IOT: The Future of Technology

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Abstract- IOT *(Internet of Things) is an advanced automation and analytics system which exploits networking, sensing, big data, and artificial intelligence technology to deliver complete systems for a product or service. These systems allow greater transparency, control, and performance when applied to any industry or system. IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations, and much more through smart devices and powerful enabling technology.*

I. INTRODUCTION

The **Internet of things** (**IoT**) is the introduction of Internet connectivity into the world of objects and devices of everyday life. Embedded with electronics, Internet connectivity, and other forms of hardware (such as sensors), these devices gain the ability to communicate with the other fellow devices over the internet, and then they can be remotely monitored and controlled. [1, 2]

The definition of the Internet of things has evolved due to convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.[3] Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In the consumer market, IoT technology is associated with the various home appliances which adhere to the concept of “smart home”, that support one or more common ecosystems, and which can be controlled and monitored via devices associated with that ecosystem, usually smartphones or smart speakers and other such devices. However, the IoT concept has faces prominent criticism, in terms of privacy and security concerns related to these devices and their intention of pervasive presence.

II. LITERATURE SURVEY

The concept of a network of smart devices was discussed as early as 1982, with a modified Coke vending machine at Carnegie Mellon University becoming the first Internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold or not.[4] Mark Weiser's 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of the IoT.[5, 6] In 1994, Reza Raji described the concept in *IEEE Spectrum* as "[moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories".[7] Between 1993 and 1997, several companies proposed solutions like Microsoft's at Work or Novell's NEST. The field gained momentum when Bill Joy envisioned device-to-device communication as a part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.[8]

The term "Internet of things" was likely coined by Kevin Ashton of Procter & Gamble.

A research article mentioning the Internet of Things was submitted to the conference for Nordic Researchers in Norway, in June 2002,[9] which was followed by an article published in Finnish in January 2002.[10] The implementation described there was developed by Kary Främling and his team at Helsinki University of Technology and more closely matches the modern one, i.e. an information system infrastructure for implementing smart, connected objects.[11]

III. APPLICATIONS

The extensive set of applications for IoT devices [12] is often divided into consumer, commercial, industrial, and infrastructure spaces.

3.1 COMMERCIAL APPLICATIONS

I] INDOOR LOCALISATION

Indoor localization or indoor positioning is a key enabling technology for IoT applications such as guiding customers or visitors inside a shopping mall or a convention centre, where conventional navigation technologies such as GPS is not available. Even though there are indoor localization solutions that use RFID or BLE beacons with known fixed locations inside a building, it requires additional hardware and installation costs thus making the implementation of these systems costly in terms of time and money. However, using Wi-Fi signals to perform localization makes it a better alternative to the beacon based systems as it does not require the installation of new hardware, thus reducing complexity and cost of the system.

In the literature, some research have focused on the study of RF signal propagation in indoor environments while others have developed localization methods that exploit various aspects of RF signal propagation such as propagation time, angle of arrival and received signal strength (RSS) to achieve localization. Methods such as Time of Arrival (TOA) and Time Difference of Arrival (TDOA) use propagation time for localization. These methods require time synchronisation between target device and measuring stations and between measuring stations respectively.

Methods that use propagation angle, such as Angle of Arrival (AOA) require measuring stations to have special antenna arrangements in different orientations. In addition to being complex, these systems suffer reduced performance due to propagation time and angle is directly affected by multipath effect existing in indoor environments. Methods using RSS however provide a better alternative.

Fingerprinting method uses RSS measurements and is less complex in implementation that it does not require special hardware or the access point locations. It can be implemented in software reducing costs [13]. Performance of localization algorithms are quantified using its accuracy, precision and robustness. Accuracy is a measure of how much the result has deviated from the expected outcome, while precision is a measure of how consistently the result is within a certain value range. Robustness is how well the algorithm performs under poor Radio Frequency (RF) conditions [14]. Past researches have resulted in precisions in the range of 90%, but it is also important to know the error value considered when calculating the precision.

