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Review on Online Monitoring and Control in Industrial Automation–An IoT Perspective

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Abstract: Internet of things (IoT) is developing much fast than any other technology. IoT framework can be called as a gathering of smart gadgets that connect on a shared premise to satisfy a shared objective. IoT systems may use different processing and communication architectures, technologies, and design methodologies. This selection is based on the target it must be achieved. This review work focussed on the step into the different communication protocols used in IoT systems.
Keywords: Internet of things, Communication protocols, Security, Sensors, Actuators.

1. Introduction

Mark Weiser – A researcher initiated the concept called IoT through his ubiquitous computing theory[1]. A decade after Weiser's intuition, the same point was again raised at the Massachusetts Institute of Technology (MIT), and explicitly by the Auto-ID Center. Thisgroup was working in the field of arranged Radio Frequency Identification (RFID) and developing sensing technologies. Their vision was to develop a "Smart World", i.e. an insightful framework connecting objects, information and people through the computer network[2].Their developments in this field resulted in what now call it as IoT. It can be simply defined as a group of interconnected things (tags, sensors, and so on) over the Internet, which have the ability to measure, communicate and act all over the world[3]. The term Internet of Things (IoT) was first proposed by Kevin Ashton in 1999. He used this term in the context of supply chain management[4].Nowadays, the concept of IoT has many realms. From a consistent perspective, an IoT framework can be called as a gathering of smart gadgets that connect on a shared premise to satisfy a shared objective. At the technological floor, IoT systems may use different processing and communication architectures, technologies, and design methodologies. This selection is based on the target it has to be achieved[5]. IoT use has been developing quickly because of key applications in businesses [4]. With the capacity to gather, impart/offer and cycle information, IoT gives colossal chances to ventures. For instance, IoT-empoweredfollowing and checking can improve the proficiency of creation of item dissemination. Moreover, to improved activities, IoT likewise offers numerous imaginative arrangements, for example, the production of new plans of action. For instance, deals of merchandise could be expanded with related administrations with the assistance of IoT-created information furthermore, constant network [5]. So as to assess the business estimation of RFID innovation, Tzeng proposed a system that underscores conveying business esteem through business measures and extending the plan of action with the expectation that it urges more associations to embrace RFID. In any case, IoT selection in enormous mechanical applications faces numerous difficulties [6].

The primary difficulties incorporate (1) Energy productivity, (2) Communication and information related difficulties (availability, inertness, throughput, standardization)(3) Scalability (network size, interoperability) and (4) Security and wellbeing (dependability, protection assurance). A portion of these difficulties are shared by various IoT innovation segments: from sensor gadgets to backend framework and Service-Oriented Architecture (SOA) plan [7]. IoT applications have just experienced sensible achievement in certain enterprises, for example, medical care administrations, food flexibly chain (FSC) and foundation checking (e.g., energy and ecological administration and related application spaces). Generally speaking, the similitude among these enterprises is that lives are in question at the work environment. Thusly, it is considered as high-hazard Environment, Health and Safety (EHS) enterprises. EHS is a control and forte that includes reasonable parts of ecological assurance and security at work. In basic terms, it is the thing that associations must do to ensure that their exercises don't make hurt anybody [8]. Our core interest is on high-hazard EHS ventures with specific accentuation on medical care administration industry, food gracefully chain, mining and energy businesses (oil and gas, atomic), clever transportation (associated vehicles), and building and framework the executives identified with the shrewd urban areas idea and crisis reaction the board. IoT-based applications are somewhat broad in these enterprises [9]. For instance, [10] identifies and classifies ebb and flow research topics identified with information culmination in medical care, proposes ways for the IS people group to lock in in the improvement of earth maintainable strategic policies, and consider arrangements that guarantee uncongested and smooth explorer with broad constant revealing. An objective of this paper is along these lines to introduce the attributes of IoT-based applications in industrial environment ventures through a complete survey of distributed examination.

2. Application of IoT in Different Industrial Sector

IoT has developed a number of utilizations, of which just a little part is right now accessible to the general public[11] as shown in Figure 1. One of the innovative mainstays of the IoT, to be specific RFID innovation, has just been consolidated into a wide cluster of items. According to the application fields and market segments, IoT gives upper hands over current arrangements, and can be used indifferent kind of industrial management sectors such as, environmental monitoring, smart cities, smart business/ inventory and product management etc.,[12].

