



## **Smart Cities: Integration of GPS and IoT Approach**

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### **Abstract**

The technical revolution is now a marvelous revolution. It is quite different from its prior upheavals even though it was born from the same technological revolutions. Technology has become an integral part of daily life including health, education, agriculture, safety, entertainment, construction, economy, and all these areas are depending on the cooperation between the Global Positioning System (GPS) and Internet of Things (IoT). We are looking at the recent studies findings regarding the integration of IoT and GPS and trying hard to use them in an efficient and integrated way to build a smart city that can be constructed from separate units of intelligent systems based on IoT and GPS, which can be combined to work on the same principle. What sparked us to introduce this work is to save time and effort for other researchers to start where previous studies have ended in this context to reach the greatest benefit to achieve innovation and development of forward buildings and living smart cities from different viewpoints. The main contribution of this paper is proposing a Smart City Control Authority (SCCA) to curb all city facilities and adopt a smart system to improve the quality of life.

**Keywords:** Positioning system, intelligent system, navigation, Information Communication Technology  
ICT



## **1. Introduction**

In the current decade, everyday life tasks became evidently easier by time due to smart devices and apps, which outgrew from the revolutions in the development of communications and Internet. Ever since the US launched GPS in the 1970s; GPS has begun to be a cornerstone for the global information infrastructure. The free and open use of GPS features greatly facilitated its entry into technology developments for various fields of life such as agriculture, industry, marine, war, time, aviation, space, land survey and many other sectors (Gps.gov, 2019). GPS has the potential to support many of the latest developments and systems (NovAtel, 2019), which is primarily the grandfather of IoT (Faa.gov, 2019).

IoT is defined as “a large-scale network where various networks coexist, and are capable of interacting with one another through various gateways and middlewares, with the support of the complex control plane” (Mutlag et al., 2019), which allows every device or object (by its self or its value) in the real world to connect to the Internet. There are many applications that depend on IoT, such as remote healthcare, emergency response, industrial internet, smart farming and other services that enhance the quality of life. In modern life expectation of IoT impact growth, as per (Ray, 2016) by 2020 the number of Internet-connected devices will be about 25 billion, which facilitates data analysis and intelligent decision-making independently. Moreover, the National Intelligence Council (NIC) has launched IoT as one of six "Disruptive Civil Technologies" (Xu, He and Li, 2014). Figure 1 shows the growth of IoT devices.

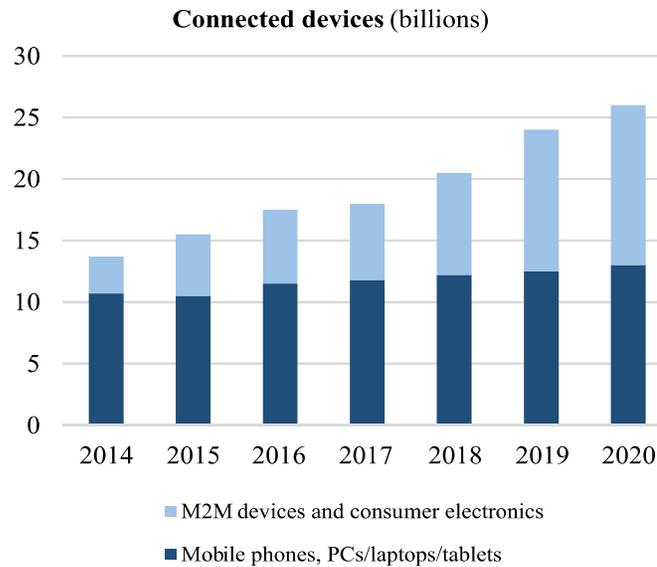


Figure (1): The growth of devices connected to IoT (Sinha, Wei and Hwang, 2017).

In this context, Smart city is a clear example of GPS and IoT services. The main idea of the smart city is the use of information and communication technology (ICT) with Internet support for integrated solutions based on sustainable development and improving people's quality of life in all aspects, (Badshah et al., 2018) such as education, work, law enforcement, crisis management, decision-making, etc (Dameri, 2017).

