IOT as Enabling Technology for Future Smart Farming

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ABSTRACT:

IoT (Internet of Things) is a new paradigm to provide a set of new services for the next wave of technological innovations. IOT systems allow users to achieve deep automation, analysis and seamless integration of the cyber world with the physical world. IoT has the capability to change the present world that we live in; advanced industries, connected vehicles, and smarter cities are all components of the IoT equation. The global population is set to touch 9.6 billion by 2050. So, to feed this much population, the farming industry must embrace IoT, so applying IoT to the agriculture industry could have the greatest impact to the present agriculture sector. In this paper we explored the IoT use cases in agriculture and we presented some issues and challenges considered from the technological perspective. We discussed different visions that stand behind IOT paradigm in order to facilitate a better understanding of the IoT's features. Internet of Things is enabling farmers to take up to date decisions to improve crop yields, increase productivity and enhance operational efficiency along with learning better resources of management that timely results in minimum wastage. The main scope is to deliver a comprehensive overview of open issues and challenges to be tackled for IoT future research.

Keywords: *IoT (Internet of Things), Cyber world, smarter cities.*

1. INTRODUCTION

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction”. As per Gartner, 25 billion devices will be connected to the internet by 2020 and those connections will facilitate the used data to analyze, preplan, manage, and make intelligent decisions autonomously. We have different service sectors, such as: transportation, smart city, smart domestics, smart health, e-governance, assisted living e-education, retail, logistics, agriculture, automation, industrial manufacturing, and business/ process management etc., have already been getting benefited from IoT.

1.1 Farmers with IOT Are Better Together

The IOT is transforming the agriculture industry like never before by increasing the agricultural productivity and empowering farmers to deal with the enormous challenges they are facing as of now. Till now, agriculturalists were struggling to find new solutions for water management and today’s IOT technology is helping farmers to comply with state and federal water regulations by reducing the water consumption up to 25% with the help of IOT technology, networks, and data collection.

2. ARCHITECTURE

IoT Architecture

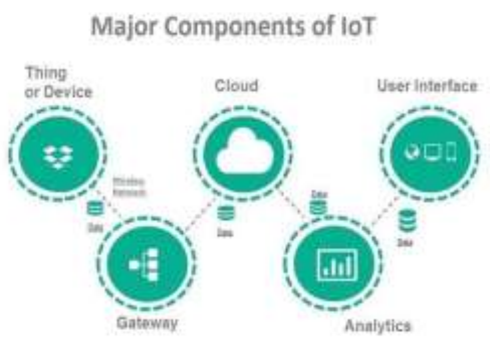


Fig .1. IoT Device Components

2.1 IoT Functional Blocks

An IoT system is comprised of a number of functional blocks to facilitate various utilities to the system such as, sensing, identification, actuation, communication, and management Fig. 2 presents these functional blocks as described below:

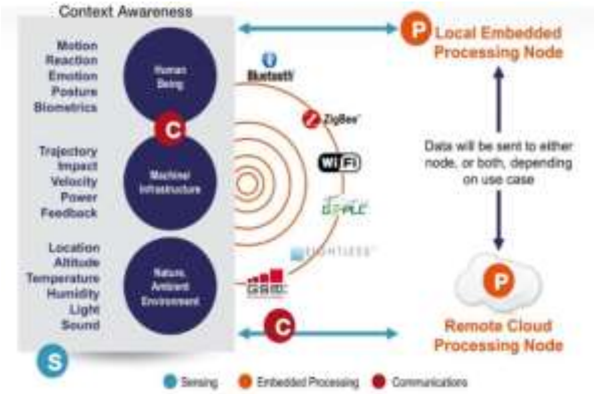


Fig. 2. IoT Functional Blocks

2.2 IoT Devices

An IoT system is based on devices that provide sensing, actuation, control, and monitoring activities. IoT devices can exchange data with other connected devices and application, or collect data from other devices and process the data either locally or send the data to centralized servers or cloud based applications back-ends for processing the data, or perform some tasks locally and other tasks within IoT infrastructure based on temporal and space constraints (i.e. memory, processing capabilities, communication latencies, and speeds, and deadlines). An IoT device may consist of several interfaces for communications to other devices, both wired and wireless. These include (i) I/ O interfaces for sensors, (ii) interfaces for Internet connectivity, (iii) memory and storage interfaces, and (iv) audio/ video interfaces. IoT devices can also be of varied types, for instance, wearable sensors, smart watches, LED lights, automobiles and industrial machines. Almost all IoT devices generate data in some form of the other which when processed by data analytic systems generate leads to useful information to guide further actions locally or remotely, For instance, sensor data generated by a soil moisture monitoring device in a garden, when processed can help in determining the optimum watering schedules.

