

Value, benefits and challenges of smart cities



Abstract:

In this paper discussion is made about smart cities, their value, what benefits they provide in society and the challenges that are being faced when there is a need for the implementation of a smart city project. Concept of smart cities is drawn from smart environment. The main purpose of smart cities is to utilize the sources at maximum without causing any wastage. Recently there has been a lot of advances in its concept and a lot of researches are being going on in this area. Rather than some defined definition, smart city is more of a concept. This study analyzes how human computer interaction/interfaces are impacted in smart cities, what issues there can be in relation of HCI concepts, the challenges and how they can be improved. Also the possible solutions of these HCI specific challenges are discussed.

Introduction:

Smart cities are defined as the environment where any network related services are made more flexible and design in the way that they can improve their efficiency and sustainability. This is being done by making use of information and telecom technologies. The main objective to do so is to improve the way of living of the habitants. The purpose of smart cities is to provide an environment to habitants that is more green, safe and secure and friendly where operations can be performed with much more efficiency.

Smart city constitutes of multiple components that include smart transport and infrastructure, smart healthcare and technology and smart energy as well. The word smart is to make all these facilities efficient and faster with less wastage in terms of cost and time. Information technology is the key

here that is helping in transformation of conventional cities towards the smart cities. Within the umbrella of smart cities, two technologies Internet of Things and Big Data play a very crucial role in achieving that. It won't be wrong to say the smart environment could not be achieved if the technological advances in IoT and BD had not been done. However still there is a need of improvement in these technologies to resolve the issues and making the global smart cities. (Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M., 2014)

Smart cities make use of the digital technologies and then utilize them in providing better experiences to the inhabitants for public services and better utilization of resources when at the same time adding less negative impacts over the environment. A smart city can be comprised of various components. It is not necessary that a city should be having all these components in order to be considered as smart, a city can deploy a few of those components yet can be considered as the smart city. Few of them are as follows:

- Smart Transportation
- Smart Governance
- Smart Energy
- Smart Citizen
- Smart Building
- Smart Healthcare
- Smart Technology

There has been an immense increase in the world population in the last few decades and this has also increased the expectation in standard of living. As

per a study conducted around seventy percent of population till the year 2050 will be living in urban area. For now the resources in cities are around 73% and they are also contributing in generation of greenhouse gases. So considering that in the next few years the negative impacts that can be affecting the environment can be predicted. This is the reason that became the necessity to shift the focus of researchers towards the concept of smart cities. The main purpose of smart cities is to prevent and deal with the problems that are causing immense increase in urbanization. The cost for the implementation of smart cities can be huge initially, but once such systems are deployed they will help a lot in reduction of the overall cost in respective areas. For example they will help in lowering the energy usage, water usage, pollutants emission in environment and transportation usage and also will help in controlling city wastage (Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A., 2011)

Smart Cities Standards:

Worldwide the smart cities are characterized as hugely diverse in terms of their requirements and the components they comply to. However ISO that is International Organization of Standardization provide the standards that shall be complied too to ensure the quality of services, their efficiency as well as the security insurance. Standards are of utmost importance and play crucial role in smart cities development. They also helps in formulization of the requirements required for monitoring smart cities performance, technically and functionally. Standard are also used to deal with the issues that come across in development of smart cities like water issues, transportation issues, security and climate changes. (Shapiro, J. M., 2006). IEEE has also

been playing a major role in formulating such standards that can be applied to smart cities including eHealth standards, smart grids and smart transportation systems. ISO37120 is a very good example of one such standard. This standard is capable of providing 100 indicators indicating city performance and these additionally contain forty six main and fifty four additional indicators. Few of the indicators are related to the domain of economics, finance, energy and lastly but not the least environment. These indicators are then used for civic entities to baseline performances, comparing them with different cities data and identification of lessons learned in order to suggest improvements in services provided (Hancke, G. P., & Hancke Jr, G. P., 2012)

Characteristics of Smart Cities:

There are many attributes of smart city and they include provide improve quality of life, sustainability and over all smartness that improve the living standard of habitants. Sustainability can only be achieved when there is an improvement in governance of city, improved infrastructure, better health facilities and waste and pollution is in control and any issues related to these factors are dealt. The measurement to quality of life can be made by taking into consideration the wellbeing of financial and emotional state of habitats.