Fingerprinting method

Fingerprinting method is one of the most used methods for localization because of its above-mentioned benefits.

Fingerprinting method involves storing the RF characteristics, known as fingerprints, of locations of the indoor environment in a database and comparing the fingerprint of the unknown target location with the fingerprints in the database to find an approximated location of the target [15]. As such fingerprinting method is composed of two phases (Fig 1):

1) Offline Phase

This phase is also called the Data Collection phase during which, the fingerprints of the concerned indoor area are collected and the database is created. The indoor area is divided into an equally spaced grid where the grid points are called reference points (RP), at which the data will be collected. Past studies have showed that multipath effect, reflection, diffraction and scattering cause RSS to randomly vary around a mean value at a location [16]. RSS value is also affected by fading, which consists of two parts, Large-scale fading and small-scale fading. Large-scale fading is caused by attenuation due to signals being absorbed by various materials and objects in the environment. Large-scale fading decides the mean RSS. Small-scale fading is caused by multipath effect. As such, RSS in an indoor environment can be approximated to a Gaussian distribution with a mean and a standard deviation. For a more accurate approximation of mean and standard deviation, large number of samples will need to be collected at each RP. In literature, number of samples collected were as high as 10,000 [17]. After collecting samples the calculated mean and standard deviation will be part of the fingerprint of that RP [16, 18].

2) Online phase

In the online phase the algorithm takes a sample fingerprint from the unknown target location and compares it with the fingerprints in the database to classify the RPs that are most likely (or closest) to the target location. There are several known algorithms such as probabilistic, k-Nearest-Neighbour (KNN), neural networks, support vector machine (SVM) etc. This work uses the probabilistic and KNN methods to find two sets of estimated coordinates and finally combine them.

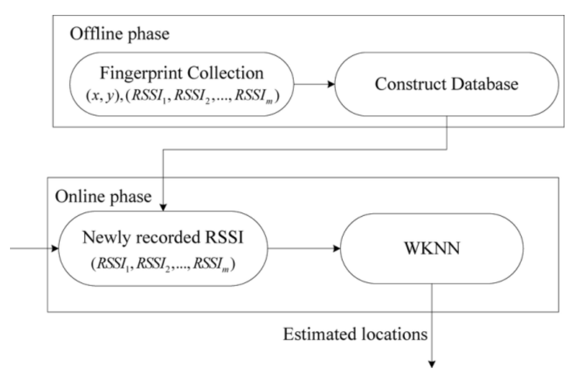

Fig 1 Two phases of fingerprinting method

II] HOME SECURITY SYSTEM

The need of security systems for Home is considered as one of the important aspects of our modern life. These systems could be motion detectors, monitoring cameras, door or window sensors, and Image analysis. The security system consists of two steps:

- Sensor-based systems which are used as movement sensors to trigger the security camera.
- Motion-based systems such as security cameras to capture the image for image analysis.

Image analysis is the mining of dataset in sequence from captured images by means of digital image processing techniques. Image analysis tasks can be as complicated as identifying a person from their face. Image Analysis is largely used for pattern recognition, digital geometry, and signal processing. Image Processing is processing of images using any form of signal processing for which the input is an image, or a series of images. The output of image processing may be either an image or a set of parameters related to the input image [19]. Most of the image processing techniques treat the image as a two-dimensional signal and apply signal processing techniques to it. Images which consists of three-dimensional are processed as three-dimensional signals where the third dimension being time or the z-axis. Object recognition is also one of the techniques used for image processing. For, finding and identifying objects in an image or video sequence, despite the fact that the image of the objects may vary somewhat in different view-points, in many different sizes and scales or even when they are translated or rotated [19]. Images can even be recognized when they are partially hindered from view.
Appearance-based method like

- Grayscale-based matching
- Edge-based matching
- Divide and Conquer search is compared with prior dataset that is stored in the fog database. Algorithms like Template matching and Cooley- Tukey algorithms are used to compare and fetch the result. Due to the spatial and time complexity to reach speedy solution to match the image captured with the dataset, we need an efficient algorithm.

