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SMART MIRROR-NETWORK ARCHITECTURE BASED ON IOT AND CLOUD COMPUTING TECHNOLOGY

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Abstract:
Internet of things is a beautiful concept which is going to make our life most comfortable. The concept behind this technology is connecting anyone or anything at anytime in anyplace and extension to it is any service and any network. The enabling technologies are RFID sensors, smart technology and Nano technology. Smart mirror has extreme functionalities and is embedded with various electronic features. The technology behind is Sensor display, GPS navigation, Bluetooth connectivity and cameras. In this paper we survey on network architecture and propose the research direction for smart mirror. It relies on RFID, WSN, and smart mobile, interoperating with each other through a CoAP/6LoWPAN/REST network based on cloud platform.

Keywords: internet of things, RFID, WSN, smart mobile, smart mirrors, CoAP, REST, cloud computing

1. INTRODUCTION

Internet of things is the megatrend in Industry from 2002 onwards. There are many definitions gathered by different researchers and publishers. We gather from our study few definitions which perfectly define the Internet of Things. First one - “The Internet of things (stylized Internet of Things or IoT) is the internal working of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items—embedded with electronics, software, sensors, actuators and network connectivity that enable these objects to collect and exchange data”[1]. Another definition is - “By embedding short-range mobile transceivers into a wide array of additional gadgets and everyday items, enabling new forms of communication between people and things, and between things themselves”[2]. The other definition is - “The term “Internet of Things” has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects”[3]. The future definition is – “Things having identities and virtual personalities operating in smart spaces using intelligent interfaces to connect and communicate within social, environmental, and user contexts”[4].
We realized from the study that The Internet of Things is far bigger than anyone realizes. Internet of things is said to be “the next big thing”, but people aren’t thinking big enough. According to people Internet of Things revolves around increased machine-to-machine communication. It’s built on cloud computing - networks which gather data from sensors continuously, virtual metadata, that make our lives smarter. But really the vision for future and what we draw big enough about is - “It is not M2M interaction which is making sense, but the actual role of sensors”. A sensor measures, it evaluates; in short, it gathers data. Therefore, “The Internet of Things is really formed with connection of sensors and machines”, i.e. gathering data and leveraging it. In essence, not all gathered information makes sense and Cloud-based applications are the key to implement it.
The cloud is the only promising technology for The Internet of Things, which is the key behind leveraging the data, interpret and transmit the data coming from various connected sensors - to make you access anything, anytime and anyplace[36].

There are three IoT components which enables seamless ubiquitous comp: (a) Hardware—made up of sensors, actuators and embedded communication hardware (b) Middleware — on demand storage and computing tools for data analytics and (c) Presentation — novel easy to understand visualization and interpretation tools which can be widely accessed on different platforms and that can be designed for different applications. In this section, we discuss a few enabling technologies which will make up the three components stated above.
To implement an Internet of Things application the most promising technologies are Ultra-High-Frequency (UHF), Radio-Frequency Identification(RFID), Wireless Sensor Network(WSN) and smart mobile . Among these, all apps go frequently with RFID, as they can go for decades, for its passive tags don't need a source of energy to operate. RFID is a cost effective and low power consumption technology with passive and/or Battery-Assisted Passive(BAP) devices, with name tags to transmit data when the electromagnetic field is generated by an interrogator, named reader[5][6].
We gathered information that the recent availability of UHF RFID tags with increased capabilities, e.g. sensing and computation[7]-[9], represents a further added value. The reason we combine these two is, RFID operates solely under the reader coverage region, i.e, up to 15m and 25m when respectfully passive and BAP tags are implemented. Moreover, WSN are self-organizing ad-hoc networks of small, cost-effective devices (motes) which communicates and cooperate in a multihop fashion to provide monitor and control functionalities. They consume more power compared to UHF and RFID[10]-[12]. We found that none of the available solutions has the seamless integration of different technologies according to the so-called Internet of Things (IoT) vision[13]. Therefore, with this we will be able to leverage new control for IoT based applications which access through the internet, allowing the development of innovative applications to exploit pervasive collected data.

