Unit 5. Case Study

5.1 IoT for Smart city applications

5.2 IoT for Smart Home

5.3 IoT for Health & Lifestyle

IoT & Smart Cities

As populations and urbanization rise in the coming years, many cities may turn to technology and advanced networks to help them manage resource constraints. In particular, cities could increasingly turn to a section of the **Internet of Things (IoT)** known as smart city solutions.

What is Smart City?

Smart cities use IoT devices such as connected sensors, lights, and meters to collect and analyze data. The cities then use this data to improve infrastructure, public utilities and services, and more.

IoT can be used in many ways to make cities more efficient ranging from managing the traffic, controlling air pollution, handling waste management, creating smart buildings, planning for natural disasters, etc. So let's see how modern technologies combined with civic planning can result in smart cities that are more efficient and cost-effective.

Smart City Technologies:

Smart city devices work to make everyday tasks easier and more efficient, while relieving pain points related to public safety, traffic, and environmental issues. Here are some of the most popular smart city technologies:

Smart Utility Meters

A top IoT device among utility companies is the smart meter. These devices attach to buildings and connect to a smart energy grid, allowing the utility companies to manage energy flow more effectively.

Smart meters also allow users to track their energy consumption—leaving a significant financial impact. Insider Intelligence expects utility companies to save $157 billion by 2035 due to smart meter adoption and implementation.

Smart Transportation

Connected vehicles have made their way to the forefront of public transit—and the efforts have already started to bear fruit. Insider Intelligence projects US connected cars will make up 97% of the total number of registered vehicles by 2035.

Specifically voice search and location data capabilities are attractive to drivers, and as smart applications continue to evolve and grow, so will the adoption of smart transit.

Smart Grids

Arguably the greatest implementation of smart architecture and infrastructure is smart grids, which help tremendously with resource conservation. Amsterdam, for example, has been experimenting with offering home energy storage units and solar panels for households that are connected to the city's smart grid.

These batteries help lower stress on the grid at peak hours by allowing residents to store energy during off-peak hours. The solar panels also let residents sell spare energy from the panels back to the grid.

Smart Waste Management Solutions

Waste management is both costly, inefficient, and can cause traffic buildup. Smart waste management solutions can alleviate some of these pain points by monitoring how full trash cans are at a given point and send that data to waste management companies, providing the best waste pick-up routes.

Some smart waste bins, like the EvoEco, have the ability to tell users which items should be composted or recycled and can even show messages that share how much an organization can save by recycling.

Smart Air Quality Monitors

There are constantly air particles, dust, dirt, cleaning chemicals, floating around in the air of one's office building or home. Smart air quality monitors can detect these particles and inform users of pollutants.

Monitoring indoor air quality (IAQ) can better alert people of unsafe pollutant levels via an indicator light or push notifications to one's Smartphone or tablet.

5.1 IoT for Smart city applications

Traffic Management

It is important to control the traffic in cities otherwise there are huge traffic jams in popular places and totally empty streets otherwise. This also depends on the design and layout of the roads but it can be managed by having smart traffic lights. For example, the traffic lights should automatically adjust according to the volume of the traffic so that green lights should have a longer duration where there more traffic and shorter duration when the streets are empty. Sensors can also be embedded in roads and bridges to monitor their conditions so that they can be repaired when there is much wear and tear. After all, roads with potholes are also a major cause of traffic pollution!

Air Pollution

Air pollution is a major problem in many metropolitan cities where the particulate matter in the air is so high it is damaging to the lungs in the long run. But IoT along with machine learning can be used to reduce air pollution. This is possible by collecting data related to city pollution like emissions from vehicles, pollen levels, airflow direction, weather, traffic levels, etc using IoT from various sources and then calculating pollution forecasts to see the trends in pollution so they can be controlled.

