Research Directions for the Internet of Things: Use of Sensors in Smart Cities

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ABSTRACT

This paper gives a brief overview of the sensors network in Internet of Things (IoT) for building smart cities. The internet of things (IoT) is the network of visible physical devices like vehicles, Railways, cameras and other items are embedded with hardware, electronics, software, sensors, and network connectivity that enables these devices to collect and exchange data.The Internet of Things is about installing sensors for physical devices, and connecting them to the internet through specific protocols for communications and exchanging information, in order to establish intelligent recognition, location, tracking, monitoring and management. Smart City solutions are based on multiple architectures, standards and platforms, which are mention in Internet of Things (IoT). Furthermore, the paper will present and discuss the technical solutions and best-practice principles adopted in the pune Smart City project, a proof-of-concept deployment of an IoT sensor network in the city of Pune, performed in collaboration with the city municipality.

Keyword - *Internet Of Things, smart city, Web of thing, Wireless network sensor,RFID, Embedded web resources*

INTRODUCTION

The Internet of Things (IoT) is model that visualize future, in which the objects of everyday life will be provided with micro-controllers, transceivers for communication, and suitable protocol stacks that communicate with one another and with the users. [1]. The IoT concept, hence, points at making the Internet even more extensive. Furthermore, by enabling easy access and interaction with a variety of devices such as home appliances, cameras, monitoring sensors, actuators, displays, vehicles, and so on, the IoT will encourage the development of a number of applications that make use of the extent amount and variety of data generated by such objects to provide new services to citizens, companies, and public administrations. This model finds application in many different area, such as home automation, industrial automation, medical aids, mobile healthcare, intelligent energy management and smart grids, automotive, traffic management, and many others [2]. However, such a varying field of application tries to satisfying the requirements of all possible application scenarios a formidable challenge. This difficulty has led to the growth of different and, sometimes, incompatible plan for the practical realization of IoT systems. Therefore, from a system perspective, the understanding of an IoT network, together with the required backend network services and devices, still lacks to established best practice because of its complexity. In addition to the technical difficulties, the assumption of the IoT model is also made difficult by the lack of a clear and widely accepted business model that can attract investments to deploy these technologies [3]. In this complex scenario, the application of the IoT model to an urban context is accepted after many try by national governments to adopt ICT(information and communications technology) solutions for happening of the so-called Smart City concept [4].

The objective of this paper is to discuss how sensors are used in Smart cities and IOT framework. We describe various specific sensors installing in Smart cities for everything and connecting them to the internet through the specific protocol for information exchange and communication in order to achieve recognition, location, tracking, monitoring and management with the technical support from the IOT. 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.

This paper is organized as follows. Section 2 provides a general overview of the system architecture of IoT. Section 3 overviews the concept of Smart City and how IOT sensors are used in Smart cities. Section 4 presents the "Smart City: Pune" project which describe implementation of IOT sensors in Smart cities.

1. BACKGROUND OF INTERNET OF THINGS

Internet of Things is a new revolution of the Internet. Objects make themselves recognizable and they obtain ability to communicate information about themselves. They can access information that has been aggregated by other things. This transformation is associated with the exposure of cloud computing capabilities and the transition of the Internet towards IPv6 with an almost unlimited addressing capacity.[5]

The vision of Internet of Things (IoT) is to have smart and connected sensors or devices. In IoT, communication can done by Sensors to device communications, device to sensor communication and device to human interaction.

The IERC(European Research Cluster) definition states that IoT is "A dynamic global network infrastructure with self-configuring capabilities and make use of communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use smart interfaces, and are continuously integrated into the information network."[5]

Now, understand the IoT architecture. IoT architecture consists of three main parts sensors, network connectivity and data storage applications. The same has been depicted in figure-1. As shown in the figure, Sensors in the IoT devices either communicate directly with the Big data cloud or central server for data storage or communicate via network and communication devices.

The first level concerns the **Connected Devices** and includes the sensors themselves, hardware kits that control the sensors and provide the connectivity to the chosen network protocol. Sensors for various applications are used in different IoT devices as per applications such as temperature, power, humidity etc.