Communication: The communication block performs the communication between devices and remote servers. IoT communication protocols generally work in data link layer, network layer, transport layer, and application layer.

Services: An IoT system serves various types of functions such as services for device modeling, device control, data publishing, data analytics, and device discovery.

Management: Management block provides different functions to govern an IoT system to seek the underlying governance of IoT system.

Security: Security functional block secures the IoT system by providing functions such as, authentication, authorization, privacy, message integrity, content integrity, and data security.

Application: Application layer is the most important in terms of users as it acts as an interface that provides necessary modules to control, and monitor various aspects of the IoT system. Applications allow users to visualize, and analyze the system status at present stage of action, sometimes prediction of futuristic prospects.
IOT in agriculture is the main backbone of India's Economic growth. The most important barrier that arises in traditional farming is climatic change. The major effects of climatic change include heavy rainfall, most intense storm and heat waves, less rainfall etc. Due to these effects the productivity decreases. Climatic change can additionally raise the environmental consequences such as seasonal changes in the life cycle of plants. To boost the productivity and minimize the barriers in the agriculture field, there is need to use innovative

technology and techniques called the Internet of Things.

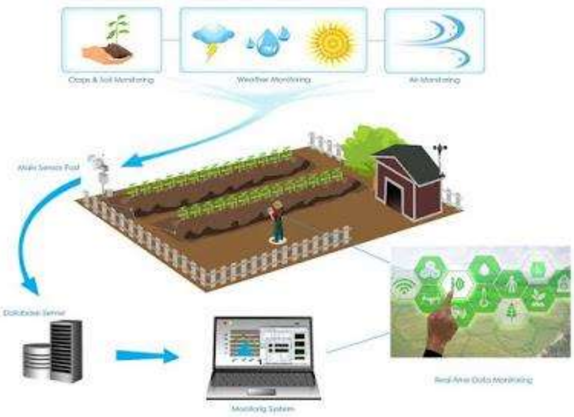


Fig 3. IoT Architecture for Agriculture

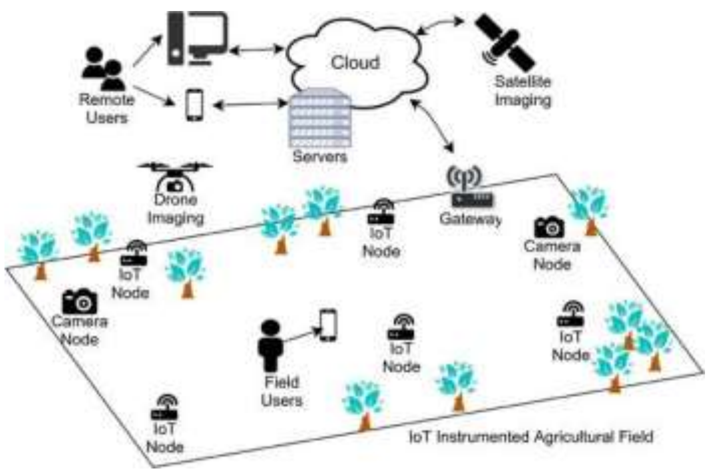
Water Management: The sensors within the farmland are capable of notifying during a period concerning the wet level in lands and may stop spoiling of water to unravel this downside sensible irrigation systems high-powered by latest IoT technology will facilitate conservation of water resources higher by watching irrigation through remote sensing technologies. This capability is more aggravated if the period detector information will trigger action within the motor by switch it off or on. The motor is mechanically switched on or off looking on the necessity for irrigation and level of the water resource. Besides, sensible sensors will determine the issues within the irrigation system framework in the associate degree in progress and may counteract depleting of water while not legitimate management. For spills in pipelines, such sensible sensors square measure a doubly effective absence of as they're usually hidden from reading and create detection of leaks extremely difficult. The prompt detection of leaks and faults in can change users addressing the problem quickly and can facilitate saving water.

Crop Monitoring: Web of Things empowers the cultivation and crop observation straight forward and skillful to upgrade the efficiency of the product and henceforth benefits for the rancher. Wireless sensing element system and sensors of assorted types area unit utilized to collect information of yield conditions and natural changes and these data area unit transmitted through the system to the cultivator that starts remedial activities.

Soil Monitoring: Internet of things (IoT) for an agricultural atmosphere includes monitoring of various agricultural environment factors such as soil humidity, temperature, and moisture along with other factors can be of significance. A standard to compute these factors in a farming atmosphere meant farmers physically taking measurements and examine them at numerous times.