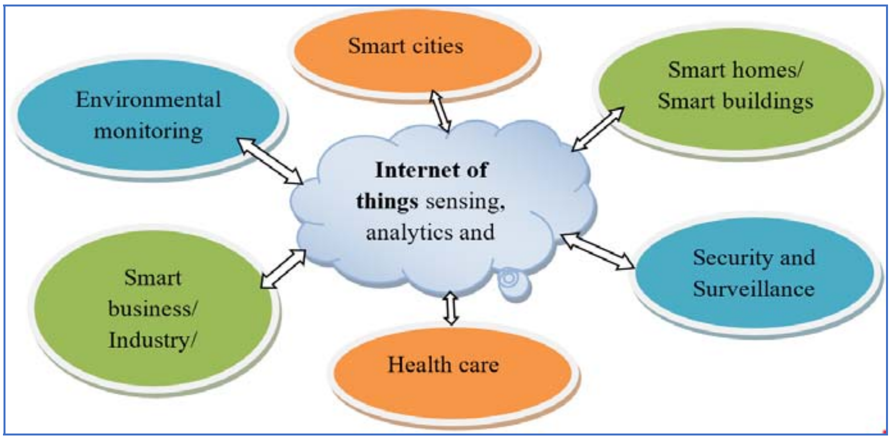

Figure 1. Schematic diagram showing the IoT end users and application areas

3. IoT Elements

There are three major elements that should be included in the IoT system as shown in Figure 2 [13]are,

- Hardware includes sensors, actuators and embedded communication hardware
- MiddlewareComputing tools which are used for data analytics
- Presentation Front End

Straightforward perception and understanding apparatuses which can be broadly usedto at various stages and which can be intended for various applications[14].

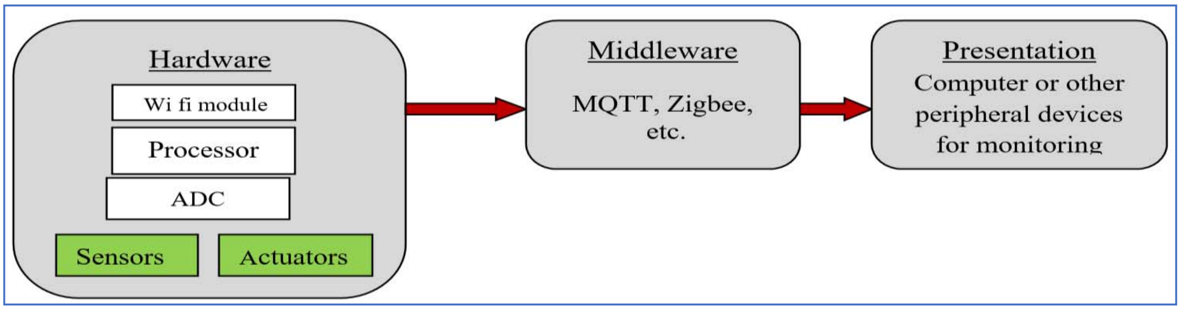

Figure 2. Basic elements of IoT in a process station

4. IoT Based Temperature Monitoring in an Industry

An industry usually involves many critical processes and these processes are mainly done by machines. The different essential processes like exploration, extraction, refining, transporting, marketing petroleum products etc. involves increase in temperature. In some process stations, temperature is one of the parameters to be continuously monitored as given in Figure 3 [15].