The hardware kits are used to connect and control the sensors, provide them power, and gather the data and send to the network via communication protocol. At this level the hardware may have to be concerned with error reporting, power management, data storage and a number of tasks required to control the device or sensor.

The second level concerns the **Network and Communication devices** hardware device capable of transmitting an analog or digital signal over the device, other communication wire, or wirelessly. this is the very basic level of connectivity for the sensor device to the network. It includes WiFi, RFID, 2G, 3G, 4G (GSM. GPRS, GPS) Bluetooth, NFC.

The third level concerns the **Big Data Stores** is midelware which act as Gateway. It takes care of various wireless standard interfaces and hence one gateway can handle multiple techologies and multiple sensors. It help to communication with hardware sensor devices and that data will pass to end user application.

The fourth level concerns the **Desicion Support Tools,** connects all the device types. This layer can be seen as a translator that speaks many languages. It includes IoT Management Services like Data Security,BPM, BRM, Analytics, OSS & BSS.

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The fifth level concerns the **Application** layer is where the business functionality lives. Whether it is an application that tells information of sensors devices and scheduling software that is using multiple data points from sensors to schedule predictive maintenance of large assets.

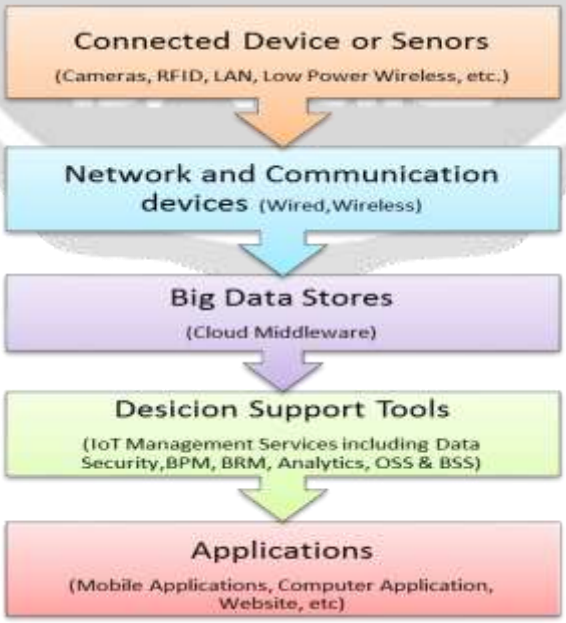

Fig 1 - Architecture of IOT

2.1. Advantages of IoT

1. **Information:** For making better decisions knowing more information is very importatnt.As per saying knowledge of particular thing very important and knowledge is power.
2. **Monitor:** The second advantage is monitor. By monitoring, exact quantity of things get known to human and helps in further decision making. For example by monitoring the expiration date of any product can help in avoid that things.
3. **Time:** We can save quite large time by IoT.And in today's modern life, we all could use more time.
4. **Money:** The biggest advantage of IoT is saving money. If the price of the tagging and monitoring equipment is less than the amount of money saved, then the Internet of Things will be very widely follow

2.2 Disadvantages of IoT

1. **Compatibility:** Currently, there is no international standard of compatibility for the tagging and monitoring equipment. The manufacturing companies of these equipment just need to agree to a standard, such as Bluetooth, USB, etc.
2. **Complexity:** As the system is complex more failure can be faced. With the Internet of Things, failures could sky rocket.
3. **Privacy/Security:** With all of this IoT data being transmitted, the risk of losing privacy increases.
4. **Safety:** Safety is ultimately in the hands of the consumer to verify any and all automation because of information being transmitted over web or internet.