Thus, technology is the key element of building a smart city (Yin et al., 2015), (da Silva et al., 2013).

The intent of this review paper is to provide through related works and discussion of current smart systems a virtual view of how can a smart city design be. In this paper, we will explore some recent GPS and IoT applications that have resulted in the integration of smart cities. We organize this paper into four parts: the first part is the introduction, the second part contains the related works in GPS along with IoT in the world of information revolution and motivation behind it, the third part is discussion for some of what has been discussed in the integration of GPS and IoT, and finally, the fourth part is the conclusion.



## 2. Related Works

GPS has no limits of use, it is used and observed in many fields such as industry, marine and airplane navigation. However, there are more uses that are not observed but they are majors and they make difference such as service providers (Byon, Shalaby and Abdulhai, 2006).

Many companies are seeking to improve the quality of their services and gain user satisfaction by obeying to service delivery times, GPS helped in that and reflected a significant positive difference resulting in a high proportion of the work schedules accuracy.

Figure (2) below shows how business operators see the impact of using GPS software on time, 35% said that it had developed it significantly, 46% said it had developed it on average, and 14% felt that the development was simple. In contrast, 5% of them do not see that it has any kind of impact. (Software Advice, 2019).

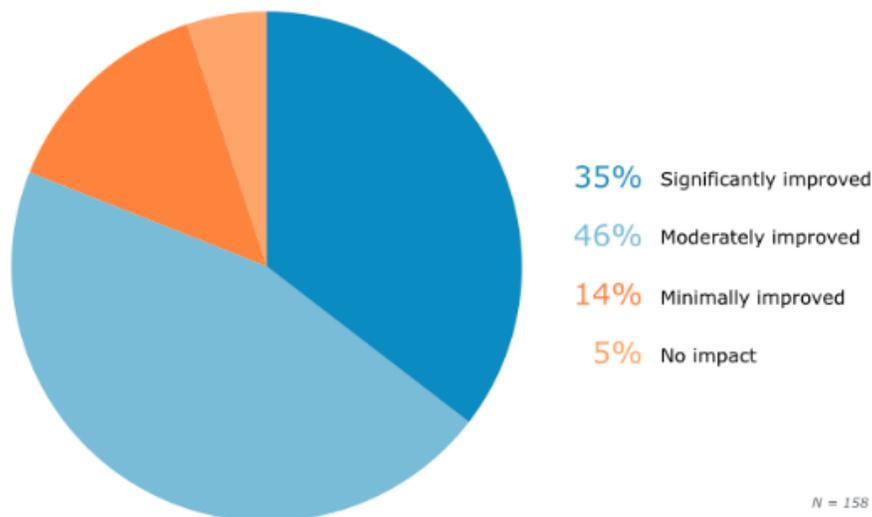


Figure (2): The improvement after implementing GPS software on works achieving (Software Advice, 2019)

The work in (Tarapiah et al., 2016) is in health care purpose. The authors designed a system which gives the doctor who follows the patients status the authority to watch and trace the patient's condition and location, beside other health parameters and determine the needless hospitalization. These critical data are reported on spot to the doctor in real time.



On the other hand, in military purpose, this study (Chhabra et al., 2017) aims to track the location of the missing soldiers and follow up their health through a system that receives the required information such as the soldier's location, body temperature and pulse rate, this is achieved by a small unit carried by the soldier himself. This system uses GPS to monitor the required information in real time as well as GSM to be able to use wireless connections.

The contribution in (Dabir et al., 2018) is in social care purpose, the researchers suggested an electronic system that combined GPS and IoT into a smart stick to provide assistance and aid for old people, it is also beneficial for people with special needs by providing their accurate location or detect any hazard problem in their heartbeats. This can be illustrated in Figure 3. The proposed system is connected to their family or their caretakers, and an alarm is sent to reach their accurate location and provide suitable aids.