Healthcare

Healthcare is an extremely important aspect of life, especially in current times when non-communicable diseases like heart problems and cancer are increasing in big cities while there are still a lot of deaths from infectious diseases in poorer places. In such a situation, IoT technology can surely help in enhancing the healthcare system so that the best healthcare is received by everybody. One example of this is microbots that can directly enter the bloodstream and reach any place inside the body to deliver medicines. Another application of IoT and sensors in healthcare is remote patient monitoring wherein patients can be monitored 24/7 and emergency responders called if there are any problems.

Public Transport

Public transport, whether it be buses or trains, are at the heart of any city. This is especially true in big cities where there are big traffic jams and the metro train can be

a lifesaver! However, smart public transport can streamline traffic and also make commuters' life much easier. It is very convenient when the trains and buses are connected with a single app and you know exactly when the next service will arrive and how long you need to wait. In addition to that, predictive analytics can be used to optimize the routes of public transport which provide maximum benefit and minimum cost.

Water Management

There is no life without water! But water is also a finite resource which is reducing at an alarming rate. Therefore, using smart water management techniques in cities so that water can be conserved for future generations is a good idea. Sensors can be used to monitor water levels, pipe conditions, tank pressures, etc. in municipal water pipelines and tanks to optimize water management. These will ensure that water is not wasted and that problems like leaky pipes or high pressure in tanks can be handled without any loss of water. Sensors can also be used to monitor the groundwater levels so that they can be replenished if there is a groundwater shortage.

Buildings

Cities are obviously incomplete without buildings and larger cities have a lot of skyscrapers as well. Now the challenge is to build smart buildings using IoT where all the functionalities like lighting, air conditioners, heating, security, etc. can be connected and controlled from a single source. This will reduce the costs of operating a building as well as increase efficiency. For example, air conditions and heaters in a building can be set to change the internal temperature according to the outside temperature. Sensors can also be used to monitor the air quality inside the building and also automatically switch on lights only when there are people. All these actions will save a lot of energy and also reduce the electricity bill!

Waste Management

Waste management systems in a city can be optimized so that there is efficient waste collection and disposal which helps in keeping the city clean and hygienic. After all, mismanagement of waste can lead to contamination of the soil, air, and water as well as provide a breeding ground for a host of bacteria (not to mention the horrible smell!) But IoT technology with sensors in the waste bins can be used to find when the bins are full and dispose of them accordingly. This is better than just disposing the waste on particular days only when the bind might not be full sometimes or overflowing with the danger of contamination on other days.

Parking

It doesn't sound like parking is a problem but it is actually a big headache, especially in large cities. Less available space means that drivers have to waste their time finding parking spaces and increase road traffic in this process (while also becoming more and more irritated!) This issue can be solved by using IoT connected sensors around the city that point out the empty parking spaces around wherever your destination is. This data will also allow city officials to see where there is congestion due to less parking space and where there is lots of empty space available. This can then be used to optimize parking and prevent traffic jams as well as driver irritation!

Natural Disaster Management

It is not possible to prevent natural disasters like hurricanes, earthquakes, tsunamis, etc. but it is entirely possible to anticipate these disasters before they occur and then manage them effectively. For example, sensors in combination with IoT can be used to anticipate when earthquakes are going to occur by analyzing the makeup of the ground, seismic plate interaction, energy propagation in the ground, etc. Similarly, sensors can be used to obtain flood detection data like river level readings, rainfall records, terrain and elevation of an area, etc. to predict when and where a flood might occur and the severity of the flood as well.

Infrastructure

The infrastructure of a city i.e. its roads, buildings, etc are essentially what form the city. And smart infrastructure is a very important part of creating a smart city. This includes using IoT along with sensors to use technology intelligently which can save energy and cost for a city. An example of this is using smart streetlights along the roads that only turn on when they detect motion and stay off the rest of the time. This will definitely save energy and reduce the cost to the city.