2. CONCEPT OF SMART CITY

A 'smart city' is an urban region that is highly advanced in terms of overall infrastructure, sustainable real estate, communications and market ideas. It is a city where information technology is the main infrastructure that provide essential services to residents. There are many technological platforms involved, including automated sensor networks and data centers.[6]

According to the documents released on the Smart Cities website, the core infrastructure in a smart city would include: [6]

- Adequate water supply
- Assured electricity supply
- solid waste management
- Public transport
- Affordable housing, especially for the poor
- Digitalization
- Standard environment
- Safety and security of citizens, particularly women, children and the elderly
- Health and education

In a smart city, economic development is maintained by successful market drivers such as supply and demand. They benefit everybody, including citizens, businesses, the government and the environment. The concept of smart cities originated at the time when the entire world was facing one of the worst economic crises. In 2008, IBM began work on a 'smarter cities' concept as part of its Smarter Planet initiative. By the beginning of 2009, the concept had attract the imagination of various nations across the globe.[6] Countries like South Korea, UAE and China began to invest heavily into their research and formation. Today, a number of excellent precedents exist that India can emulate, such as those in Vienna, Aarhus, Amsterdam, Cairo, Lyon, Málaga, Malta, the Songdo International Business District near Seoul, Verona etc.[6]

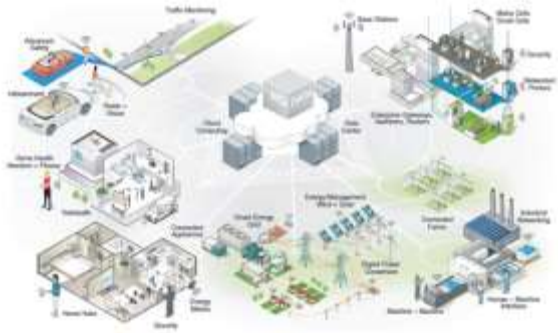

Fig -2: Smart city

3.1 Smart solutions

"In the approach of the Smart Cities Mission, the objective is to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions," says the statement from the Ministry. [6]

Fig -3: Smart Solutions in smart city

Following approaches of IOT network used in Smart city:

Web of thing

The Internet of Things (IoT) suffers from a lack of interoperability across platforms results in developers faced with high cost and limited market potential. To achieve this goal need of platform independent API meaning making it interoperable with each other on different platforms.

Web of Things is essential and take the role to encourage development of applications and services for the IOT i.e physical things and their virtual representation. This includes sensors and actuators, as well as physical objects tagged with a bar code. Relevant Web technologies such as HTTP access RESTful services, and naming objects to linked data and descriptions, and JavaScript APIs for virtual objects which act as proxies for real-world objects.

The Web of Things (WoT) is a concept to incorporate every-day physical objects into the World Wide Web by giving them an Application Programming Interface (API),to facilitate the creation of their virtual profiles as well as their integration and reuse for various applications. The Web of Things is primarily an evolution of the Internet of Things where the aim is to how to connect objects together at the network layer.[7]

Wireless network sensor

WSNs (Wireless network sensor) are collections of compact-size, relatively inexpensive computational nodes that measure local environmental conditions or other parameters and forward such information to a central point for appropriate processing. WSNs nodes (WNs) can sense the environment, can communicate with neighboring nodes, and can, in many cases, perform basic computations on the data being collected. WSNs support a wide range of useful applications.[8]

Example

Area monitoring, Health care monitoring, Environmental/Earth sensing, Air pollution monitoring, Forest fire detection, Landslide detection, Water quality monitoring, Natural disaster prevention

RFID

Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's. Active tags have a local power source such as a battery and may operate at hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method of Automatic Identification and Data Capture (AIDC).[10] RFID is a very valuable technology tool. It holds the promise of replacing existing identification technologies like the bar code.[9]

Example:

Railway smart card, Metro Monthly Passes, RTO License, Smart traffic.

