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A Survey on Internet of Things (IOT) Technologies, Architecture, Protocols, And Application.

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ABSTRACT

Internet of Things (IoT) connects the intelligent devices through internet. It helps to connect smart devices like smart running shoes, smart medical alert watches, smart vehicles, smart phones, etc. with each other for an application need. These smart devices are enabled with internet which can communicate with one other in the automated manner. In an IoT environment, mostly the connected devices are of limited energy, limited processing capability and limited memory space. IoTcommunication model needs special care so that it is comfortable with these low end devices which are frequently prone to failures.This paper presents a review on the basic architecture models, communication protocols of IoT, and various IoT applications such as smart agriculture, smart healthcare, smart home, smart industry, and smart vehicle are discussed in detail.
Keywords: Internet of Things, smart agriculture, E-Healthcare, smart vehicle, smart industry, IoT protocols.

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INTRODUCTION

Future internet is going to be the interconnection of smart devices. IoT is the technology which enables these smart devices to connect with the internet to exchange data among different devices without human interaction. IoT connects smart devices such as personal digital assistant (PDA) devices, vehicles, buildings, animals, plants, soil etc. to the internet. These smart devices contain different type of sensors for sensing various physical phenomena in the surrounding environment. With the help of IoT gateway, the sensed data will be transmitted to the cloud system where the data will be processed and stored for the future analytics. Along with that a special kind of device called actuator may be there for taking necessary action based on the sensed data. Certain high rank application of IoT are as follows: smart home, smart farming, smart city, smart healthcare, smart vehicle, smart industry, etc. Beyond these applications, novelIoT applications are also being proposed for others domains like sports.M. A. Ikram, et al [1] discussed about IoT Football architecture for monitoring footballer in a match or during the training period. In future sports alsowill become one of important application of IoT technology. But there are some other obstacles in IoT like standardized protocol demand, communication model, security challenges, etc.

Traditional Machine to Machine (M2M) communication like point to point (P2P) tumble into IoT based communication model. Pawan Kumar Verma, et al [2] reviewed M2M applications needs like interoperability, ultra-scalable connectivity, and heterogeneity. IoT satisfies the application needs and it builds a ubiquities connectivity using M2M communication with its smart devices. In order to build an IoT application, certain technologies are to be combined and they areRadio Frequency Identifier (RFID), Bluetooth Low Energy (BLE),IPv6 over Low Power Wireless Personal Area Network (6LoWPAN),ZigBee, etc.Antonio J. Jara, et al[3] made a survey about IPv6 Challenges, Solutions and Opportunities for IoT. It is suggested to enable devices with IPv6 technology is the first step to connect people, things, and services. Figure 1, represent the general model of IoT framework

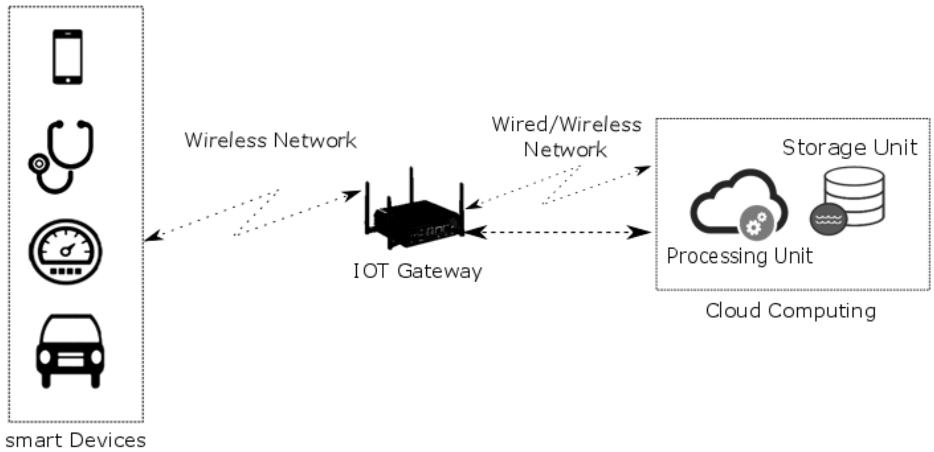

Figure 1: A typical framework of an IoT environment

The remaining part of the paper is organized as follows: Section 2 provide an overview on the layer architecture, Section 3 onprotocols of IoT, Section 4 provides a brief survey on various IoT applications. A final conclusion is presented in Section 5.

IOTLAYERED ARCHITECTURE

In general, layered architecture is the best model to define a communication network. It classifies the activities based on their functionalities and assigns it to a particular layer. This layered approach increases modularity in the design.Institute of Electrical and Electronics Engineers (IEEE) standards association project P2413 [4] has recommended a three layered structure for the IoT applications. The layers are as follows: (i) Sensing layer, (ii) Networking and Data Communication, (iii) Application layer. Figure 2 illustrate the IoT layered architecture.

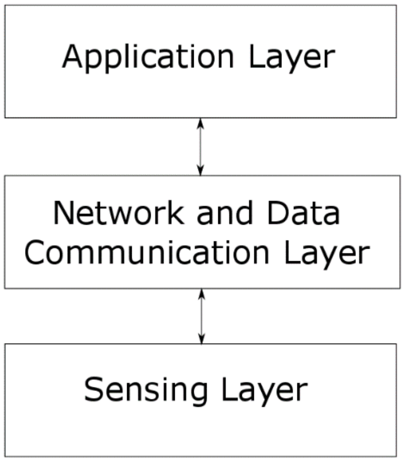

Figure 2: Architecture model of IoT framework

Sensing layer:

The baselayer of P2413 architecture is sensing layer. It is also called as device layer or perception layer. The physical device like sensors which are collecting the data from the environment is coming under this layer. The collected data will be sent to the network layer either directly or with the help of IoT gateway. To transfer data between sensing device and IoT gateway, technologies such as ZigBee, Bluetooth, BLE, 6LowPAN, etc. are widely used.