Conclusion:

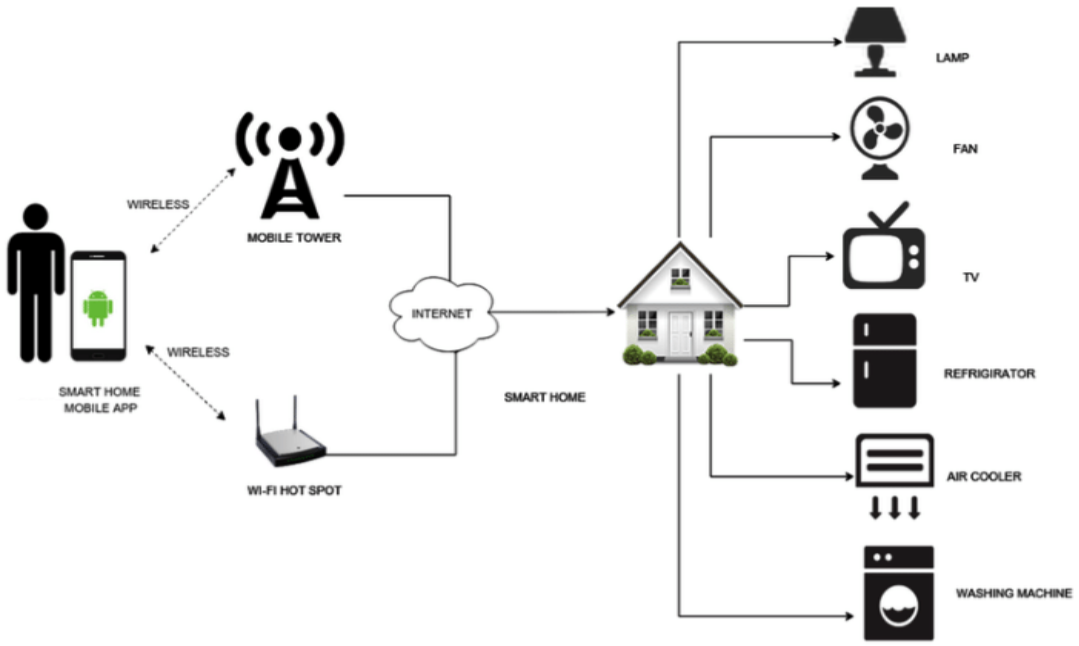
These are only some of the applications of IoT in creating smart cities. There are many more options that can be explored to make cities a better option for more than 70% of the world's population in the future. Many of these applications are already used in the big metropolitan cities around the world, however, there are many barriers to creating truly smart cities. Some of these may be **bureaucracy** or the fact that it takes time to integrate the existing systems with new technology. Whatever the reason, there is no doubt that the future is smart!

5.2 IoT for Smart Home

A **smart home system** can be something that makes our life quite easy. Starting from energy management where the power controls system in the AC appliances where we use the thermostat, all this is managed to cut down the power consumption that's taking

place. A door management system, security management system, water management system are the part of this as well. Still, these are vital things that stand out in the smart home system. The limitation of IoT in smart home application stops where our imagination stops. Anything that we wish to automate or want to make our life easier can be a part of smart home, a smartphone system as well.

How IoT in Smart Home Works?



The home can be called smart when it has a range of smart devices that you can control remotely by setting them the way you like to automatize house maintenance. They can also be united into one network. For example, the lights can turn on at the moment you enter the home (lamps will know it from the sensors) or your vacuum cleaner can start cleaning every day at 11 AM.

But the true magic starts when IoT (Internet of Things) joins this team. It provides all the devices with internet access which broadens the possibilities of such a home network. For instance, now you can see what happens in your house watching security cameras through your smartphone or computer. IoT applications allow you connecting devices to each other and letting them communicate without your participation. Imagine this: the moment your car leaves the parking near the office, the conditioner starts cooling your house so that after a hot day you could enter a pleasantly cool home.

Benefits of IoT Smart Home Technologies

The cool house on a hot day — far not the only profit you get. Let's now see the most significant benefits of the IoT smart home applications.

