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Real life Applications of Internet of Things

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Abstract : The Internet of Things is the next technological revolution after the revolution of computer and internet. IoT integrates the new technologies of computing and communication (e.g. Sensor networks, RFID, Mobile communication and IPV6 etc). The Internet of Things is an emerging topic of technical, social, and economic significance. The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate exchange and consume data with minimal human intervention. Internet connect "all people", Internet of Things connect "all things". Interconnection of Things or Objects or Machines, e.g., sensors, actuators, mobile phones, electronic devices, home appliances, any existing items and interact with each other via Internet.

1. Evolution of IoT

The term "The Internet of Things" was coined by Kevin Ashton in a presentation to Proctor & Gamble in 1999. Ashton is a co founder of MIT's Auto ID Lab. He pioneered RFID use in supply chain management. Internet of Things means "Sensors and actuators embedded in physical objects are linked through wired and wireless networks, often using the same Internet Protocol (IP) that connects the Internet. There is, however, no single, universal definition. Within the Internet Engineering Task Force (IETF), the term "smart object networking" is commonly used in reference to the Internet of Things. In this context, "smart objects" are devices that typically have significant constraints, such as limited power, memory, and processing resources, or bandwidth. Projections for the impact of IoT on the Internet and economy are impressive, with some anticipating as many as 100 billion connected IoT devices and a global economic impact of more than $11 trillion by 2025.

So far IoT has been gaining attraction in industry such as logistics, manufacturing, retailing and pharmaceutics. With the advances in wireless communication, smart phone, and sensor network technologies, more and more networked things or smart objects are being involved in IoT. As a result, these IoT related technologies have also made a large impact on new ICT and enterprise systems technologies (see Fig. 1).

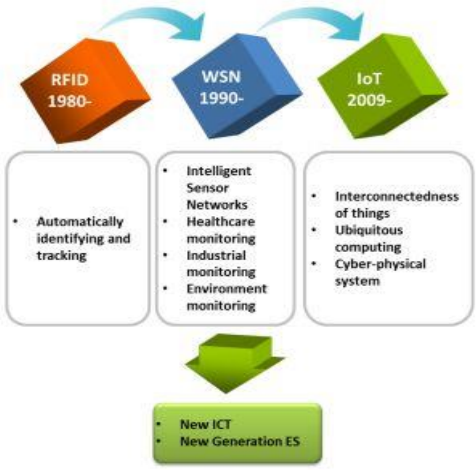

Fig. 1. IoT related technology and their impact on new ICT and enterprise system

The Internet of Things (IoT) is an important topic in technology industry, policy, and engineering circles and has become headline news in both the specialty press and the popular media. This technology is embodied in a wide spectrum of networked products, systems, and sensors, which take advantage of advancements in computing [1] power, electronics miniaturization, and network

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interconnections to offer new capabilities not previously possible.

This technology promises to be beneficial for people with disabilities and the elderly, enabling improved levels of independence and quality of life at a reasonable cost. IoT systems like networked vehicles, intelligent traffic systems, and sensors embedded in roads and bridges move us closer to the idea of "smart cities'', which help minimize congestion and energy consumption. IoT technology offers the possibility to transform agriculture, industry, and energy production and distribution by increasing the availability of information along the value chain of production using networked sensors. However, IoT raises many issues and challenges that need to be considered and addressed in order for potential benefits to be realized.

IoT primarily exploits standard protocols and networking technologies. However, the major enabling technologies and protocols of IoT are RFID, NFC, low-energy Bluetooth, low-energy wireless, low-energy radio protocols, LTE-A, and WiFi-Direct. These technologies support the specific networking functionality needed in an IoT system in contrast to a standard uniform network of common systems.

1.1. Radio Frequency Identification Technology (RFID)

Radio Frequency Identification Technology has moved from obscurity into mainstream applications that help speed the handling of manufactured goods and materials. RFID enables identification from a distance, and unlike earlier bar-code technology, it does so without requiring a line of sight. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data such as manufacturer, product type, and even measure environmental factors such as temperature. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance. In contrast, consider a supermarket checkout counter, where you must orient each bar-coded item toward a reader before scanning it. RFID is increasingly used with biometric technologies for security. RFID is used to automatic data capture allowing contact less identification of objects using radio frequency.

1.2. Radio Protocols

ZigBee, Z-Wave, and Thread are radio protocols for creating low-rate private area networks. These technologies are low-power, but offer high throughput unlike many similar options. This increases the power of small local device networks without the typical costs.

1.3. LTE-A

LTE-A, or LTE Advanced, delivers an important upgrade to LTE technology by increasing not only its coverage, but also reducing its latency and raising its throughput. It gives IoT a tremendous power through expanding its range, with its most significant applications being vehicle, UAV, and similar communication.

1.4. Wireless Fidelity Direct

Wireless Fidelity Direct eliminates the need for an access point. It allows P2P (peer-to-peer) connections with the speed of Wireless Fidelity but with lower latency. Wireless Fidelity Direct eliminate an element of a network that often bogs it down, and it does not compromise on speed or throughput.