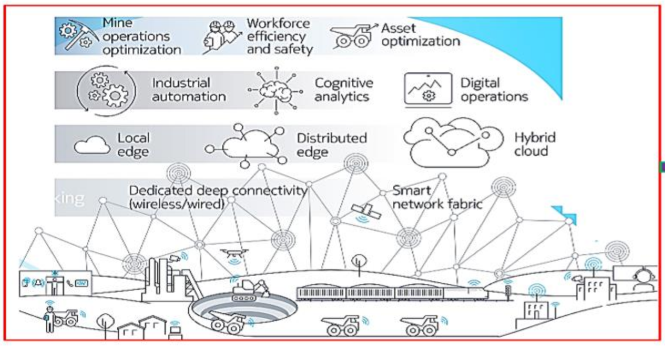

Figure 3. The architecture of temperature measuring system in industry using IoT

The major parameter that is to be continuously monitored and controller in oil and gas industry is the temperature at a particular range for their safety and also for the effective functioning of the industry. Food industry needs to continuously monitor the temperature for the preservation of food; otherwise they have to face a huge financial loss. Like this temperature becomes an important parameter in the industry. IoT helps in providing a continuous monitoring and controlling system for the industry and also saves the data for the future reference [16].The sensor is the back end of an IoT which is in contact with the process station. The sensors can be either wired or wireless. Traditionally wired sensors are used. These sensors have to be connected to the data acquisition module for further processing. The working of an IoT system begins with the data collection. First, the sensors collect data from their surroundings. It can be one sensor or a network of multiple sensors that are bundled along to create a sensing device [17]. The sensor data if it is a continuously variable, it is being processed by converting it into digital data by the Analog to Digital Converter (ADC) within the data acquisition unit.

The DAQ part includes the microcontroller where the interface of the data takes place and the conversion of the data from analog to digital takes place and the control action is also taking place here[18]. Looking on the security laws in use, the quantity of drawing cablesacross associate industrial space will cause huge amounts. Planning, installing, and maintaining these cables represent an outsized portion of the price of possession. The main concern of an industry is safety, security, reliability and cost of production. Network failures can have catastrophic consequences in the production and thus in the profit and are therefore not an option[19].The sensors which follow the standard protocols have a higher cost and they still lack popularity in industrial environment. The blend of these variables has enhanced the suitability of using a sensor arrange comprising of a huge number of intelligent sensors forcollection, processing, analysis and broadcasting of valuable information[20].

If we consider a temperature measurement system, with observance, it's meant to gather, record and report temperature regarding the process. A continuous analysis of the temperature from the process station helps to spot the required corrective actions largely concerning weaknesses and improvement points on the chain[21].The information is then distributed to the cloud[23].Once the data stored in the cloud platform, software performs some kind of processing on it. The appropriate data analyzing software such as data clustering algorithms used to find the parameter is within the range or not [24-32].

5. Communication Protocols

In an IoT system two things are important, the IoT hardware platform and the communication technologies. Short distance data transmission modules such as Zigbee, WiFi, Bluetooth, Z-wave etc are mostly used for medium range applications[33]. Long distance data transmission technology say different manufacturers such asLoRa, SigFox[34], GSM, LTE, Cat-M, NB-IOT[35] are most widely used advanced wireless communication technologies. SigFoxbased long range communication technology has the advantages of low cost, low bandwidth, but it possesses minimum speed with lesser packets data to be transmitted per second. NB-IOT device is the other long range communication technology which supports enormous connections [36]. LoRa is a rising technology in today's market with its operation and the first affordable implementation for industrial usage [37]. LoRAWAN defines the communication protocol and therefore the system design, whereas LoRA defines the physical layer [38]. Each gateway has the ability to forward the received packet from the end-node to the cloud-based network server**.** All the gateways are connected to the core network server through the standard IP connections as detailed in Table 1 [38].The different communication protocols possess advantages and limitations. Soto suggest one is practically difficult. One has to select them according to their need.

Table 1.Comparison of different communication protocols (adapted from[39])

Parameters	Standard	Frequency	Data transfer Rate	Transmission distance	Energy Consumption	price
LORAWAN Protocol	LORAWAN R1.0	868/900 MHz	0.3–50 Kb/S	<20 Km	Very Low	High
Bluetooth Protocol	IEEE 802.15.1	2.4 GHz	1–24 Mb/S	8–10 M	BLE: Very Low	Low
Mobile Communication Protocol	2G-GSM, CDMA 3G-UMTS, CDMA2000 4G-LTE	865 MHz, 2.4 GHz	2G: 50–100 Kb/S 3G: 200 Kb/S 4G: 0.1–1 Gb/S	Entire Cellular Area	Medium	Medium
LR-WPAN Protocol	IEEE 802.15.4 [Zigbee]	868/915 MHz, 2.4 GHz	40–250 Kb/S	10–20 M	Low	Low
Wimax Protocol	IEEE 802.16	2–66 GHz	1Mb/S–1 Gb/S (Fixed) 50–100 Mb/S(Mobile)	<50Km	Medium	High
SIGFOX	LOPOWAN	868 MHz in Europe 915 MHz in USA	From 10 To 1000 Bps	30 To 50 Km in Rural And 3 To 10 Km in Urban Areas.	About 61mA (Low)	Low

The given Table 2 compares some of the communication protocols available in the market. When the different data and specifications are studied, the LoRaWAN communication protocol is very much effective and advisable for the industries, especially those concerned with the IoT.Another important aspect to be discussed is the IoT hardware platform. The IoT hardware platform makes a link between the data and cloud using various communication technologies [40-44]. There are many available platforms in the market and to choose from them, is based on the need of the user and the facilities provided by the manufacturer.