Smart city is comprised of four main factors which are first and foremost environment, society, economy and lastly the governance. The society factor contributes that the city is for its citizens and should be providing all comfort and facility to the habitants. The economy factor deals with the concept that smart cities shall be providing job opportunities to the habitant and hence

contribute in increased economy. The environmental factor states that city can provide sustainability for the current as well as the future generations by maintaining its current state and resources. Lastly the governance deals with the concept that there shall be robustness in city capability to create and conform to the policies created and other factors. (Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A., 2011)

Smart City Challenges:

Starting up the smart cities is very miscellaneous and difficult task indeed. Some of them are efficiency, communication, cost, sustainability, security and safety. Due to dependency of natural atmosphere, political interference, social groups and budgeting these projects may face many difficult tasks. The greatest huddle in creating these big model is cost. Design and operation cost are included in actual cost. Cost in designing the smart city is one time, but the operation cost plays an important role in upholding the smart city. Cost of design must be efficient enough to understand the smart city whereas the operation cost is long term cost budgeting to holdup the maintenance with low problems. The major factor in developing and completion of this task is cost efficient whereas the operation productivity is more difficult: there is a risk of cost in attaining more productivity and sustainability of the smart city. Carbon discharge and city wastage removal is required to improve the sustainability and productivity and it cut down the operation cost. Smart cities required to handle the population as people are indulging, this will help in long term planning and sustainability with efficient operation cost. Smart cities are strong enough to handle disasters and failures. Nature always come with the disasters but there are many factor

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due to which the failure will occur for example failure in ICT, or power failure. Many operations lead toward failure due to the natural disasters of the smart cities. Smart cities are proactive about these disasters and backup plans are already made whenever these situations are occurring within limited time. The cost of design and operation will be exaggerated by these challenges. In achieving more efficient smart city, the smart cities must use the ICT, sensors and IoT devices and analysis on big data and storage of this data is required. Safekeeping of information and infrastructure is vital and difficult task in design. Conclusively the safety of the people staying in the smart city is the most vital and basic factor in growth of the smart city which also raises up the cost of design and operation (Shapiro, J. M., 2006).

The Internet of Things (IoT) in Smart Cities:

The infrastructure of the smart city is based on the development of Internet of Things (IoT). It can also be understood as the IoT is the technical key of the smart cities. There must be the following three core features contained in smart cities i. e. interconnection, instrumentation and intelligence delivered by the IoT devices. This is reflected from the analysis of smart city that IoT can play an important role. The routine usage of IoT such as smart meters, smart sensors, radio-frequency identification (RFID) and smart phones in core development of infrastructure of smart cities make more reliable and feasible place to live. The infrastructure IoT may consist of many components together with sensors, electronics, software, networks and firmware. The network of related physical objects (called "things") together with sensors, smart phones, computers, wearable devices, actuators, buildings, homes, vehicles, structures, and energy systems is called IoT. This

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is the responsibility of IoT to communicate the different types of devices and applications for getting progressively smart, secure services and reliable. A big number of sensors consisting IR, RFID, and GPS, infrastructure, connect the buildings, transport, networks and services through ICT. There are many responsibilities of IoT infrastructure i. e. information communications and exchange, location determination, intelligent recognition, monitoring, tracking, identity management and pollution control (Hancke, G. P., & Hancke Jr, G. P., 2012)

Big Data in Smart Cities:

Overall whenever we talk about the big data we are referring the difficult and complex data sets which are not fetch by our traditional database management tools and applications. The Big Data, Internet of Things (IoT), and Smart cities are strongly co-related as one needs the other two. The city data which are marked in space and time and are produced in the smart cities can be Big Data. The Big Data in the smart cities may be produced from a large group of sensors, emails, websites, databases, and social media. It is projected that the propagation of sensors, social networks, web pages, image and video applications, and mobile devices are producing more than 2.5 quintillion bytes per day. The challenges of Big Data are many consisting of mining, visualization, capture, analysis, storage, sharing and search. Big Data requires new methods of processing to enable improved decision making, vision detection and procedure optimization. Cultured data analysis devices are essential to search and extract appreciated designs and knowledge from the Big Data of the IoT and smart cities. (Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M., 2014)

Human Computer Interfaces:

In addition to the factor that how well a software program is coded and efficient it is in terms of performance and features provided, the success of a software program is largely dependent on the fact that how easily it connects with the users of the system and how much it conforms to the usability aspect. Any design that is user centered is much likely to be accepted by the users quickly rather than another that provides a lot more features but cannot be categorized as user friendly. A user friendly or usable software is normally termed as intuitive by the software developers. By intuitive they mean it can be self-driven, does not require extensive trainings, easy to use and learn and is efficient by same time effective. Although there cannot be any measurement tool to judge these factors however they lead the software developers in the right direction of achieving usability and ultimately project success. HCI concepts help in the analysis of which programs or projects are better when compared to others and which will be easily acceptable by market (Rogers, Y., Sharp, H., & Preece, J., 2011).