Farmers Detect Crop Diseases: Farmers can able to notice several diseases within the season's crop through mobile phones, attributable to sensible wireless sensors employed in the sector and conjointly exploitation tiny drones to acknowledge the sickness of plants by exploitation sensors & WSNs in a very drone. Then data can send to mobiles concerning the knowledge concerning the sickness of a plant. Agricultural specialist's area unit able to gauge the crop's condition to sickness supported soil and weather (humidity, temperature, and rainfall) parameters. Anticipate plant stress, weed germination, persecutor infestations and different factors, we'll use less water to flush salts from the profile.

IoT cloud platforms for agricultural: Cloud computing provides sharing of resources with an economic cost. Cloud computing service providers offer the services within an economical cost. It has been used for storage of



agriculture data. It is used in agriculture sector along with IoT.

Fig 4. IoT Instrumented Agricultural Field

3. APPLICATION DOMAINS OF IOT CLOUD PLATFORMS

Wireless Communication Standard

Communication Protocols form the backbone of IoT systems and enable network connectivity and coupling to applications. Communication protocols allow devices to exchange data over the network. The protocols define the data exchange formats, data encoding, addressing schemes for devices and routing of packets from source to destination. Other functions of the protocols include sequence control, flow control, and re transmission of lost packets.

802.11 - WiFi IEEE 802.11

It is a collection of Wireless Local Area Network (WLAN) communication standards. For example, 802.11a operates in the 5 GHz band, 802.11b and 802.11 g operate in the 2.4 GHz band, 802.11n operates in the 2.4/5 GHz bands, 802.11ac operates in the 5 GHz band and 802.11ad operates in the 60 GHz band. These standards provide data rates from 1 Mb/s to 6.75 Gb/s. WiFi provides communication range in the order of 20 m (indoor) to 100 m (outdoor).

802.16 - WiMax

IEEE 802.16 is a collection of wireless broadband standards. WiMAX (Worldwide Interoperability for Microwave Access) standards provide data rates from 1.5 Mb/s to 1 Gb/s. The recent update (802.16 m) provides data rate of 100 Mb/s for mobile stations and 1 Gb/s for fixed stations. The specifications are readily available on the IEEE 802.16 working group website (IEEE 802.16, 2014).

802.15.4 - LR-WPAN

IEEE 802.15.4 is a collection of Low-Rate Wireless Personal Area Networks (LR-WPAN) standards. These standards form the basis of specifications for high level communications protocols such as ZigBee. LR-WPAN standards provide data rates from 40 Kb/s to 250 Kb/s. These standards provide low-cost and low-speed communication to power constrained devices. It operates at 868/915 MHz and 2.4 GHz frequencies at low and high data rates, respectively. The specifications of 802.15.4 standards are available on the IEEE802.15 working group website (IEEE 802.15, 2014).

2G/3G/4G - Mobile Communication

There are different generations of mobile communication standards including second generation (2G including GSM and CDMA), third generation (3G-including UMTS adCDMA2000) and fourth generation (4G-including LTE).

IoT devices based on these standards can communicate over cellular networks.

Data rates for these standards range from 9.6 Kb/s (2G) to 100 Mb/s (4G) and are available from the 3GPP websites.

802.15.1 - Bluetooth

Bluetooth is based on the IEEE 802.15.1 standard. It is a low power, low cost wireless communication technology suitable for data transmission between mobile devices over a short range (8–10 m). The Bluetooth standard defines a personal area network (PAN) communication. It operates in 2.4 GHz band. The data rate in various versions of the Bluetooth ranges from 1 Mb/s to 24 Mb/s. The ultra low power, low cost version of this standard is named as Bluetooth Low Energy (BLE or Bluetooth Smart). Earlier, in 2010 BLE was merged with Bluetooth standard v4.0.

LoRaWAN R1.0

LoRaWAN is a recently developed long range communication protocol designed by the LoRaTM Alliance which is an open and non-profit association. It defines Low Power Wide Area Networks (LPWAN) standard to enable IoT. Mainly its aim is to guarantee interoperability between various operators in one open global standard. LoRaWAN data rates range from 0.3 kb/s to 50 kb/s. LoRa operates in 868 and 900 MHz ISM bands. According to Postscapes, LoRa communicates between the connected nodes within 20 miles range, in unobstructed environments. Battery life for the attached node is normally very long, up to 10 years.

Cloud solutions IoT cloud solutions pave the facilities like real time data capture, visualization, data analytics, decision making, and device management related tasks through remote cloud servers while implying ‘‘pay-as-you-go” notion. Various cloud service providers are gradually becoming popular in the several application domains such as agriculture.

4. SECURITY SERVICES

Security

Security issue has always been an area where network related researchers are continuously striving to get through. IoT is not out of its scope. In this section a few relevant works are presented to cope up with architectural issues in IoT based security.