Table 2. Comparison of different IoT platforms

Parameters	processor	Clock speed (MHz)	System memory	Bus width (bits)	Communication supported	Programming language
Electric Imp 003	ARM Cortex M4F	320	120 KB	32	IEEE802.11 b/g/n,IEEE802	Squirrel
Beagle Bone Black	Sitara AM3358B ZCZ100	1 GHz	512 MB	32	IEEE 802.11 b/g/n, 433RF, IEEE 802.15.4, BLE 4.0, Ethernet, Serial	C, C++, Python, Perl, Ruby, Java,Node.js
Intel Edison	Intel QuarkTM SoCX1000	100	1 GB	32	IEEE802.11 b/g/n, IEEE 802.15.4,433RF, BLE 4.0, Ethernet, Serial	Wiring, C, C++,Node.JS,H TML5
Intel Galileo Gen 2	Intel QuarkTM SoC X1000	400	256 MB	32	IEEE 802.11b/g/n,IEEE 802.15.4,433RF, BLE4.0, Ethernet, Serial	Wiring Wyliodrin
Arduino Yun	ATmega32 u4and Atheros AR9331	16400	2.5 kB, 64 MB	8	IEEE 802.11b/g/n,IEEE 802.15.4,433RF, BLE4.0, Ethernet, Serial	Wiring
ARM mbed NXP LPC1768	ARM Cortex M3	96	32 KB	32	IEEE802.11 b/g/n,IEEE 802.15.4,433RF, BLE 4.0,Ethernet, Serial	C, C++
Arduino Uno	ATMega32 8P	16	2kb	8	IEEE 802.11b/g/n, IEEE802.15.4, 433RF, BLE 4.0, Ethernet, Serial	Wiring

The different specifications of commonly used IoT hardware have been platforms been studied above. The speed of the device, the bus width i.e., the no of bits, the language used for programming the device all plays an important role in the selection of the device. After taking into consideration of all the essential features of the various hardware platforms it is advisable to prefer ARM cortex processor-based device in IoT systems for more efficiency [45].

6. Threats in IoT

There are certain factors which keep the industrialists away from IoT in which delight of protection and privacy requirements plays a vital role. Moreover,the excessive wide variety of interconnected gadgets arises scalability issues; therefore, a flexible infrastructure is wanted in a position to deal with protection threats in such a dynamic environment [46-49].Although there are certain difficulties, the users are more attracted towards this developing technology as it gives a real-time monitoring, data storage, accessibility [50]. This makes the IoT more popular among the industrials as their process parameters will be monitored continuously, and real time parameters can be accessed by them.Traditional security counter measures cannot be directly utilized to IoT technologies due to extraordinary standards and conversation stacks involved [51].

This literary work put forwards a view into different industries like oil and gas industry, chemical industry and other industries where temperature monitoring is a process parameter and has to be monitored. How these monitoring is done using different communication protocols and how they are using IoT for this purpose [52].IoT is becoming the present days developing technology. The industries are been transformed from conventional monitoring methods.IoT is the basis for this change in the industries, as it makes the monitoring and controlling of the process parameters much easy and faster [53]. This is made possible by the different communication protocols and these protocols are developing as the technology is developing [54-58]. So, to go in line with one technology makes it outdated after couple of years. to find a solution for this is a task yet in front.

7 .Conclusion

In this literary work, temperature monitoring in different industries using IoT was made to a study. Main support of IoT is its communication protocols, through which it is connected to the industry as well as the server. this factor is made to looked for much in all the industries.Through this work the different protocols are compared. On studying the literary works, it is noted that different industries are selecting the protocols according to their need. So, it is not so appropriate to insist any method, but they are free to choose. Concluding this work, it is advisable to use Long Range wide area network at present for those going for IoT systems. LORA is the most commonly used IoT communication network which offers data collection at remote locations where signal strength is poor. BY properly selecting the cloud access given by different vendors, cost effective remote monitoring will be achieved in future.

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