2. THE SMART MIRROR

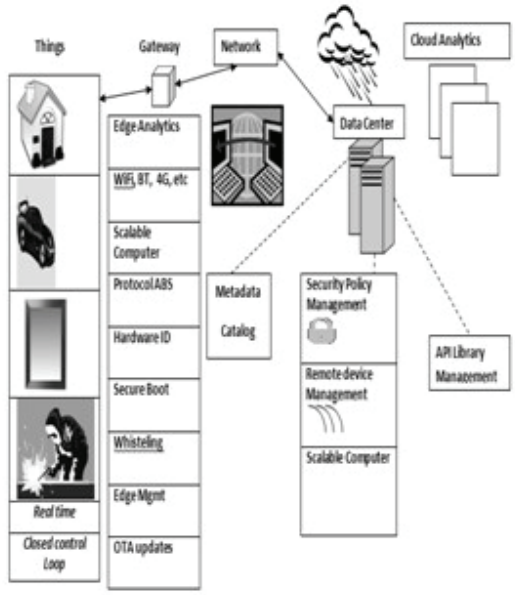
The Smart Mirror is one such application which is highly functional and embedded with various electronic features and technology such as Sensor display, GPS navigation, Bluetooth connectivity and cameras. Smart mirror is also equipped with wireless communication which enables voice recognition and hands-free calling. Smart mirror has self-dimming, self-repairing and self-cleaning capabilities. Application of smart mirror is used in various sectors such as automotive, household, hotels, educational institutions, healthcare sector, consumer sector, retail and advertising sector.[27][28]
Focus on road safety concerns helps to increase the demand for integrated electronic functionality of smart mirror in automotive sector. Electrochromic self-dimming smart mirrors helps in the road safety by increasing response times and minimizing driver fatigue. Many other features such as integrated sensor displays, touch capability, GPS and Wi-Fi connectivity improves driving experiences. According to a research report, around one-fifth of all new automobiles sold in 2013 have rear-view smart mirrors equipped with light sensor-triggered and self-dimming capability. Various other factors such as style, innovative design, comfort, safety and convenience leads to boost the growth of smart mirror market. The total market size for smart mirror in automotive sector is expected to reach around USD 2.4 billion by 2020.
Imagine a fitting room with a "smart" mirror that suggests jeans to go with the red shirt you brought in. It snaps a video so you can compare the image side-by-side with other colorful shirts you try on. It might even show you how the shirt will fit without you having to undress[28][29]
The patented MemoryMirror from Palo Alto a California-based company, called MemoMi, is one of the most advanced in this so-called virtual dressing, a feature that's expected to be tested in US stores later this year. The mirror is outfitted with sensors, setting off motion-triggered changes of clothing. MemoryMirror uses pixel technology that captures even small details such as a wrinkle on a skirt as it moves.
Even for those trying on the clothing, the mirror also doubles as a video camera, capturing a 360-degree view of what an outfit looks like and making side-by-side comparisons. Shoppers can replay the video and share with friends[30][35].

3. RELATED WORK

Architecture refers to physical elements, their functionalities, working principles and techniques. The reference for IoThNet architecture is taken from Ambient intelligence assisted living system[25] and Conceptual IoT framework with Cloud Computing at the center[36].

We identified few issues in this architecture[25]: the IoT gateway interoperability and the Wireless Local Area Network(WLAN) as well as Wireless personal area Network(WPAN), multimedia streaming and security. We infer that IPv6-based 6LoWPAN is the basis of The IoThNet from studies on various papers [18], [21], [23],[26]-[33]. We take the protocol stack of 6LoWPAN and the IoThNet concept, sensors and wearables use IPv6 and 6LoWPAN systems for data transmission over the 802.15.4 protocol. Data are then transmitted through User Data Gram Protocol (UDP). But the 6LoWPAN does not support mobile IPv6(MIPv6), a subset of the new IPv6 protocol which is responsible for mobility.

Picture 1: Reference Architecture for Internet of Things based on cloud platform



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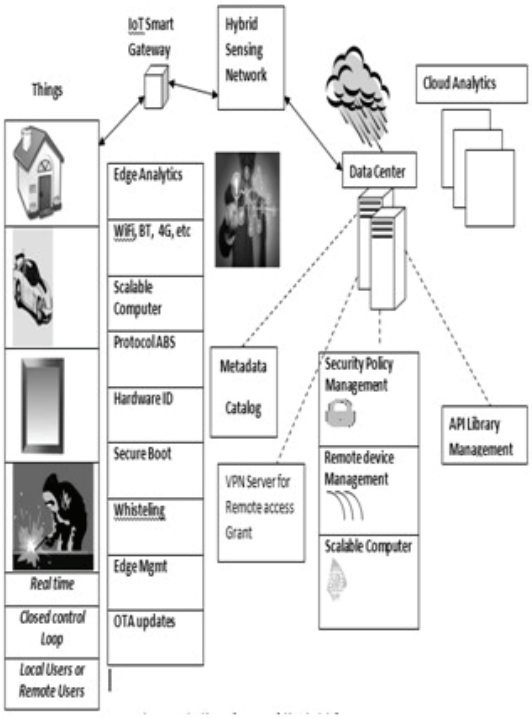
4. PROPOSED ARCHITECTURE

We exploit the potential of combining complimentary technologies and standards, such as RFID, WSN, smart mobile, 6LoWPAN, and CoAP. We propose two kinds of WSN nodes; one is an RFID Gen reader to store sensor data and the other is RFID Gen tag for storage of information (retail store information). Therefore the latest design arrivals can be easily retrieved by RFID Gen2 reader scattered around the store. It is delivered to voice system and Hands gesture. To make them easily accessible locally and remotely we connect it to cloud storage. Now, WSN-based transmission is activated to promptly inform staff via Push notifications on a customized mobile application (Intel is working on Android Apps). Retail Store Manager can now access data on their smart phones by connecting to a portable UHF RFID reader and use the same mobile application to interact with their customers during their regular activities.