1.5. Wireless Sensor Network (WSN)

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location. WSNs measure environmental conditions like temperature, sound, pollution levels, humidity, wind, and so on.

Wireless sensor network (WSN) as an ''exciting emerging domain of deeply networked systems of low-power wireless motes2 with a tiny amount of CPU and memory, and large federated networks for high-resolution sensing of the environment''. Sensors in a WSN have a variety of purposes, functions, and capabilities. The field is now advancing under the push of recent technological advances and the pull of a myriad of potential applications. The radar networks used in air traffic control, the national electrical power grid, and nationwide weather stations deployed over a regular topographic mesh are all examples of early-deployment sensor networks; all of these systems, however, use specialized computers and communication protocols and consequently, are very expensive. Much less expensive WSNs are now being planned for novel applications in physical security, health care, and commerce. Sensor networking is a multidisciplinary area that involves, among others, radio and networking, signals processing, artificial intelligence, database management, systems architectures for operator-friendly infrastructure administration, resource optimization, and power management

2. Applications of IoT

2.1. Smart Home Automation

Internet of Things (IoT) conceptualizes the idea of remotely connecting and monitoring real world objects (things) through the Internet [1]. When it comes to our house, this concept can be aptly incorporated to make it smarter, safer and automated. This IoT project focuses on building a smart wireless home security system which sends alerts to the owner by using Internet in case of any trespass and raises an alarm optionally. Besides, the same can also be utilized for home automation by making use of the same set of sensors. The leverage obtained by preferring this system over the similar kinds of existing systems is that the alerts and the status sent by the Wifi connected microcontroller managed system can be received by the user on his phone from any distance irrespective of whether his mobile phone is connected to the internet.

Smart home automation is very popular due to its numerous benefits in promising area, these techniques will controls all the electronic devices which will reduce the human involvement to get minimize. It will provide various benefits such as greater safety, comfort, and security, a more rational use of energy and other resources thus contributing to a significant savings. This research application domain is very important and it will implement in future as it offers very powerful means for supporting and helping special needs of the elderly and people with disabilities for monitoring and control of home appliances. There are a number of factors that needs to be considered when designing a smart home system. The system is very friendly with the dramatic increase in smart phone users, smart phones have gradually turned into all-purpose portable devices where the people can provide for their daily use. In this paper, a low cost wireless controlled smart home system for controlling and monitoring the home environment is presented. Embedded micro-web server with real IP connectivity is used for accessing and controlling of appliances and other devices remotely from an Android based app, which can be used from any Android supported device. The Raspberry pi is used for the micro web server thus eliminating the use of PC and the system requires user authentication in order to access home automation system in smart home.

Voice activation for switching applications may also incorporate to aid users especially for the elderly and the disabled persons. Smart homes require sophistication control in its different gadgets which are basically electronic appliances. This has revolutionized the area of home automation with respect to a rapid increased level of affordability and simplicity through the integration of home appliances with smart phone and tablet connectivity. Smart phones are already feature-perfect and can be made to communicate or interact with the other devices in an ad hoc network which has the connectivity options like Bluetooth and Wi-Fi. With the advent of mobile phones, Mobile applications development has seen a major outbreak. To Utilizing this opportunity for a smart home, select the mobile phone commonly because it is found in normal household can be joined in a temporary network inside a home with the electronic equipment's. Android, by Google Inc. provides the platform for the development of the mobile applications for the Android devices.

According to the International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker, Android maintained its position in global market share. Bluetooth is a short-range wireless communication technology that comes in handy as the solution while communicating over an adhoc topology network environment like connecting the home appliances with home environment with mobile phones. The job of a sensor is to convert a physical quantity into numerical data. A single sensor or a number of different types of sensor can be integrated into one single device to collect data from the same spot which can be referred as a sensor node. When many sensor nodes are organized into a distributed network to collect the data from a large indoor environment, call this a sensor network. A data communication link through wire can be established for each of these nodes to transmit collected data to a central data collection sink node. The use of wire has become primitive and proved to be cumbersome for the sensor nodes residing far from the user.

Objectives of HAS (Home Automation Systems):

a. Controlling Home Appliances via Application: To develop an application that includes the features of switches mode application. Switch Mode can be used to control the switches of home appliances.
b. Real Time Video Streaming from Web Camera: To receives the quality video for the camera to the android application. Internal block diagram of Wireless Temperature sensor
c. Secure Connection Channels between Application and Raspberry pi: Use of secure protocols over Wi-Fi so that other devices cannot control the home appliances. There are some Options for securing the connection in SSL over TCP, SSH.
d. Controlled by any device capable of Wi-Fi (Android, IOS, PC): To make the home appliances flexible in control, any device can be capable of using Wi-Fi based connectivity which will control the home appliances from remote location.
e. Extensible platform for future enhancement: The application is to be highly extensible, with possibility of adding features in the future as needed.