Control and Monitoring

The IoT significantly improves the way you can control and monitor all the processes taking place at your home. The fridge can notify you if your yogurt gets spoiled in two days or can add milk into the shopping list.

Every day the IoT application collects data about the way your household works, processes it and shows you the most significant insights.

Cost and Energy Savings

With detailed statistics about the work and energy consumption of each smart device, you can easily optimize their usage and adjust your smart home settings in a more cost-saving way. You can also allow your smart home system to do everything on its own. The system will shut down the devices which are not in use and reduce power consumption if there is no one at home.

Environment Impact

Except for cutting down your bills, energy savings help to reduce a negative impact on the environment and live a 'greener' life.

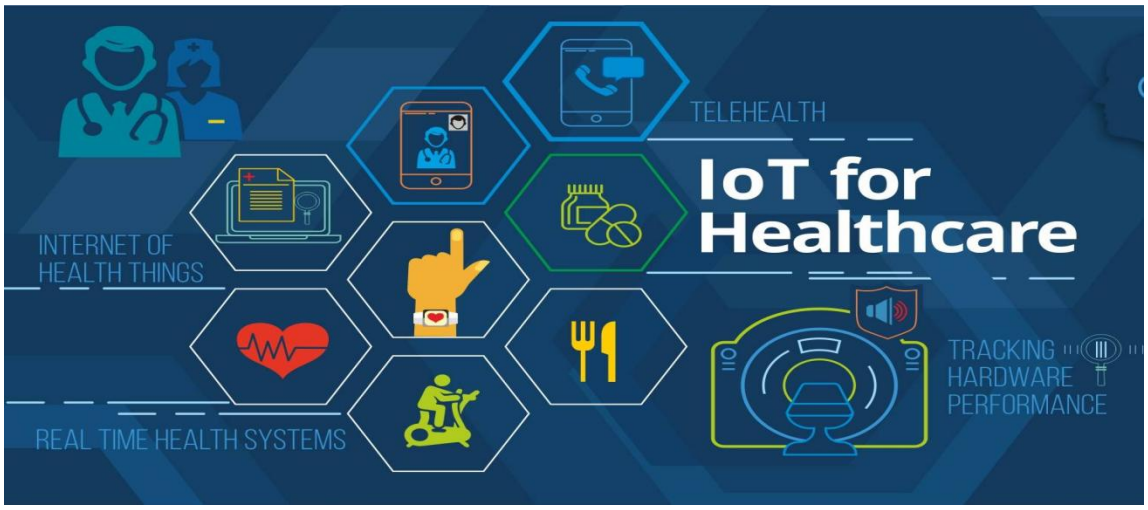
Better Security

The smart home security system is a great tool for protecting your property since it provides total control of everything inside and outside of your house. Security cameras, smart locks, as well as motion, smoke, and other sensors — all these gadgets work together and notify you if something goes wrong. You can check what is going on inside and around your house sitting in the office or lying on the beach halfway around the world.

Comfort

People always wanted to have everything in more comfort and convenient way, and IoT in smart homes, perhaps, is the greatest achievement in this direction. It perfectly copes with the task of simplifying and improving your life: a lot of processes in your home run autonomously, yet the overall control still remains in your hands. Is not it the future our ancestors dreamed of?

5.3 IoT for Health & Lifestyle



Before Internet of Things, patients' interactions with doctors were limited to visits, and tele and text communications. There was no way doctors or hospitals could monitor patients' health continuously and make recommendations accordingly.

Internet of Things (IoT)-enabled devices have made remote monitoring in the healthcare sector possible, unleashing the potential to keep patients safe and healthy, and empowering physicians to deliver superlative care. It has also increased patient engagement and satisfaction as interactions with doctors have become easier and more efficient. Furthermore, remote monitoring of patient's health helps in reducing the length of hospital stay and prevents re-admissions. IoT also has a major impact on reducing healthcare costs significantly and improving treatment outcomes.

IoT is undoubtedly transforming the healthcare industry by redefining the space of devices and people interaction in delivering healthcare solutions. IoT has applications in healthcare that benefit patients, families, physicians, hospitals and insurance companies.