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COM5 (Arduino/Genuino Uno)
Waiting for FONA GPS 3D fix...
Checking for Cell network...
--> AT+CREG?
<-- +CREG: 0,1
--> AT+CIPGSMLOC=1,1
<-- +CIPGSMLOC: 0,72.870056,19.026396,2018/02/26,05:09:25
GSMLoc lat:19.026393
GSMLoc long:72.870048
--> AT+CGPSSTATUS?
<-- +CME ERROR: 100
Waiting for FONA GPS 3D fix...
Checking for Cell network...
--> AT+CREG?
<-- +CREG: 0,1
--> AT+CIPGSMLOC=1,1
  
```

Figure (3): the command interface of smart walking stick (Dabir et al., 2018)

In (shree, 2016) the authors suggested a child monitoring system which is managed by the parents and can be installed on smart devices. The system depends on GPS tracking the child's location and does not require any direct interaction from the children to achieve its tasks. It automatically and easily sends the child's location via text messages. The proposed system architecture is presented in Figure 4.

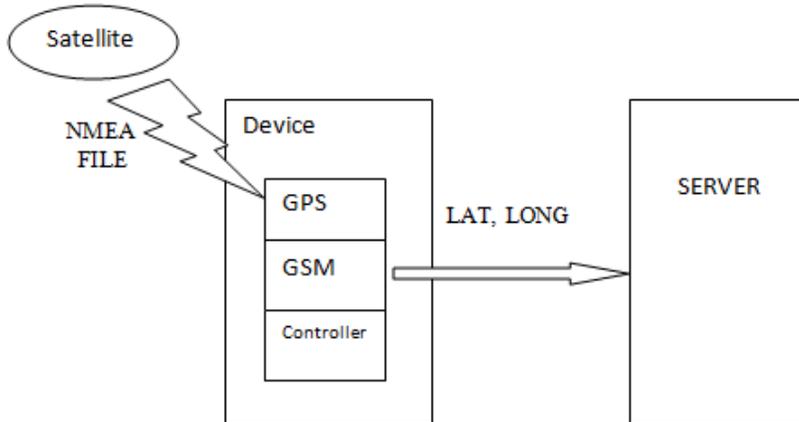


Figure (4): the architecture of children safety application (shree, 2016)

The system stores emergency numbers of the child's parents. If the child is at risk, a rescue request message containing the child's location is sent.

In transportation and road purpose, Kumar et al. in (Kumar and Hegde, 2017), they designed a system based on maintaining the safety of vehicle occupants. The suggested design which is represented in Figure 5 contains three types of sensors, Tilt, IR, and Vibration, working together with GPS and IoT to support detecting, predicting incidents and also crashing, reporting immediately to those who provide medical support to the injured and security of other vehicle occupants on the road.

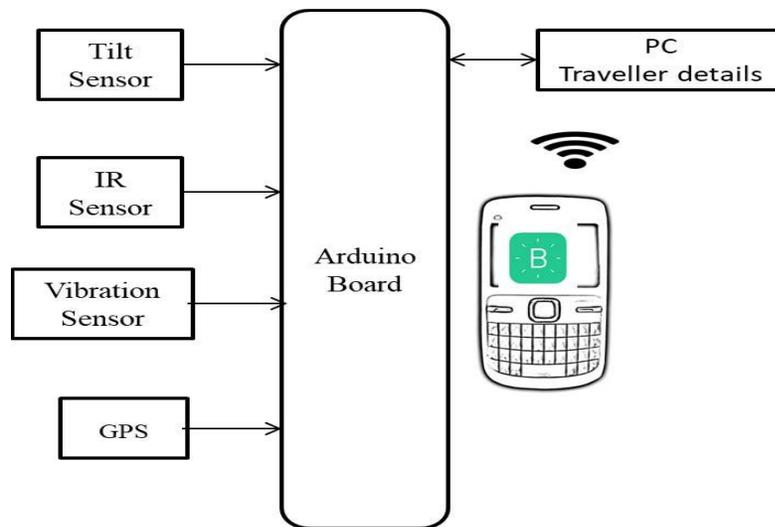


Figure (5): the design of proposed system (Kumar and Hegde, 2017)

Similarly, in survey purpose in (Gowtham et al., 2018) the authors proposed renewing electronic land survey system with GPS and IoT.

The proposed system has avoided many of the problems that have occurred in the old methods of land survey, which may involve forgery, taking longer time and too much effort to prove or transfer ownership or prevent manipulation of individual ownership.

The proposed system provides land owners with the right to follow land documents using their mobile phones and other smart devices with greater security and accuracy in land information.

It works in real-time and allows land sell and buy beside verification of lands data via Internet.

It supports security features such as watermarks in the owner's documents and system protection with strong passwords that are difficult to break.

Foregoing works can embed into smart city structure. In a recent study (DLODLO, Gcaba and SMITH, 2016) authors conducted a survey on how to build smart cities and what areas in any city can be clever by embedding Internet of things in transport, tourism, health, crime prevention, governance, disaster management, environmental management, and energy management. Internet applications have been



restricted and identified for these different areas.

In addition, in a laboratory environment, standard technology solutions for energy control and comfort at home have been developed to demonstrate the concept of implementing the smart city infrastructure. All of this has led to a change in the way cities operate and the way they provide services.