2.2. Intelligent Transportation

Wireless sensing in intelligent transportation differs on several points from the traditional concepts and design requirements for WSN. In most cases, sensors can rely on some sort of infrastructure for power supply, for example the aspect of energy efficiency is usually of secondary importance in these systems. WSN applications in intelligent transportation can be subdivided into two categories: 1) Stationary sensor networks, either on board of a vehicle or as part of a traffic infrastructure. 2) Floating sensor networks, in which individual vehicles or other mobile entities act as the sensors. The latter category comprises applications related to the tracking and optimization of the flow of goods, vehicles and people, whereas the former comprises mainly applications that were formerly covered by wired sensors.

2.3. Sensing of Network Traffic Flows

Intelligent traffic management solutions rely on the accurate measurement and reliable prediction of traffic flows within a city. This includes not only an estimation of the density of cars on a given street or the number of passengers inside a given bus or train but also the analysis of the origins and destinations of the vehicles and passengers. Monitoring the traffic situation on a street or intersection can be achieved by means of traditional wired sensors, such as cameras, inductive loops, etc. While wireless technology can be beneficial in reducing deployment costs of such sensors, it does not directly affect the accuracy or usefulness of the measurement results.

However, by broadening the definition of the term “sensor” and making use of wireless technology readily available in many vehicles and smart phones, the vehicles themselves as well as the passengers using the public transportation systems can become “sensors” for the accurate measurement of traffic flows within a city. Techniques for collecting traffic flow data from vehicles are collectively referred to as floating car data (FCD). This includes methods relying on a relatively small number of vehicles explicitly transmitting their position information to a central server (e.g. taxis or buses sending their position obtained via GPS) as well as approaches relying on location information of mobile phones obtained from real-time location databases of the cellular network operators. The latter approach does not actually involve any sensing by the vehicle itself, but still makes use of a wireless network (i.e. the existing cellular network) to sense or rather infer the current characteristics of traffic flows. The technical challenges lie particularly in the processing of the potentially large amounts of data, the distinction between useful and non-useful data and the extrapolation of the actual traffic flow data from the observation of only a subset of all vehicles. Extensions of the FCD idea involving information gathered from the on-board electronics of the vehicles have been proposed under the term extended floating car data (XFCD). Collecting and evaluating data from temperature sensors, rain sensors, ABS, ESC and traction control system of even a relatively small number of cars can be used to derive real-time information about road conditions which can be made available to the public and/or used for an improved prediction of traffic flows based on anticipated behavior of drivers in response to the road conditions. Privacy issues must be taken into consideration whenever location or sensor data is collected from private vehicles.

However, this is a general concern related to the monitoring of traffic flows, and schemes that don’t make use of wireless technology (e.g. relying on license-plate recognition) also have to consider the car owners’ privacy. Equivalent to the measurement of vehicle movement by FCD, passenger behavior in public transportation systems can be analyzed with the help of wireless technology. For example electronic tickets, which typically employ RFID technology for registering the access to a subway station, bus or tram, effectively turn the passenger into a part of a sensor network, shown in Fig. 2.

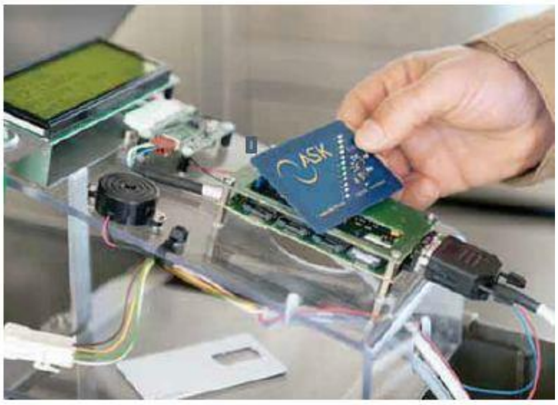

Fig. 2. Electronic tickets for smarter travel

The possibilities for gathering information about passenger movement and behavior can be further increased if smart phones are used to store electronic tickets. Especially for gathering information about intermodal transportation habits of passengers, electronic ticket applications for smart phones offer possibilities that conventional electronic tickets cannot provide. It remains to be seen, however, to which extent users will be willing to share position data in exchange for the convenience of using their mobile phone as a bus or metro ticket.

2.4. City Logistics

Urbanization is posing a lot of challenges, especially in rapidly developing countries where already huge cities are still growing and the increasingly wealthy population leads to a constantly rising flow of goods into and out of the city centers. Delivery vehicles account for a large portion of the air pollution in the cities, and streamlining the flow of goods between the city and its surroundings is the key to solving a lot of the traffic problems and improving the air quality. A promising approach towards reducing the traffic load caused by delivery vehicles is the introduction of urban consolidation centers (UCCs), i.e. warehouses just outside the city where all the goods destined for retailers in a city are first consolidated and then shipped with an optimized routing, making the best possible use of truck capacity and reducing the total number of vehicles needed and the total distance travelled for delivering all goods to their destinations. To achieve such optimization, careful analysis and planning of traffic flows in the city as well as monitoring of the actual flow of the goods are needed. Rather than just tracking a subset of vehicles as they move through the city, tracking of goods at least at a pallet level is required. The pallet (or other packaging unit) thus becomes the "sensor" for measuring the flow of goods, and a combination of multiple wireless technologies (GPS, RFID, WLAN, cellular) in combination with sophisticated data analysis techniques are applied to obtain the required data for optimizing the scheduling and routing of the deliveries and ensure timely arrival while minimizing the environmental impact of the transportation.