Technologies used in Smart Cities:

To achieve smart cities there can be variety of projects including smart transportation, healthcare systems, and car parking system, air pollution controlling systems, Go Green and many other. All of these systems however utilize few common technologies which include sensors, modalities that interact with user, hand and body gestures and movements, eye movement scanning, speech recognition, action recognition, bio-signals and many

other. All of these technologies however make use of sensors, these sensors sense the outside activity pass this on to the system and then the desired action takes place.

There had been a lot of innovation in sensors since the time they have developed. They have transformed from larger to small size and cheaper and achieving more accuracy. These days sensors provide much more efficiency and responsiveness and are helping in achieve a better communication with machines. (Von Hardenberg, C., & Bérard, F., 2001)

Human Computer Interfacing with Smart Camera:

Smart system being deployed in smart cities are mostly containing cameras, either it could be traffic control system or some user authentication, cameras are there everywhere. Even in recording hand and body movements smart cameras are being used. They help the user in interacting with the system. These cameras capture the picture and then translates it into the information as processed by the system. The well-known example is the hand gesture sensing in a field view of device that senses the movement. However there are many challenges in relation to that, the foremost is the effective tracking system. Any deformed target or objects that are not rigid in nature keep on changing their state while being tracked and this causes additional challenges also the system user has to move the gesture in a specific way and field and this takes some time as well. So in cases either there is a lot of repetition of this action required or sometimes the action is not well understood and gives incorrect results as well. Also these camera sensors does not capture the image in case there is an object in hand.

One of the solution to this problem is to handle secondary motions of the body or the hand when it is holding any objects. So there shall be the usage of color camera with advanced image processing algorithms in the system that can trace and separate any objects in the hand with the hand gesture to record the correct gesture. In addition to that another solution could be usage of 3D visualization. This though can be costly but can better capture the image and process the information in better ways. (Rogers, Y., Sharp, H., & Preece, J., 2011).

Human Computer Interfacing with Direct Touch:

With the development of smart cities there has been immense advances in touch screen UIs. These UIs are not only being used in smart phones and tablets and PCs, rather these touch screens are used in many other projects as well for instance navigators deployed on malls or bus or railway stations, that help the user better navigate through the place. When talking about touch screens the main factor to consider is what you see is what you get. The UI design, icons, labels should be designed and placed on UI in such a way that it eases the user to go through it. There shall be proper page navigations with correct information being displayed to the user rather than messing up the screen with load of unnecessary information. Simplicity is the key here when user is going through direct touch systems. User should be having a natural feeling that they are controlling the system (Von Hardenberg, C., & Bérard, F., 2001)

Human Computer Interfacing with Face Recognition:

Face recognition is the technique that can be used in a lot of systems contributing to smart cities. Mostly they can be used in smart security systems deployed on airports, stations and even in traffic monitoring system. The face recognition however provide very limited information for instance if there is something change in user's face for example beard grown or mustache or change in hair style then face recognition system does not relate the captured image with the information stored in data and hence it can cause irritation at the end of user. There is an immense need of improvement in face recognition algorithms where they shall be matching the facial features. Sparse Representation based Classification algorithms can be applied to improve it. Also the performance of camera to capture images shall be improved and make efficient. System should be able to divide the frontal or neutral faces from any other changes in face in terms of expression or change in style. (Streitz, N. A., 2011)

Human Computer Interfacing with Speech Recognition:

Speech recognition is yet another form of technology being vastly used in smart cities. A good example of speech recognition is being used in mobile phones or in smart home automation system where the speech recognition can be used to unlock home or other security features. There can be issues like in case the person is facing some health problems effecting his voice then the sensors cannot recognize the voice. Also any noises around can become hurdle in recognizing the actual voice. Another example could be security system installed in cars. Cars are mostly on roads and there can be noise all around all the time. So in this case at times voice recognition does not work as expected and cause issues to users. As a solution in voice

recognition system there shall be the algorithms involved that remove any noises in the speech first and then try to recognize the voice or speech.

Another important issue is speech recognition is the accent. All user cannot have same accent of pronouncing words, so some time the instruction given in interpreted as something else and does not give desired results. Speech recognition systems shall be designed not only to take English as the input speech but there is a need of speech recognition in other languages as well that will also help the local uneducated habitants. (Streitz, N. A., 2011)

Conclusion:

The study provides the insight of smart cities and how human computer interaction impacts smart cities. The challenges being faced in implementation of smart cities and the associated HCI challenges are discussed. Also the discussion is being made about the possible solutions that shall be incorporated in resolving those issues. Improved visualization and data interpretation are they key to enhance the human interaction with systems.

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