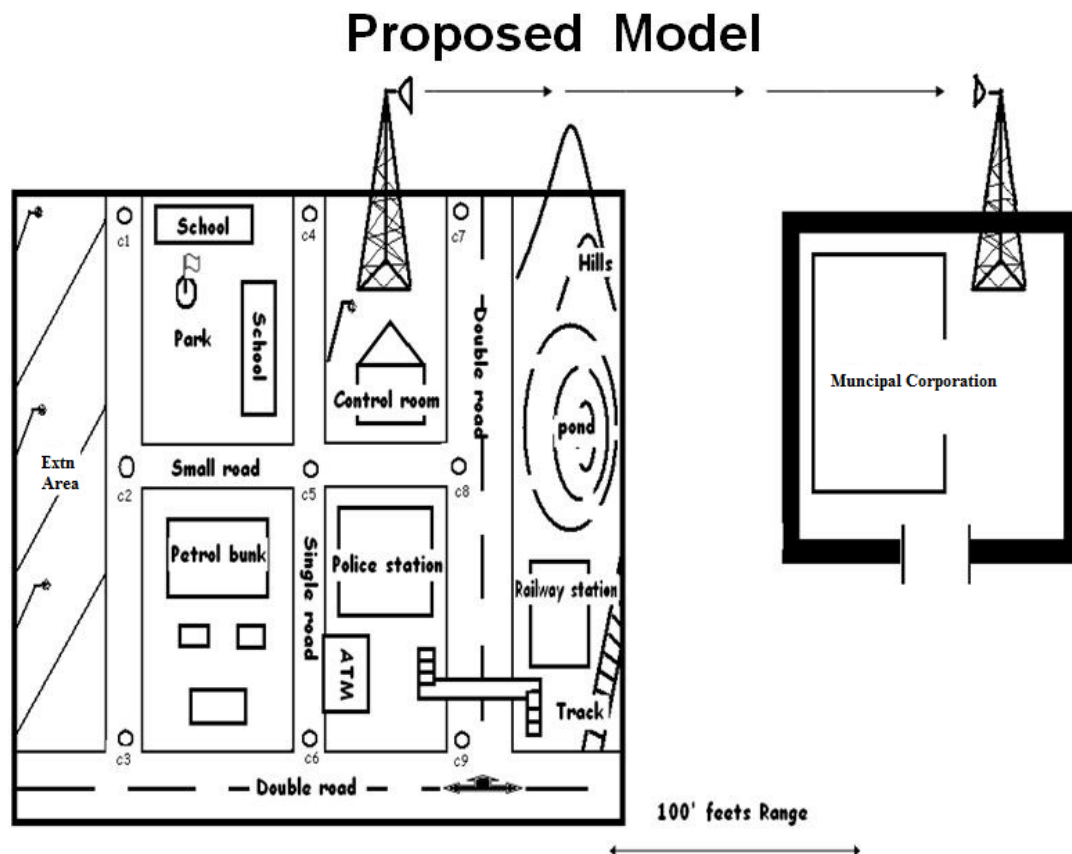

Fig. 3. 1. 3: Proposed model.

The overall idea of this paper is understood by seeing the above diagram referred in figure 3. 1. 3 proposed model. This proposed model includes the overall view of the city which shows the manhole locations and different areas of the city. All the problems occurred in manhole are detected by sensors and sends this information to remote monitoring station.

3. 2 Serial communication:
In order to do serial communications enter the parameters in the port setting box, as shown in table 1.

Table 1.

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

3. 2. 1 Accessing serial data using python [8, 9]
1) Download and install python 2. 7.
2) Introduction to pySerial in python:

To access the serial data from serial port *pySerial* package has been installed. This module encapsulates the access for the serial port. It provides backend for python running on windows, Linux, Jython and IronPython (. NET and Mono)[8].

Requirements:
a) Python 2. 3 or newer, including Python 3. x,
b) ctypes extension on Windows (is in standard library since Python 2. 5+).

3. 2. 2. Introduction to SQLite in python [9] SQLite3 is a very easy to use database engine. It is self-contained, server less, zero-configuration and transactional. It is very fast and lightweight, and the entire database is stored in a single disk file. It is used in a lot of applications as internal data storage. The Python Standard Library includes a module called "sqlite3" intended for working with this database. This module is a SQL interface compliant with the DB-API 2. 0 specification. DB-API 2. 0 interface for SQLite databases. It provides a SQL interface compliant with the DB-API 2. 0 specification described by **PEP 249** [9].