2.5. On-board Wireless Sensor Networks

Vehicles of all kinds rely on an increasingly large number of sensors to ensure safe and smooth operation. This includes sensors primarily providing information to the driver as well as sensors that are part of the propulsion or vehicle dynamics systems. Due to the safety-critical nature of those subsystems, wireless technology is not usually a feasible option for these applications.

However, especially in large vehicles such as busses, trains, and airplanes, a lot of sensors and actuators serve non-safety-critical purposes, e.g. monitoring cabin temperature, collecting data used in preventive maintenance of the vehicle or monitoring the status of transported goods. In railway applications, WSNs can play an important role in the refurbishment of old carriages with state-of-the-art electrical systems. In airplanes, saving the weight of copper or aluminum cables by applying wireless sensors for non-critical applications is an important consideration. Wireless sensors employing energy harvesting techniques have been discussed even for monitoring the mechanical stress on composite materials forming part of the aircraft structure. Wiring the sensors in such "smart materials" would increase the weight of the structure and therefore significantly reduce the advantages of the composite material over conventional metal structures.

2.6. Smart Roads Infrastructures

The use of sensors can contribute to these projects by creating a series of smart applications that may lead to a better and safer world. Throughout the years, many transport infrastructures-bridges, tunnels or viaducts-have collapsed due to natural disasters or because of poor maintenance. One of the best examples is the bridge in Minneapolis in 2007 that killed 13 people and injured 145. In 2008, this bridge was re-built using a sensing system to collect data regarding structural behavior and corrosion.

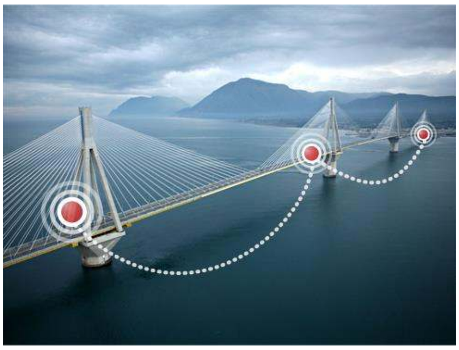

Fig. 3. Charilaos Trikoupis Bridge (Greece)

Monitoring bridges is one of the more successful applications of Smart Roads. For instance, the six-lane, 2.9 km Charilaos Trikoupis Bridge (see Fig. 3 above) in Greece is outfitted with 100 sensors that monitor its condition. Soon after opening in 2004, the sensors detected abnormal vibrations in the cables holding the bridge, which led engineers to install additional weight to dampen the cables. The sensor networks for these kinds of bridges include accelerometers, strain gauges, anemometers, weigh-in-motion devices and temperature sensors.

Wireless sensors can also be used to monitor the state of road surfaces. For example, the Massachusetts Institute of Technology (MIT) carried out a research project to detect the number of potholes in a road, using Boston taxis to cover the entire city. A similar approach was undertaken by the University of Sri Lanka to monitor Sri Lanka´s roads.

Additionally, monitoring systems in tunnels are also widespread around the world. From air flow to visibility, and a wide range of gases (CO, CO2, NO2, O2, SH2 and PM-10) are the most demanded parameters to monitor air quality inside tunnels. At this time, many of these systems are wired installations: the deployment of Wireless Sensor Networks would save money, increase safety and reduce installation times.

Weather conditions are highly related to road safety. There are a lot of different weather applications in which Wireless Sensor Networks can improve safety in our roads. Weather stations or remote sensors to measure temperature, humidity and other similar parameters are already being used in highways to make them Smart Roads. But why not extend it at a higher level? As an example, the Madrid city government has recently installed a series of temperature sensors buried under the road surface to monitor the appearance of ice plates in real time. Furthermore, other real time applications are being developed and carried out using wireless sensors, such as monitoring water levels on viaducts, creating noise maps in roads close to cities or even monitoring traffic congestion. Fortunately, the use of Smart Roads technology has only just begun. Do you want to know what´s next?

Road traffic fatalities are one of the most important causes of death globally. According to the

World Health Organization (WHO), more than 150,000 people will be killed on the roads by 2020, since cars will be more present in developing countries, increasing the number of vehicles on the world´s roads up to 2 billion. Weather conditions affect road safety - therefore, the use of sensors and smart applications could reduce the number of road accidents. Smart Roads could take advantage of solar energy for power, clearing city streets of ice and snow by simply melting it away. Furthermore, temperature-responsive dynamic paint could be used to make ice crystals visible to drivers when cold weather makes road surfaces slippery.

Smart Lighting could also be applied to Smart Roads by fitting the roads with power-saving lights that gradually brighten as vehicles approach then switch themselves off after they pass. In fact, a photo-luminescent paint for road markings is about to be used in the Netherlands. This paint would charge during the day to illuminate the tarmac for up to 10 hours overnight.