IoT for Patients - Devices in the form of wearables like fitness bands and other wirelessly connected devices like blood pressure and heart rate monitoring cuffs, glucometer etc. give patients access to personalized attention. These devices can be tuned to remind calorie count, exercise check, appointments, blood pressure variations and much more.

IoT has changed people's lives, especially elderly patients, by enabling constant tracking of health conditions. This has a major impact on people living alone and their families. On any disturbance or changes in the routine activities of a person, alert mechanism sends signals to family members and concerned health providers.

IoT for Physicians - By using wearables and other home monitoring equipment embedded with IoT, physicians can keep track of patients' health more effectively. They can track patients' adherence to treatment plans or any need for immediate medical attention. IoT enables healthcare professionals to be more watchful and connect with the patients proactively. Data collected from IoT devices can help physicians identify the best treatment process for patients and reach the expected outcomes.

IoT for Hospitals - Apart from monitoring patients' health, there are many other areas where IoT devices are very useful in hospitals. IoT devices tagged with sensors are used for tracking real time location of medical equipment like wheelchairs, defibrillators, nebulizers, oxygen pumps and other monitoring equipment. Deployment of medical staff at different locations can also be analyzed real time.

The spread of infections is a major concern for patients in hospitals. IoT-enabled hygiene monitoring devices help in preventing patients from getting infected. IoT devices also help in asset management like pharmacy inventory control, and environmental monitoring, for instance, checking refrigerator temperature, and humidity and temperature control.

IoT for Health Insurance Companies – There are numerous opportunities for health insurers with IoT-connected intelligent devices. Insurance companies can leverage data captured through health monitoring devices for their underwriting and claims operations. This data will enable them to detect fraud claims and identify prospects for underwriting. IoT devices bring transparency between insurers and customers in the underwriting, pricing, claims handling, and risk assessment processes. In the light of IoT-captured data-driven decisions in all operation processes, customers will have adequate visibility into underlying thought behind every decision made and process outcomes.

Insurers may offer incentives to their customers for using and sharing health data generated by IoT devices. They can reward customers for using IoT devices to keep track of their routine activities and adherence to treatment plans and precautionary health measures. This will help insurers to reduce claims significantly. IoT devices can also enable insurance companies to validate claims through the data captured by these devices.

IoT Applications in Healthcare:

Implantable Glucose Monitoring Systems

Patients who suffer from diabetes can have devices with sensors implanted in them, just below their skin. The sensors in the devices will send information to a patient's mobile phone when his or her glucose levels get too low and will record historical data for them too. This way, patients will also be able to tell when they are most likely to be at risk for low glucose levels in the future, as well as in the present.

Activity Trackers During Cancer Treatment

Usually the right treatment for a cancer patient relies on more than just his or her weight and age. Their lifestyles and fitness levels also play a huge role in what the proper treatment plan for them will entail. Activity trackers track a patient's movements, fatigue levels, appetite, etc. Plus, the data collected from the tracker prior to treatment and after treatment has started will tell healthcare professionals what adjustments need to be made to the recommended treatment plan.

Heart Monitors with Reporting

Patients can wear devices that monitor their heart rates, and that can determine whether they have high blood pressure. Healthcare providers will have access to reporting of patient's heart monitor data when they need to pull it during checkups and exams. The wearable devices can even alert healthcare professionals when patients are experiencing arrhythmias, palpitations, strokes, or full-blown heart attacks. Ambulances can then be dispatched in a timely fashion, which can be the difference between life and death.

Medical Alert Systems

Individuals can wear something that looks like jewelry but is designed to alert family members or friends in case of an emergency. For instance, if an individual is wearing a medical alert bracelet and fell out of bed in the middle of the night, the people they designate to help in the case of an emergency would be immediately notified on their smartphones that their help was needed.