PROPOSED SYSTEM

i) Problem Definition

The sensor that are fixed in the door, invokes the digital cameras in the rooms to capture image or motion. The captured image is sent to the fog where the dataset or database is stored. The Digital image processing techniques analyses and interprets the captured data. Information mining, Image enrichment and Feature extraction are the three imperative mechanism of digital image processing.

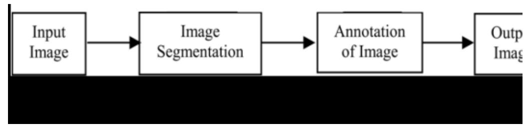

Fig. 2 Mechanism of Digital Image Processing

Image enrichment techniques help in improving the visibility of any feature of the image suppressing the superfluous information. Information mining techniques help in obtaining the statistical information about any meticulous portion of the image. An image processing system consists of a crossing point between the sensor system and the camera.

The signal transmitted by the sensors is an either electrical or optical signal which is converted to digital signals. This signal invokes the camera to capture the image or motion and sends the image to the fog where the dataset is stored. The server or the database in the fog starts matching the captured image with the dataset, if it matches, then it takes no action. If the image doesn't match, then it sends an alert message to the owner or the authenticated person of the house.

The spatial and time complexity involved in matching the image and the time taken to retrieve the information from the dataset in the fog is a concern. So, we deploy an efficient algorithm for spatial and time complexity to match the image in the database and to take the counter action.

ii) Framework

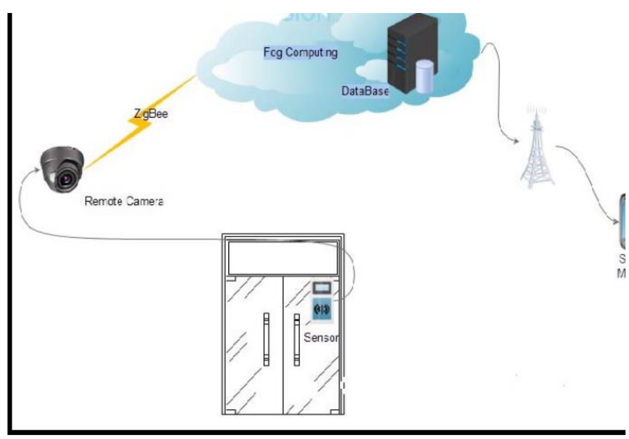

Fig 3 Framework for Home Security

The framework for the home security gives the outline of the components which consists of the Sensor in the frame of the door or window of the house. When the sensor rays that pass through gets cut or disturbed then it invokes the camera to capture the image or motion that occurs inside the house. The captured image is analyzed through the *Template matching or Divide and conquer search* with that of the

dataset which was already stored in the fog database. Here, in fog storage we use these Digital image processing techniques in order to get even the complicated image that has been captured to be easily compare with the stored image. Even though, we retrieve the data from the fog computing in high speed when compared to cloud computing, we use the efficient algorithm for speedy process. If a mismatch occurs then an alert message is sent to the owner of the house to his/her mobile. Internet of Things (IoT) requests mobility support and wide range of Geo distribution in toting up to location awareness and low latency features. Therefore, we needed a new platform to meet all these requirements. Fog computing as a paradigm that extends Cloud computing and services to the edge of the network. Fog reduces service latency and improves Quality of Service
(QoS).