Current and future Smart Roads applications can be carried out with Libelium´s horizontal solution. Wasp mote wireless sensors have a number of characteristics that make them ideal for infrastructure usage, such as wireless communication capacities, autonomous power, security and small size. Wasp mote devices have an internal lithium battery that allows them to run for months and even years, as part of an efficient energy management infrastructure system.

Fig. 4. Wasp mote Plug & Sense

From monitoring a bridge to a tunnel, Wasp mote already integrates an accelerometer and accommodates up to 8 different sensor boards, to cover all the previous described Smart Roads applications. A new line of encapsulated devices Wasp mote Plug & Sense, (see Fig. 4 above) come equipped with six connectors to which sensor probes can be attached directly, allowing services to be scalable, sustainable and easy to deploy. The Wasp mote Plug & Sense! Platform may be solar powered to allow energy harvesting and years of autonomy. Once installed, the sensor nodes can be programmed wirelessly thanks to an over-the-air programming (OTAP) feature. Sensors can be replaced or added without having to uninstall the mote itself, keeping maintenance costs to a minimum.

2.7. Intelligent Traffic Light Flow Control System

Traffic lights at intersections are usually controlled by units located close to the intersection, taking inputs from a set of sensors (e.g. inductive loops) as well as commands from a centralized control unit and switching the individual lights (also known as signal heads) according to the traffic rules and situational requirements. With the number and complexity of sensors and display elements increasing, the task of a traffic controller today is really based on communication rather than a pure switching of the connected components. Traffic lights may be equipped with count-down timer displays, variable message signs display updates speed limits, and optical or radar-based sensors deliver information about the occupancy of individual lanes or the speed of vehicles passing the intersection. Upgrading the infrastructure of an existing intersection with state-of-the-art technology requires also providing the necessary communication links between sensors, signal heads, variable message signs, traffic controllers and other components. Wireless technology can help reduce the cost by eliminating the need to route communication cables (e.g. Ethernet) to all devices in an intersection. Such an installation will in most cases not be a pure sensor network, as it will usually also include display components or actuators.

Furthermore, a combination of wired and wireless communication links and possibly even a combination of different wired/wireless standards within the same system due to a combination of components from different vendors is not unlikely. Interaction of the traffic infrastructure with vehicles through wireless communication (e.g. granting priority to busses or emergency vehicles at intersections) is another promising application for wireless technology in traffic infrastructure. Though not all possible applications actually involve the exchange of sensor data over the wireless communication links, there are also a number of scenarios in which either vehicles share their sensor data with the infrastructure elements (e.g. regarding speed when approaching the intersection) or where the infrastructure provides sensor data to the vehicles (e.g. regarding road congestion on the other side of the intersection).

Design of traffic light Wireless Sensors Networks is used as communication infrastructure in the proposed traffic light controller. It had designed, built, and implemented a complete functional WSN and used it to validate our proposed algorithms. The functional TSN was built using some available of-the-shelf components, shown in Fig. 5.

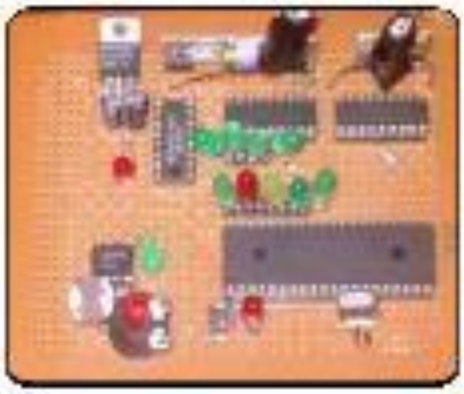

Fig. 5. The in-house built traffic sensor node

The entire TSN is encased in such a manner to be placed on pavement made on the testing roads. For the system components to be able to communicate (e.g., traffic control box and the BS), a traffic WSN communication and vehicle detection algorithms were devised. To be specific, two algorithms are developed, namely, the traffic system communication algorithm (TSCA) that is presented in this section and the traffic signals time manipulation algorithm (TSTMA), which is presented in the next section. These algorithms interact with each other and with other system components for the successful operation of the control system. To illustrate, the components of our traffic control system and their interactions. The process starts from the traffic WSN (which includes the TSNs and the traffic BS), the TSCA, and the TSTMA, and ending by applying the efficient time setting on the traffic signals for traffic light durations. The TSCA is developed to find and control the communication routes between all the TSNs and the BS as well as the interfacing with the traffic control box in a simple and power efficient manner.

2.8. Smart Healthcare

One of the application domains that can benefit from IoT solutions is e-health, which can be defined as the health care practice supported by electronic devices and information and communications technologies and that can include electronic medical records, electronic prescriptions, remote monitoring, and health knowledge management. In the e-health context, wireless body sensors are small biomedical devices that are placed on the human body or are hidden under clothing. These devices have wireless capabilities in order to allow increasing patient comfort and mobility, thus not impairing his/her normal activities while monitoring his/her health status regardless his/her location. In this perspective, such devices they can improve the quality while reducing costs of medical services by paving the way for the development of advanced, innovative health care monitoring applications.