Embedded web resources (System)

Embedded systems have traditionally been isolated, self-contained systems and communicated with other systems within a limited range on a local network. But, this is no longer the case. Embedded systems—especially small, deeply-embedded devices use TCP/IP and the Internet to communicate with each other and with the people managing them.[11]

For example Remote car which we had play in childhoods, that car contain embedded kit which contain of chips, sensor etc which used to control via remote. But this cars can controllable for short distance. IN IOT things can be controlled via mobile or desktop application for large distance with help of clouds or internet. For example, the embedded web application can change the direction of a dish, start a hydraulic motor on the tank, open or close a valve on a production line, or make nightclub lasers dance to the music. Virtual buttons in a browser-based form replace (or duplicate) the hard buttons normally built into the system.[11] Even more importantly, embedded systems, like those in the tank, are increasingly deployed in remote locations. When you're facing these odds, web-based applications offer more versatility and less component cost, and can take advantage of LAN or Internet infrastructure.[11]

Example:

Traffic Control system, Smart banking, Electricity Billing system

3. CASE STUDY FOR IMPLEMENTATION OF IOT SENSOR IN SMART CITY: PUNE

The Various type of sensors network discussed in this paper has already been successfully applied to a number of different areas in the context of IoT systems.

In this section, we describe a practical implementation of sensors network, named "Pune Smart City," that has been realized in the city of Pune; it is effort of the collaboration between public and private parties, such as the

municipality of Pune(PMC), which sponsored the project, Pune Smart City Development Corporation Limited (PSCDCL).

Smart city vision is divided in two area Pan City Initiatives and Local Area Initiatives.On the pan-city, main focus is on public transport with installation of GPS and real time tracking of PMPML(Pune Mahanagar Parivahan Mahamandal Ltd) buses through mobile app, vehicle health monitoring system for PMPML, intelligent road asset management, traffic map using mobile GPS and punished those violating traffic rules.

A- Smart Pune Public Transport System[12]

- Vehicle health monitoring system (VMS) across 1080 buses with intelligent kits and back-end maintenance management system
- Real-time tracking of buses (VTS) by installing GPS and setting up a central control room, to monitor driving quality and service levels
- CCTV surveillance and panic buttons on 510 buses to improve security
- Public information system (PIS) comprising of bus guides and LED screens shows other critical information, along with mobile app and website providing real-time information
- In-bus entertainment through Wi-Fi in buses.

B- 'Smart Pune Traffic Management System' [12]

- Adaptive traffic signals with central command center
- Smart parking across 7 Multi-level-car-parks, with PIS and real-time mobile app
- Private bus aggregators as rBus and Shuttl application to provide premium bus options
- Intelligent road asset management to improve road condition.
- Traffic mobile apps and online portal with live and forecasted traffic
- Traffic analysis using CCTV feed and mobile GPS

C- 'Smart Water' solutions [12]

- Water audit across 2500 km pipeline
- Helium leak identification system to reduce internal water leakage drastically
- 100% smart metering across 42,650 commercial connections
- Smart meters for domestic consumption along with revised telescoping tariffs through "give-up-water subsidy" campaign to accept smart metering and revised telescoping tariffs
- 24x7 water supply to the city includes 2000 domestic, 300 commercial and 2000 slum connections
- Setup an ICT enabled separate billing and recovery department for water with world class customer service and improved collections

D- Leverage ICT solutions for citizen convenience and e-governance[12]

- Wi-fi connectivity at 1Mbps+ speed – 100+ access points for 10,000 simultaneous logins
- Pune Smart "DigiTel" Card for a connected community
- Intelligent operations center with integrated data across utilities, transport and public safety
- Digital Special Purpose Vehicle (SPV) to improve SPV functioning with Geo enabled city operations for multiple activities such as Land management, Tax assessment
- E-SPV: Comprehensive online portal with multiple activities across all departments with citizen desk for physical verification

4. CONCLUSIONS

In this paper, we analyzed the smart solutions currently available for the implementation of sensors network in IoTs. The discussed technologies are very close to being standardized, and industry are already active in the production of devices that take advantage of these technologies to making things smart, such as those described in Section 3. The enabling technologies, help to connect with your device and help to access the data at anywhere. It's provide easy way to accessing monitoring and exchanging information with your physical device. A concrete proof-of-concept implementation, deployed in collaboration with the Pune city, has also been described as a relevant example of application of the sensors network in IoT paradigm to smart cities.

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