4. Result analysis
Sensor unit senses all the physical parameters like temperature, water overflow, manhole lid open or closed, explosions due to release of chemical and electrical energy inside the manhole and convert these inputs into electrical output, this electrical output received as a input to PIC 16F877A and programmed in such a way that to display all the alert information into readable text messages and displayed on the monitor. Figure 4. 1 shows the route map of the city indicates the exact location of manholes. Figure 4. 2 - 4. 5 shows the all the alert text messages on the LCD display. Figure 4. 6 gives the continuous buzzer alert if any one of the event occurs.
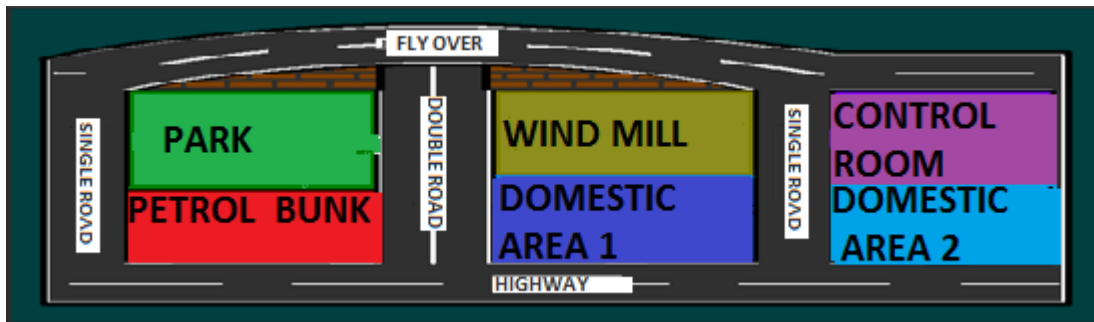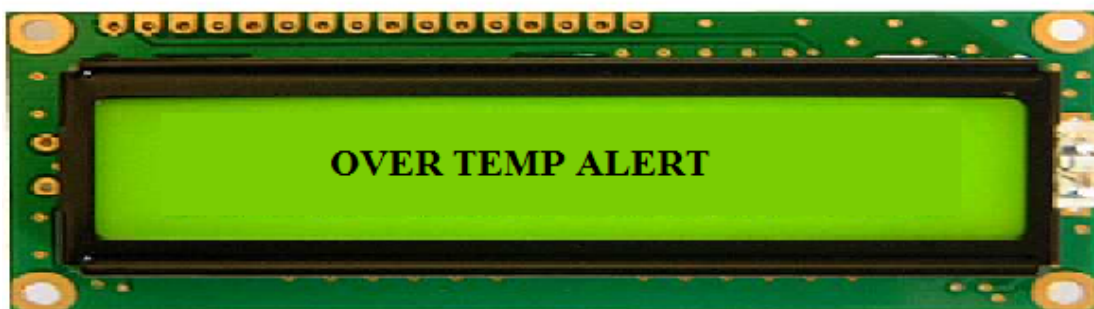
Fig. 4. 1: Route map

Fig. 4. 2: Over temperature alert message display.

Fig. 4. 3: Lid open alert message display.
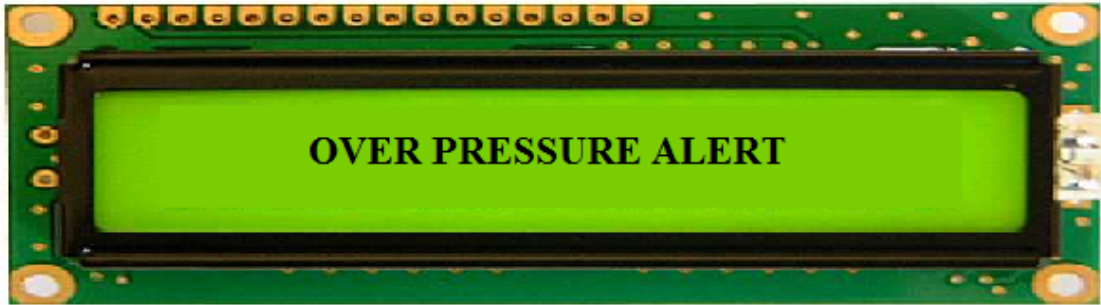

Fig. 4. 4: Overflow alert message display.

Fig. 4. 5: Over pressure alert message display.

Fig. 4. 6: Buzzer alert.

Conclusion and future scope of work
Sensor networks are considered as the key enablers for the IoT paradigm. However, due to the widening variety of applications, it is increasingly difficult to define common requirements for the WSN nodes and platforms. This paper addresses all

phases of the practical development of an Underground Drainage and Manhole monitoring System (UDMS) through IoT applications for metropolitan cities. A real-life, demanding application is selected as reference to guide. Aspects of sensor network platform considered are: platform structure, flexibility and reusability, optimization of the sensor nodes, optimization of the communication, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. This paper can be used to guide the specification, optimization and development of sensor network Platforms for other IoT application domains.

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