IoT-based healthcare systems deal with human-related data. Although collected from innocuous wearable sensors, such data is vulnerable to top privacy concerns. In IoT-based healthcare applications, security and privacy are among major areas of concern as most devices and their communications are wireless in nature. Due to direct involvement of humans in IoT-based healthcare applications, providing robust and secure data communication among healthcare sensors, actuators, patients, and caregivers are crucial. Misuse or privacy concerns may restrict people to utilize IoT-based healthcare application.

IoT enables people and objects in physical world as well as data and virtual environments to interact with each other, hence realizing smart environments such as: smart transport systems, smart cities, smart healthcare, and smart energy as part of a prosperous digital society. The rising cost of healthcare, and the prevalence of chronic diseases around the world urgently demand the transformation of healthcare from a hospital centered system to a person-centered environment, with a focus on citizens' disease management as well as their wellbeing.

Recently, there have been efforts in designing Smart e-Health Gateways for IoT-based healthcare applications. In most of IoT-based healthcare applications, especially in smart homes/hospitals, there exists a bridging point (i.e., gateway) between a sensor network and the Internet which often just performs basic functions such as translating between the protocols utilized in the Internet and sensor networks. In a smart home/hospital, where the mobility and location of patients are confined to hospital facilities or buildings, gateways can play a key role. The stationary nature of such gateways enables them with the exclusivity of being non-resource constrained in terms of power consumption, memory, and communication bandwidth. This property can be exploited by outsourcing some burden of resource-constrained medical sensors/actuators to be performed on smart e-health gateways. By taking responsibility for handling some burdens of a sensor network and a remote health-care center, smart e-health gateways can cope with a number of challenges in ubiquitous healthcare systems such as security, scalability, and reliability.

A close attention that required to hospitalized patients whose physiological status should be monitored continuously can be constantly done by using IoT monitoring technologies. For smart health sensors are used to collect comprehensive physiological information and use gateways and the cloud to analyze and store the information and then send the analyzed data wirelessly to caregivers for further analysis and review as shown in Fig. 6. It replaces the process of having a health professional come by at regular intervals to check the patient's vital signs, instead providing a continuous automated flow of information. In this way, it simultaneously improves the quality of care through constant attention and lowers the cost of care by reduces the cost of traditional ways of care in addition to data collection and analysis [6].

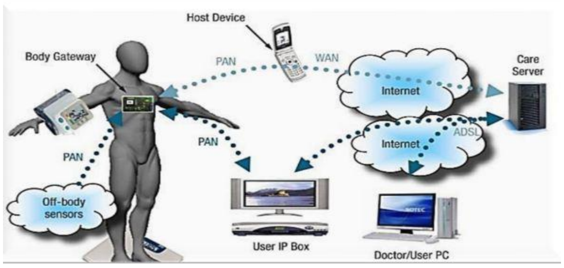

Fig. 6. Smart healthcare concept

2.9. Smart Healthcare

The AMBRO mobile gateway architecture considers four modules: i) the BSN, ii) the mobile gateway, iii) the AMBRO cloud, and iv) IPA of the caretaker, as depicted in Fig. 7. The BSN module is composed by sensors that monitor the person in real time. On this case, there are two types of devices: one Shimmer [2] using an accelerometer and a gyroscope for fall detection, and a smart watch with an embedded heart rate sensor to count the number of heart beats. The information gathered by both sensors is transferred to the mobile gateway through a Bluetooth connection (the smart watch uses Bluetooth Low Energy, while the Shimmer module uses Bluetooth class 2). The mobile gateway module corresponds to the Smartphone that has the AMBRO mobile gateway installed, which allow the monitoring services to be controlled. One of those monitoring services (the location monitoring service) uses the GPS receiver of the smart phone to accurately determinate the position of the monitored person. The data gathered by the monitoring services is forwarded to the AMBRO cloud through REST full Web services by using the HTTP. Inside the AMBRO cloud, the information is stored and then processed by the multiple logical modules available there. If some indicator about the monitored person is alarming, a notification is generated to the caretaker IPA through a push notification mechanism.

The location monitoring service is a tracking service used to retrieve the position of the user through the smart phone GPS. Using the low power embedded sensors of the smart phone (e.g., barometer, gyroscope, and accelerometer), this service is also able to discover the activity performed by the user. This is possible by using the Google's Activity Recognition API [3], which enables the detection of multiple possible activities for the user (e.g., still, walking, running, driving a vehicle, riding a bicycle).