Ingestible Sensors

Patients can now swallow devices with sensors that look like pills. Once the sensors are ingested, they relay information to a patient's mobile app that will help them follow the proper dosages for their medications. Most medications aren't taken as prescribed due to forgetfulness or other human error. This ingestible sensor works to ensure patients are taking the right medications, at the right time, in the right dosages. Some ingestible sensors are also being used to more accurately diagnose patients with things like irritable bowel syndrome and colon cancer.

Medication Dispensers

Devices can now be implanted in a patient that dispense medication in steady doses throughout the day. Patients will be notified when they need to refill their medications. Doctors can also be informed of missed doses during routine visits.

Wireless Sensors

Wireless sensors are being used in labs and hospital refrigerators to ensure blood samples, chilled medications, and other biomedical materials are always kept at the proper temperatures.

Trackable Inhalers

IoT inhalers are telling patients what they're doing or experiencing to cause asthma attacks, by transmitting information to their smartphones or tablets. That information can also be shared with their physicians. The connected inhalers also remind patients when to take their medications.

Wearables to Fight Depression

Apple has designed an app for its Apple Watch that helps manic depressive patients cope with their depression. The app tracks a patient's episodes outside of their scheduled appointments and helps to monitor cognitive and mood functions.

Connected Contact Lenses

Currently, connected contact lenses are reading glucose levels of diabetes patients. But soon enough, they'll be able to help restore the eye's focus and improve vision.

Location Services

Items like wheelchairs, scales, defibrillators, nebulizers, pumps, or monitoring equipment, can be tagged with IoT sensors and located easily by healthcare staff. A lot of times physical equipment can be misplaced or is hard to track down, but with IoT, staff will know where everything is.

Remote Monitoring

With IoT devices, healthcare professionals can monitor their patients who just underwent surgery or who go home for outpatient care. They'll be alerted if a patient reaches a critical state or needs immediate attention.

Expect to see IoT innovation in healthcare on the rise in 2022 and beyond. The applications of IoT in healthcare listed above are just the beginning.

Factor affecting IoT Healthcare Application

There are various factors that affect the IoT healthcare application. Some of them are mention below:

- **Continuous Research:** It requires continuous research in every field (smart devices, fast communication channel, etc.) of healthcare to provide a fast and better facility for patients.

- **Smart Devices:** Need to use the smart device in the healthcare system. IoT opens the potential of current technology and leads us toward new and better medical device solutions.
- **Better Care:** Using IoT technology, healthcare professionals get the enormous data of the patient, analysis the data and facilitate better care to the patient.
- **Medical Information Distribution:** IoT technology makes a transparency of information and distributes the accurate and current information to patients. This leads the fewer accidents from miscommunication, better preventive care, and improved patient satisfaction.

Simple Healthcare System Architecture

The application of the Internet of Things (IoT) in healthcare transforms it into more smart, fast and more accurate. There is different IoT architecture in healthcare that brings start health care system.

Product Infrastructure: IoT product infrastructure such as hardware/software component read the sensors signals and display them to a dedicated device.

Sensors: IoT in healthcare has different sensors devices such as pulse-oximeter, electrocardiogram, thermometer, fluid level sensor, sphygmomanometer (blood pressure) that read the current patient situation (data).

Connectivity: IoT system provides better connectivity (using Bluetooth, WiFi, etc.) of devices or sensors from microcontroller to server and vice-versa to read data.

Analytics: Healthcare system analyzes the data from sensors and correlates to get healthy parameters of the patient and on the basis of their analyze data they can upgrade the patient health.

Application Platform: IoT system access information to healthcare professionals on their monitor device for all patients with all details.

IoT challenges in Healthcare

- Data security & privacy
- Integration: multiple devices & protocols
- Data overload & accuracy
- Cost

Impact of Internet of Things (IoT) on lifestyle

In this post we will discuss about **Internet of Things technology contribution in the improving the standard of living** and how it will continue to make our lives easier in the upcoming years. This is just a glimpse of what will happen in the next few years.