Following China's 12th Five-Year Development Plan, China has completed a number of demonstration applications projects, such as smart city and intelligent transportation system in public Internet applications, smart coal mine, and IOFs in industrial applications. In another work on Internet things in China, a study was conducted in China on policies, research & development plans, applications, and guidelines. From China's point of view, the challenges facing China in the application of the Internet have been widely understood to make use of technologies, applications, and standardization, and have made an architectural proposal for the sensing layer, the network layer, open and public. Internet objects consist of three platforms to meet the challenge of the structure that they classified as follows: 1. Sensing and Gateway Platform, 2. Resource and Administration Platform, and 3. Open Application Platform.

The study pointed to expectations that the future of Internet things will be unified, smooth and comprehensive. It stated that the deployment of the service should be broadly framed within a set of standards so that Internet developments can be maintained as a smart system for interoperability, energy sustainability, privacy and security (Shanzhi Chen et al., 2014).

### **3. Discussion**

As we have seen in the previous section, many modern works have dealt with different methods to build intelligent systems suitable for urbanization in the modern world, and the unlimited potential of GPS along with IoT became clear.

#### *3.1 Remark of Recent Designs (A Commentary)*

In fact, each of the previously proposed systems in section 2 supports one aspect of life in one way or another, and its greater dominance over our daily lives is just a matter of time. The integrity of GPS and IoT can make sparking results which may be beyond imagination that led to the advanced world of technology.



### *3.2 Proposed Smart City Control Authority*

Our suggestion is mainly about building a smart city which offers smart solutions for a quality of life where GPS plays a pivotal role along with IoT. Initially, the suggested smart city has several and various features which are illustrated in Figure 6.

The idea basically allows full control of all these smart systems under specific authority, for example, the city municipality, traffic police, chambers of commerce, floods/tornadoes notifications, development and tourism in the same city and of course the mayor or head of the city. Actually, all these new authorities which is SCCA have the abilities to manage any contradiction occurs.

Further, SCCA is essential for performing the proposed features that have an effective and proper positive impact with the monitoring and follow-up system.

The aim from developing the idea of creating a smart city is for facilitating life and achieving every task faster and in a more accurate way since in this era everything moves fast due to technology, thus people don't have the potential for waiting so long to receive a service, and it gets even worse when they have to waste so much time just to finish regular and daily life chores such as home repairs, parking their cars, preparing breakfast or even coffee making.

Developing a smart city depending on IoT over GPS will help sparing this wasted time to be used and taken advantage of in much more important tasks.

#### *3.2.1 The Aspects of Proposed Features*

Our suggested SCCA with the integration of GPS and IoT offers support for various purposes in the people environment includes but not limited to:



#### A- Time and Attendance System

Regularly, employees can have their attendance taken by the fingerprints attendance, however, this can't guarantee that these employees remain at work, so by using GPS and Iot, the employee's location can be determined, and thus it's guaranteed that everyone is at his work place. Beside no more need to contend and wait at the fingerprint device.

#### B- Smart Tourist Visa

Tourist visas can be developed for tourists to facilitate the process of following them up on their regular stay, as well as finding them easily if they are lost in that smart foreign city.

#### C- Smart ATM Card

The smart ATM card, which can be traced back by its owner when she/he lost it, and can locate the last transaction done by the card through GPS

#### D- Smart Communication

One of the main problems that waste so much time is waiting for a technician's arrival. If the customer wasn't informed about the exact time of arrival or updates, so much time will be wasted in vain.

This can be improved by developing a software that connects the manager, the customer and the technician's together, where the technician's location can be detected by GPS through his smart device, and accordingly, time will be calculated and an automatic message will be sent to the customer to be updated with the technician's arrival time. The technician's location and the accurately estimated arrival time will be sent to the manager to be regularly informed when the technician is running late and what is the reason for it.

Another way for saving time and smart city development, is home chores achievement, where by the cooperation between GPS and IoT, a person while he is at work can send pre-orders to his house to be achieved before his arrival, for example, he can give an order to the vacuum machine to clean the floor, and by the help of IoT, orders will be sent to the vacuum to automatically clean the house.



### E- Smart Health

People with medical conditions, old age citizens or even normal citizens can undergo sudden medical condition and might be left unnoticed which can lead to worse case scenarios. However, with the help of smart watches that are regularly worn, it constantly measures the vital signs such as pulse, heart rate, respiratory rate and body temperature, and in case of any urgent medical condition, it will automatically call the ambulance and send an informatory message to the pre-saved emergency contact number who can be a parent, a sibling, a son/daughter or even a neighbor.

### F- Smart Environment

To help make our environment better, recycling can be easier by detecting the nearest garbage bin using GPS, and an alarm can be produced by the garbage bin if waste has been disposed in the wrong slot of recycling.

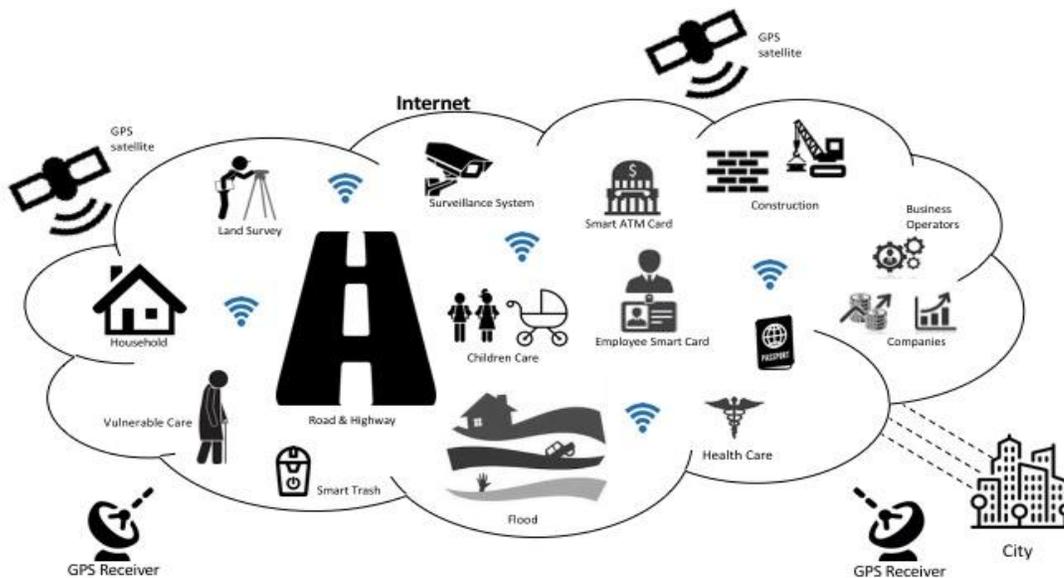


Figure (6): features of the proposed smart city



#### 4. Conclusion

This paper discusses our proposed idea of SCCA to build smart urban cities suited to the development of technology in this era. We have reviewed many of the currently proposed studies and discussed the idea of their applications and other additions to support SCCA. The suggested model manages all smart city facilities and controls its services based on specific privileges assigned to the authority unit. The authority unit holds SCCA and has standard guideline and principle that well defined under the law with privacy and security preservation. In future work, disaster management and crisis management can be supported in an open architecture and adapted to the environmental changes of smart cities depending on their geographical nature.

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