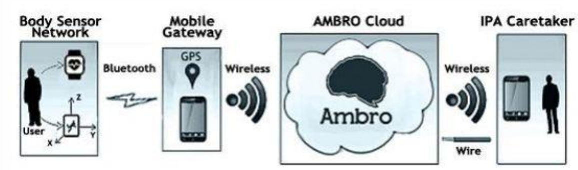

Fig. 7. Illustration of the AMBRO mobile gateway architecture

2.10. Power Consumption

The devices' power consumption in IoT environments is very important to evaluate the system performance on such scenarios [4]. This is due to the characteristics presented by IoT devices, such as high mobility, limited power supply, and capacity to communicate anytime and anywhere. To respect all these conditions without degrading the system performance, some strategies need to be applied. One of those strategies considers that objects only communicate when it is strictly necessary. By doing this, the quick discharge of the devices' batteries is avoided. Different experiments were conducted on the AMBRO mobile gateway application to evaluate the parameters that were changeable to make the power consumption of the system optimized. For the location monitoring and heart rate monitoring services, different experiments were performed by simply changing the rate on which activity detection updates were requested. Another parameter changed for each experiment performed on the heart rate monitoring service was the periodicity at the data was sent to the AMBRO cloud. On the fall detection service, the reading frequency for the acceleration and for the angular velocity on the Shimmer module changed for each scenario the AMBRO mobile gateway was experimented. To perform the experiments for the mobile gateway role, it was used a Samsung Galaxy Express 2, equipped with the Android OS 4.4.2, CPU dual-core 1.7 GHz, internal memory up to 8 GB, 1.5 GB RAM, BLE connectivity, and Wi-Fi, 2G, 3G, 4G and LTE wireless network connectivity. It was also used a Moto 360 smart watch, equipped with the Android Wear OS (version 5.0.2), a Texas Instruments OMAP 3 processor, 4 GB of internal memory and 512 MB RAM to measure the heart rate of a monitored person. In order to evaluate the results returned for each experimental scenario correctly, it was needed to verify how many hours the battery of the smartphone and the battery of the smart watch could handle when performing normal daily life tasks,. So, it was ascertained that both smartphone and smart watch could handle, in average, 40 hours without discharging completely their batteries. Table II presents the first experimental scenario that evaluated the power consumption of the devices available in the AMBRO mobile gateway communication environment.

2.11. Smart Environment

Environment plays a major effect in human life. People, even animals, birds, fishes and plants may be affected in unhealthy environment. There were many researches efforts has been paid to solve the problems of environmental pollution and waste resources [7]. Creating of a healthy environment is not easy because of industries and transportations wastes, with irresponsible human activities are daily factors that make the environment damaged [8]. The environment needs a smart ways and new technologies for monitoring and management. Monitoring the environment is important in order to assess the current condition of the environment to takes correct life decision according to collected data from monitoring systems, and management is needed to have an efficient resources consuming and use in addition to decrease the factories and vehicles wastes. Both monitoring and waste management provide a large amount of data to force the health standard by governments or healthy environment organizations to protect people and environment, and to mitigate or to avoid natural disaster that might occur [9].

Smart environment is an important technology in our everyday life which provides many facilities and solutions for many environmental applications such as water and air pollution, weather and radiation monitoring, waste management, natural disaster, and many other environment indicators as shown in Fig. 9 and all may connected to each person's through home area network. Smart environment devices integration with Internet of Things (IoT) technology is developed for tracking, sensing and monitoring objects of environment which provide potential benefits to achieve a green world and sustainable life [10]. There are many applications of internet of things in environment and that can be divided to two main categories environmental resources management, and environmental quality and protection management [11]. The resources management relates to all natural resources include animals, planets and forests, birds and fishes, coal , petroleum , land, freshwater, air and heavy metals including gold, copper and iron. All these resources are likely to decrease significantly or affected by several factors, including pollution, waste, and abuse. IoT can provides an effective way to communicate between each of these resources sensors with research and monitoring centers to make appropriate decisions in the consumption of these sources. Renewable resources include sunlight, and wind also can be managed and sensed to Ideal use in several uses, such as the provision of renewable energy sources. IoT can control these sources and their use in a number of important applications in the environment [12].

The IoT technology is able to monitoring and managing the air quality by to collecting data from remote sensor across the city, and providing full-time geographic coverage to achieve a way of better managing urban traffic in major cities [13]. The IoT also can be used to measure the levels of pollution in water in order to inform decisions on water usage and treatment. Waste management is also one of the most important environment issues [14]. The various types of waste material chemical or elements can pollute the environment and threaten life in a number of ways in ground effect on animals, peoples and plants and in addition to air and water. IoT provides an environmental protection means by control the industrial pollution by real time monitoring and management systems integrated to supervision and decision-making networks to reduce waste, and improved environment [15]. Other environment aspect is a weather forecast and monitoring.

IoT can provide a high resolution, and accuracy for weather monitoring by data exchange and information sharing. It's enabling weather systems to collect data from various vehicles on the road, and wirelessly communicate to the weather stations to support data that is inclusive of air temperature, barometric pressure, visibility or light, motion and other data needed. Sensors equipped in many buildings, vehicles integration with IoT help in collecting weather data which is further stored in clouds for analysis [16]. Radiation of course is one of the most serious problems facing the safety of the environment. The radiation produced by nuclear power plants and some industries negatively affected safety of an environmental and human health, animal and agricultural productivity [17]. For nuclear radiations, radiation control IoT sensor network is able to continuous monitoring of radiation levels around nuclear facilities for leakage detection and propagation prevention [18]. The sensors network formed by wireless link dozens of sensor devices in areas surroundings nuclear power plants with closes proximity to cities [19]. A natural disaster is a major adverse event resulting from natural processes of the earth include floods, volcanic eruptions, earthquakes, hurricanes, wildfires, blizzards and, and other geologic processes.