The work aims to provide IoT-cloud based Smart mirror[36], by combining different complimentary technologies to respond to 20 simultaneous touches and Pyramid´s polytouch all-in-one capacity. Multi-touch kiosk system is an ideal platform for interactive applications.

Each system is equipped with a barcode scanner and a thermal printer. The polytouch device is the first all-in-one touch screen to be equipped with integrated chip and PIN in compliance with the PCI Data Security Standard (PCI DSS). This PCI DSS and VISA-certified chip and PIN payment module protects against skimming and can be inspected at any time by staff.

Picture 2: Proposed Network Architecture for Smart Mirror based on IoT and cloud platform.



We design to send alert messages in case of new arrivals to the store by analyzing the received information and also would report the customer needs and desire. We design four major components: the RFID-enhanced WSN, Hybrid Sensing Network (HSN), the IoT Smart Gateway, and the cloud based storage for the user interface for visualization and management.

HSN is designed by integrating RFID-WSN 6LoWPAN network composed of four topologies: (1) 6LowPAN BRODER Routers(6LBR), (2) 6L0wPAN Routers((6LR), (3) 6LoWPAN Router Readers(6LRR), and (4)6LowPAN Host Tag. Since the 6LoWPAN standard is meant to connect the network to the Internet by translating 6LoWPAN packets into IPv6 packets and vice versa through its 6LBR, the 6LR provides forwarding and routing capabilities. In order to identify the typical 6LoWPAN Host (i.e. a node without routing and forwarding capabilities) the 6LR node is interfaced with an RFID Gen2 reader when it's done by HT. Therefore we design several 6LR in the retail store to collect data from the environment such as temperature, pressure and ambient intelligence. Along with sensing technology we introduce the main function of 6LRR nodes to track customers, staff and seasoning device along with interfaces labeled with RFID Gen2 tags. We design our webcam with HT node which is capable to detect gestures and voice parameters. Sensed data are each time logged on the user memory of the RFID Gen2 tag, which is used to allow 6LRR nodes deployed in the environment to retrieve and deliver them to the IoT Smart Gateway. We connect it directly to HSN and other end, with Internet through LAN. In order to connect to the remote data access we provide cloud infrastructure and services. Therefore in the proposed architecture, gateway plays the role of 6LBR, enabling communication between WSN nodes and remote users.

A continuous monitoring Application (MA) is run by gateway which analyzes the received data and stores them into the database (Cloud DB for controlling and managing the DB). We infer to adopt a REST Web-based paradigm to easily access the collected data either locally or remotely, whichever is needed. A Web-based graphical interface needs network operators which manage sensor and actuator nodes. This

interface should provide privileges to access both historical and real time data. It's remotely managed by cloud storage services. The retail store manager from his smartphone, which is connected to a portable RFID Gen2 reader and running a customized application, can be app with cloud interface for accessing cloud services. Therefore, with this app the retail store manager can track his current sales report all the time. The most recent information is gathered from RFID Gen2 tag and historical data from cloud storage. Important information is each time updated like, customer's regular choice, wishlist, cart items, order list, tracking order, shipment, etc. RFID Gen2 reader is standardized EPC global identification tracking of all details in sensors, HT node(Web cam) as it can enable quasi-zero-power read/write memory operations.
The integration of RFID-WSN also provides timely alerts on no stock, customer urgency, customer satisfaction, customer complaints etc. The HT node has long range, high power, reliable IEEE 802.15.4 radio transceiver to send a notification to the MA. Thus it consumes low power, indeed maximizes the battery life, since HT node allows using always the RFID Gen2 radio interface for routing operations, keeping the IEEE 802.15.4 radio off most of the time.
At the IoT Smart Gateway, the MA exploits Push Notification (PN) to inform the staff about customer's selection and billing amount. Even this is automated and they can check out by screening their cards. Since, the system is collecting sensitive and confidential data, it must ensure privacy and security. The customer can share their personal data through internet via, fb, twitter etc., and scan his card for payments. Therefore we need to provide authorization and authentication. Apart from that the data is accessed locally and remotely that needs to be safeguarded. We introduce VPN channel between app and IoT Smart Gateway. Once it grants access, the user can access his local or remote data.

5. CONCLUSION AND FUTURE WORK

This paper proposed architecture of IoT Cloud platform for monitoring, tracking, retail store details and providing it to customer. With the help of Smart mirror its gesture and voice capabilities, the customer is allowed to experiment upon various outfits and allowed to share access different store accessories[31][32][33][34]. With the IoT vision in mind, we propose a network which relays on CoAP, 6LoWPAN, and REST paradigms to allow integration among UHF RFID Gen22, WSN, and Smart mobile technologies. We propose an ultra-low-power Hybrid Sensing Network (HSN) which considers the advantage of zero-power RFID-based data transmission. In future we need to implement this architecture and further research has to be processed to prove that this architecture is best in all aspects of tracking, Monitoring, remote access and security provision along with ease to access the app via cloud.

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