Object Security

Object-based Security Architecture (OSCAR) supports facilities such as: caching and multi cast, and does not affect the radio duty-cycling operation of constrained objects while providing a mechanism to protect from replay attacks by coupling DTLS scheme with the CoAP. Authors evaluate OSCAR in two cases: (a) 802.15.4 Low Power enabled Lossy Networks (LLN), and (b) Machine-to-Machine (M2M) communication for two different hardware platforms and MAC layers on a real test bed using the Cooja emulator. The architecture has been evaluated under a smart city paradigm.

End-to-End Security

An End-to-End two way authentication security architecture for the IoT, using the Datagram Transport Layer Security (DTLS) protocol has been. The proposed security architecture is based on the most widely used public key cryptography technique (RSA) works on top of standard low power communication security perspectives. The IPM architecture is empowered by the Unit IoT and Ubiquitous IoT (U2IoT) architecture. U2IoT acts as the core of IPM provisioning three key supports, such as: establishing information security model to describe the mapping relations among U2IoT, security layer, and security requirement in which social layer and additional intelligence and compatibility properties are infused into IPM; referring physical security to the external context and inherent infrastructure are inspired by artificial immune algorithms; and suggesting recommended security strategies for social management control.

Hierarchical Security

Hierarchical security architecture is to protect against inherent openness, heterogeneity, and terminal vulnerability. The proposed architecture aims to improve the efficiency, reliability, and controllability of the entire security system. Authors investigate several types of attacks and threats that may diffuse the architecture. To oppose vulnerability, a coarse-grained security cell is designed that along with a refined secure subject protects the IoT enabled system in the form of information, data, control, and behavior. The 3-layered architecture devises a vertical division that narrows down the complexity of the cross-layer security interaction, and the transverse division based on data flow while clearing the processing logic of the security mechanism.

Multimedia Traffic Security

An efficient Media-aware Traffic Security Architecture (MTSA) is proposed that facilitates various multimedia applications in the Internet of Things MTSA sacrifices unconditional secrecy to facilitate a normalized multimedia security solution for all genres of sensors in IoT. In particular, MTSA employs a visual secrecy measure which degrades proportionally to the number of shares in a possession of an eavesdropper. MTSA is enabled with perceived multimedia distortion techniques. The MTSA reduces the complexity of multimedia computations and decreases the size of the shares. MTSA is inherited from a context-aware multimedia service based security framework.

Light Weight Security

A recent article presents comprehensive and lightweight security architecture to secure the IoT throughout the lifecycle of a device “HIMMO”. HIMMO relies on the lightweight scheme as its building block. It is not only efficient resource wise, but also enables advanced IoT protocols and deployments. HIMMO based security architecture can be easily integrated in existing communication protocols such as IEEE802.15.4, or OMA LWM2M while providing a number of advantages such as: performance and operation. HIMMO is featured by a few advancements such as: full collusion resistance, device and back-end authentication and verification, pair-wise key agreement, support for multiple TTPs and key escrow, or protection against DOS attacks.

5. CONCLUSION

The Internet has proved its existence in our lives, from interactions at a virtual level to social relationships. The IoT has added a new potential into internet by enabling communications between objects and human, making a smarter and intelligent planet. This has led the vision of "anytime, anywhere, anyway, anything" communications practically in true sense. To this end, it is observed that the IoT should be considered as the core part of the existing internet relying on its future direction, which is obvious to be exceptionally different from the current phase of internet what we see and use in our lives.

Hence, the architectural concept comes in the picture. Architecture is a framework of technology enabled things to interconnect and interact with similar or dissimilar objects by imposing human to be a layer on it. In fact, it is clear that the current IoT paradigm, which is supportive toward M2M communications, is now getting limited by a number of factors. New formulations are inevitable for sustenance of IoT which is a strong notation for the researcher to come up with.

From the above survey, it is found that publish/subscribe based IoT is flourishing now a days and being successively used in many applications. In this perspective, it should be understood that people are solemnizing their thoughts in terms of vertical silos of architectures. If this trend continues for next few years, it is mandatory that IoT may not achieve its goal related to flexibility, interoperability, concurrency, scalability, and address-ability issues. Crowed sourcing may be incorporated into the architectural conciseness. Defense, military, intelligence services, robotics etc. fields do still undercover by IoT. Tourism, education, multimedia, governance, social aware, and context aware IoT architectures have not been functional at all. A novel concept is also proposed that is based on various theoretical nomenclature and external inputs. A main contribution of this paper is to focuses on the specific architectures of IoT applications and highlights the challenges and possible research opportunities for future IoT researchers who would work in architectural as well as in IoT as a whole.

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