IoT can avoid or reduce the impact of a large number of natural disasters that affect in many aspects of life through the distribution of a number of sensor systems for many types of natural disasters and linking these systems with research and rescue announcement stations, also for declaration of emergency networking with hospitals and police stations [20]. IoT will provides a means of smart agriculture and adding great potential in resource saving. By using sensors networks, and scientific research databases, growing of plants and other agriculture productions needed by humans like vegetables and fruits can monitored and save their production processes based on managing many resources such as weather, water and sunlight. In addition, the IoT for environmental monitoring can aid in measuring emissions from factories detect forest fires or aid in agriculture [21].

2.12. Agricultural Information Technology (AIT)

Smart farming: Wikipedia defined IOT in this way: put sensors in electricity grid, railway, bridge, tunnel, road, building, water supply system, dam, oil and gas pipes, appliance, etc., and connect the internet, so as to operate certain programs and realize remote control. The central computer can realize concentrated management and control of machine, equipment and personnel based on the internet and improve production and life through more detailed and dynamic means. This is useful for integration and harmony between human society and the physical world and is regarded as the third wave of information industry development following computer and internet [22]. Major IOT technologies include radio frequency identification technology, sensor technology, sensor network technology and internetwork communication, all of which have been involved in the four links of IOT industrial chain, namely, identification, sensing, processing and information delivery [23]. Internet of things and RFID technologies can help build plant factory and realize automatic control production of agriculture. The IoT can help farmers to reduce waste and improve productivity. For example, studies show as much as 60% of irrigation water is wasted. A smart irrigation system can collect data on soil conditions and plant needs, so as to selectively water different plots of land. 14 European pilot sites for the Waterbed system demonstrated a 40% reduction in water use. Data can also be combined with weather forecasts to hold off irrigation if rain is imminent. Smart farms can also benefit from other kinds of intelligent objects. 'Smart' bins and silos can report on the levels of grain and other feedstuffs they contain to simplify management and avoid risky physical checks. These devices can also send alerts when temperatures in the containers rise to levels that might damage or degrade their contents.

IOT technology in terms of modern farm produce mainly consists of soilless culture and culture solution control technology, artificial photosynthesis technology, growing environment control technology (carbon dioxide density, humidity, wind pressure and speed), intelligent irrigation technology, etc. IOT technology and method is used in farm produce production with plant factory technology as integration. Plant factory is a highly efficient agricultural system that achieves continuous production of crops around the year through highly accurate control to environment within the facility. It uses computer to automatically control temperature, humidity, carbon dioxide concentration and culture solution of crops, so as to achieve labor-saving production of crops which are subject to no or little natural condition limitation[24]. In the production of plant factory, IOT serves the plant factory through "comprehensive sensing, reliable delivery and intelligent handling", which corresponds to the three layers of IOT, namely, sensing layer, delivery layer and control layer [23]. (1) The sensing layer mainly consists of environment testing sensor, biosensor, GPS and RFID, which work together for sensing of information in the production process. For instance, lighting sensor can show distribution of intensity of light in real time and video sensor can monitor the size of the plant, from the stage of growing, whether it is germination period, growth period or other growing periods. With spectral analysis of plant photos, to know health condition of the plants in real time; (2) the delivery layer is responsible for reliable delivery and the sensing layer collects information and delivers it to control layer and display terminal through delivery layer. In the process of delivery, 2G GPRS, 2.5G CDMA and 3G wireless broadband as well as multi-media techniques are used to achieve remote connection. For short distance delivery, wireless communication technique developed from combination of non contacting identification and various kinds of network techniques can be used. This technique can achieve fast and convenient wireless connection of equipment within a short distance. WLAN802.11 and Bluetooth have been successfully used for such purpose. Zig Bee technique fits small size and low cost wireless network, like wireless sensor network. (3) The intelligent control layer consists of PDA, controller, regulation equipment and operating terminal. This layer achieves automatic of equipment in plant factory through comprehensively analyzing information, like intelligent irrigation system.

The sensor can get the greenhouse production real-time data, such as temperature signal and humidity signal. The value of these physical variables can change into a low voltage electrical signal through the transmitter, and the transmission to the wireless communication terminal. The temperature and humidity sensor can measure the greenhouse temperature and humidity, the normal value is shown as follow. Measurement range: 40-85 degrees, 0-100%RH. Nominal Accuracy: 0.3 degrees, 1.5%RH. Supply voltage: 3.5V-24VDC, recommended 5V. The temperature and humidity sensor are shown as Fig. 8.

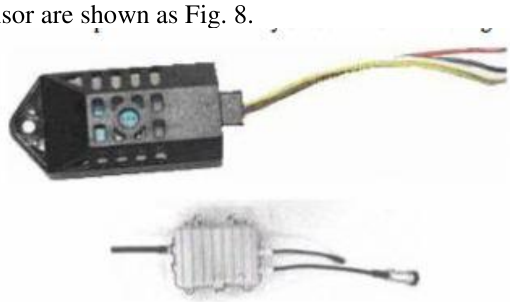

Fig. 8. Temperature and humidity sensors

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