3.2 INDUSTRIAL APPLICATIONS

I] ADVERTISING IN THE IOT ERA

The Web has gained so much importance in the market economy during the last two decades because of the development of new Internet-based business models. Among those, online advertising is one of the most successful and profitable. Generally speaking, online advertising, also referred to as Internet advertising, leverages the Internet to deliver promotional content to end users. Already in 2011, revenues coming from online advertising in the United States alone surpassed those of cable television, and nearly exceeded those of broadcast television. In addition, worldwide investment in Internet advertising reached approximately 200 billion dollars in 2016 and is expected to reach 335 billion dollars by 2020 .

Online advertising allows web content creators and service providers, broadly referred to as publishers, to monetize yet provide their business for free to end users. For example, news websites or search engines can operate without charging users, as they get paid by advertisers who compete to buy dedicated slots on those web pages for showing advertisements (ads) .

The global spread of mobile devices has also been changing the original target of online advertising.This is indeed moving from showing traditional display advertisements (i.e., banners) on desktop computers to the so-called native advertisements impressed within app streams of smart phones and tablets.More generally, the Internet advertising business will eventually extend to emerging pervasive and ubiquitous inter-connected smart devices, which are collectively known as the Internet of Things (IoT).

Enabling computational advertising in the IoT world is an under-investigated research area; nonetheless, it possibly includes many interesting opportunities and challenges. Indeed, IoT advertising would enhance traditional Internet advertising by taking advantage of three key IoT features device diversity, high connectivity, and scalability. IoT device diversity will enable more complex advertising strategies that truly consider context awareness. For example, a car driver could receive customized ads from roadside digital advertising panels based on their habits (e.g., preferred stopping locations, hotels, and restaurants). Furthermore, IoT high connectivity and scalability will allow advertising to be performed in a really dynamic environment as new smart devices are constantly joining or leaving the IoT network. Finally, different from the traditional web browser-based advertising where a limited number of user interactions occur during the day, IoT advertising might count on users interacting with the IoT environment almost 24 hours a day.

The rest of this article is organized as follows. The next section discusses the idea of IoT advertising with a use case scenario. Then we articulate key background concepts. Following that, we propose our vision of an IoT advertising landscape. In particular, we characterize the main entities involved as well as the interactions between them. We then outline the key challenges to be addressed for successfully enabling IoT advertising.

i) USE CASE STUDY

In-Car Advertising Connected smart vehicles are one of the most dominant trends of the IoT industry: automakers are indeed putting a lot of effort into equipping their vehicles with an increasing set of computational sensors and devices.
With millions of smart vehicles on the road, each one carrying possibly multiple passengers, automobiles are no longer just mechanical machines used by people to move from point A to point B. Rather, they are mobile, interconnected, and complex nodes constituting a dynamic and distributed computing system. This opens up new opportunities for developers who can leverage such an environment to build novel applications and services. In particular, smart vehicles, actually passengers traveling in those vehicles, may become interesting “targets” for advertisers who want to sponsor their businesses.

Assume a family of three is traveling in their smart car, with plans to drive to a seaside destination a few hours away from their home and spend the weekend there. To do so, they rely on the GPS navigation system embedded in their car. Bob is actually driving the car; he is a 45 year old medical doctor and he likes Cuban food. Alice, Bob’s wife, is 40 and an architect. She is very passionate about fashion design and shopping. Their son Charlie, sitting in the back of the car, is a technology-enthusiast teenager who is listening to his favorite indie rock music on his smartphone. Suppose there exists a mechanism for profiling passengers traveling in the same smart vehicle, either explicitly or implicitly. In other words, we assume the smart car can keep track of each passenger's profile. Such a profile needs to be built only from data the user agrees to share with the surrounding IoT environment.

Suppose these travelers are about to enter a city where an iconic summer music festival takes place. Interestingly, an emerging rock band is going to perform on stage that same evening. Festival promoters have already advertised that event through analog (e.g., newspapers and small billboards) and digital (e.g., the city's website) channels. However, they would also like to take advantage of an IoT ad network to send more targeted and dynamic sponsored messages, namely to reach out to possibly interested people who happen to be around, such as Charlie.