Internet of Things technology brings Secured lifestyle

With the world getting violent and insensible with each passing day, security is always a major concern these days not only for people living in metros but also for the families in small town. However Internet of things has a solution to this problem by making home security devices ***smarter and responsive***.

If your work demands you to stay out of the home for long hours leaving elders and kids alone back home you can now rely on smart devices like alarms and cameras which will instantly notify you during suspicious activities. The future home surveillance devices will be smart enough to take actions on their own to *avoid any emergency situation*.

Imagine you are out on a meeting and someone tries to break in to your house. The moment he tries to cross the first barrier, I,e the gate notifications will start reaching your phone. Also the alarms are cleaver enough to ring forcing the burglar to run for his life.

IoT makes Fitness easier

In this competitive world of today, one needs to stay fit and healthy in order to work hard. Internet of things plays a significant role in the **field of fitness** too. With devices like *Cue, HAPIfork, fitbit* and so on, staying fit has become fun and easy. These gadgets can give feedback based on your performance and advice you to perform certain activities in the proper way as done by Smart Mat. *Cool isn't it?*

Smart world

Imagine your washing machine cleaning your clothes all of its own, your Air conditioner adjusting the motor speed depending on the environment, your car sending a signal to your smart phone to change your tyres during low pressure or your bike giving you signals about a required servicing! With all the devices connected to each other the world will obviously become a better place to live in**.**

Bill payments, recharge and tax payments will be handled automatically by the smart system thanks to Internet of things.

One more advantage of having a smart home is that the devices will be able to optimize themselves in order to save electricity and un necessary expenses. Lights and fans in the living room will be able to switch off and on by sensing the presence of human beings inside the room.

Internet of Things technology makes Shopping Intelligent

If we say a day will soon come when your refrigerator and smart kitchen cupboards will have the ability to fill your shopping cart on their own, will you believe us? No? Well connected refrigerators and kitchen cupboards of future will be able to ***detect the things you need to buy with the help of sensors fitted in them***.

A signal will be sent to e-commerce sites and your shopping cart will be automatically filled up. However your final consent will be needed to complete the transaction.

Needless to mention the transaction will also become much safer by the virtue of multi-layered protection.

Remote home control

Starting from washing machines, lights, air conditioners and so on you can control every single equipment in your house from a remote location. You can lock and unlock the main door at your convenience to let in guests even when you are away from home.

Gone are the days when you need to worry about leaving the keys under the flower pot just beside the main door. What's cool is that you literally need not worry about carrying keys even!

Travelling

A lot of smart travelling gadgets have already started to knock the market making life of travelers and tourists easier than ever before. Hotels can give their guests a good time by enabling sensors in devices like coffee machines, Air conditioners, thermostats etc which will together work as a connected system and change their individual functions depending on the situations.

Starting from hotels, cab services to airlines and railways a revolution has started to come and the effect will be soon felt in a few years from now.

Safer roads

Yes the *intelligent Traffic signals and traffic control systems* will be able to work on their own based on real life situations without any manual help.

The **Autonomous intersection management** for example is a concept which will make vehicles smart enough to slow down or speed up depending upon the signal obtained from the sensors.

As stated earlier, this is just the beginning of the show and the scope of IoT is limitless. In the next 6-7 years we will see a lot of innovative and smart devices in the market with extraordinary functions and capabilities. One thing that is sure that we are entering a future which will be smarter and connected than ever before.

Final Words

Lastly, we hope even you guys agree with the fact that internet of things has actually made a great impact on each and everyone's life.

The Internet-of-Things era is unrolling before our eyes and we are all the beneficiaries of the innovation it brings, whether it's at home, at work, in the streets or in our cars. In general, it is meant to make things simpler for us. But there is one area where it does more than that: it makes us aware of our lifestyle with long-term benefits for our health.

Mass adoption of IoT-based products in users' everyday lives validate the progress brought by this technology and already shows results in the human behavior with more and more people preoccupied for their health. The ultimate result is increased life expectancy and quality.