Assume Charlie receives an advertisement on the music app installed on his smartphone, and he convinces his parents to stop to attend the concert. Other similar advertising messages might be delivered to Alice and Bob as well. For example, Alice could receive a suggestion to visit the city's shopping mall on her dedicated portion of the car's head-up display. Furthermore, the eye-tracking sensors installed in the car could detect that Bob is getting tired, as he has been driving for too long. Therefore, Bob might be prompted with the coordinates of the best local Cuban cafe on the GPS along with a voice message suggesting to have a coffee there.

We propose an IoT advertising platform that behaves as an intermediary (i.e., a broker) between advertisers (the festival promoters), end-users (Alice, Bob, and Charlie), and possibly publishers, the same way well known ad networks operate in the context of Internet advertising. Note though that in IoT, several entities can play the role of "publisher," which is not limited to a single web resource provider, but may be a composite entity with several IoT devices. As such, the automaker, as well as any other device embedded in the car or dynamically linked to it, may act as a publisher. Assuming the IoT ad network can gather information from smart vehicles and passengers traveling in a specific geographic area, that information can be further matched against a set of candidate advertisements, which in turn are conveyed to the right target. Note that triggering ad requests is somewhat transparent to the end user, that is, we do not conjure any explicit publisher-subscriber mechanism between end users and advertisers. On the other hand, users must have control over their data, which in turn may be used by the IoT ad network for targeting.

Figure 3 depicts the scenario above, where Alice, Bob, and Charlie all receive their targeted advertising messages. The IoT ad network is responsible for choosing the most relevant advertisements and delivers them through one or more IoT devices that are either embedded in the car (e.g., the head-up display and the GPS) or temporarily joined to the car (e.g., the passengers' smartphones).

We claim that IoT represents a huge opportunity for marketers who may want to leverage the IoT ecosystem to increase their targeted audience. Indeed, although online advertising is already a multibillion-dollar market, we believe one of its limitations is that it is essentially based on the activities users perform on the web. Instead, IoT advertising will overcome this limitation by bringing advertising messages to users interacting with the IoT environment (which is potentially much larger than the web).

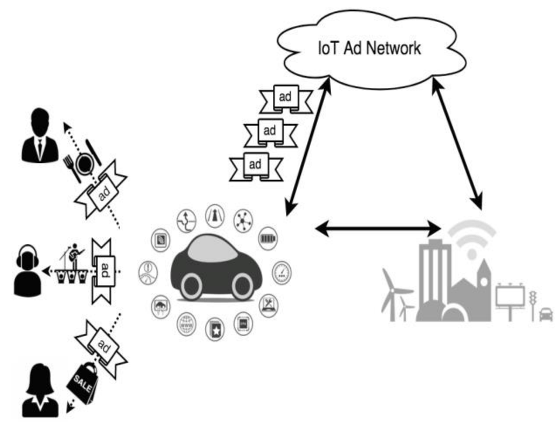

Fig 3 Scenario

ii) A VISION FOR AN IOT ADVERTISING LANDSCAPE

The ultimate aim of IoT is to provide new applications and services by taking advantage of the IoT features discussed above. Different from the simplistic approach of utilizing traditional legacy sensors combined with decision entities, the high connectivity and intelligence present in IoT along with the possibility of continuous scalability, allow building a wide pool of applications based on user generated IoT data. Among those, expanding the traditional Internet advertising marketplace is one of the most promising.

IV. CONCLUSION

IOT or Internet of Things is an emerging field of technology with a great potential. It has spread its influence across all the sectors in the economy and is proving to be of a great help. It has reduced the need of human labor and provides more efficient solutions to the problem hence simplifying human life. Also IoT seems to be quite adaptive and easy going in combination with other technologies like digital image processing, networking, sensing, big data, robotics, artificial intelligence etc. The facility of communication between the interconnected devices has made it possible for the devices to exchange data and work in coordination with each other and the external environment as well.

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