Networking layer:

The data communication between end sensors and application is handled by this layer. Data collected from the IoT gateway will be sent to the remote location (cloud unit) for storing and processing. In general, to send data to the higher layer, the telecommunication network technologies like PSTN, ISDN, 2G/3G or LTE networks is used.

Application layer:

This layer used for storing, processing and visualizing the sensed data. The outcome of this layer is based on customer initiative service request. The service request may be any one of the following categories such as smart home, smart industry, smart city, smart healthcare, smart vehicle and smart agriculture. Sensing layer data are processed and stored in the form of information suitable for the customer request. Application layer also provides manageability features to the IoT application.

PROTOCOL STACK IN IOT

Traditional protocol stack are not suitable for the constrained networks likeIoT. Various organization involved in the design of new communication protocols are working together to create protocol suite for IoT applications.The protocol standard committees like Internet Engineering Task Force (IETF), Institute of Electrical and Electronics Engineers (IEEE), European Telecommunications Standards Institute (ETSI), EPC global, etc. are working on this task.

Application protocol

Message Queuing Telemetry Transport (MQTT): Andy Stanford-Clark and Arlen Nipper [5] designed the first version of the MQTT protocol in the year 1999. The organization for the Advancement for Structured Information System (OASIS) released MQTT version 3.1.1 on October 2014. MQTT protocol is mainly designed for minimizing network bandwidth and resource requirements of a device. MQTT function based on publish/subscribe architecture in which messages are sent through message broker. Message broker is responsible for distributing publish messages to the concerned subscribers. In the message packets, two bytes fixed header indicates packet type, length of the payload and Quality of Service (QoS). Control packets are used for communication between client and server. These packets are used for connection establishment, subscription management.QoS level is three in MQTT communication between the sender and receiver and they are (i) At most once, (ii) At least once, (iii) Exactly once. Benjamin Aziz [6] analyzed MQTT QoSand finally he concluded last QoS level was potentially vulnerable.

Constrained Application Protocol (CoAP): Z. Shelby, et al [7] developed CoAP and released in RFC 7252. Constrained RESTful environments (CoRE) Working Group from IETF developed and standardized CoAP protocol. This protocol is designed for the low power device to communicate through the internet. CoAP message types are of request/response communication model between client and server. The CoAP header format is simple and binary based, it supports User Datagram Protocol (UDP) because of that CoAP is used in most of the device. In CoAP, each message has a message ID to remove duplicate message packet and it is using a method like: GET, PUT, POST, and DELETE, similar to HTTP but with low overhead. There are four types of message in Message Layer: (i) Confirmable (CON), (ii) Non-confirmable (NON), (iii) Acknowledgement (ACK), (iv) Reset (RST).This protocol is designed for low- power M2M communication. The main features of the CoAP are the message exchange in asynchronous, simple caching capabilities, URI and Content-type support, etc. COAP provide reliability in both unicast and multicast request.

Extensible Messaging and Presence Protocol (XMPP):XMPP is another application layer protocol for IoT. Initially, it was developed by the Jabber open-source community in the year 1999. Then IETFdevelops XMPP working group in 2002.The protocol is designed for XML (Extensible Markup Language)based message oriented middleware.XMPP is allowed to send the small pieces of structured data (XML stanzas) over the network in unicast or multicast. Peter Saint-Andre [8] reviewed the XMPP protocol and summarized it.Thus, XMPP protocol is codebase or service but it is not a single protocol, but a rich and convergence of different technology ecosystem.

Advanced Message Queuing Protocol (AMQP): The Advancement of Structured Information System (OASIS) organization released AMQP protocol version 1.0 on October 2012. AMQP is open standard application layer protocol used initially for business messaging like transaction messages. AMQP is a binary protocol and it support heterogeneous messaging applications. Message broker is used for publish and subscribe model. It uses two key component exchange and queues to ensure that the publisher message is sent to correct subscriber. Jorge E. Luzuriaga [9] figure out AMQP in vehicular network (i.e. Dynamic network) which is based on different scenarios. AMQP is used to construct a reliable, scalable and infrastructure of cluster messages in Wireless Local Network (WLAN) and also provide security as greater advantage.

Data-Distribution Service for Real-Time Systems (DDS): DDS is abroker-less architecture, publish and subscribe model protocol developed by the Object Management Group (OMG). DDS is applicable forM2M communication, it consists of two layers:(i) Data-Centric Publish-Subscribe (DCPS), which delivers the information to subscriber. (ii) Data-Local Reconstruction Layer (DLRL), it is an optional layer and act as the interface to DCPS. This architecture uses multicast communication, in order to provide better QoSwith high reliability which is preferable for most of the IoTapplications.

Service discovery protocols

Multicast DNS (mDNS): S. Cheshire, et al [10] had contributed to develop mDNS. It uses existing DNS protocol parameters such as structure of the message, domain name system, and resource record types. mDNS is capable of working like DNS in local network without general unicast to DNS server but send query in IP multicast packet . Small network devices are having less configuration infrastructure, in such kind of situation conventional DNS servers not suitable. This protocol provides free DNS namespace in local link and itsbenefits are (i) Less administration and configuration are required to implement, (ii) It can work even in case of no specific infrastructure, (iii) It can work well even when infrastructure fails.

DNS Service Discovery (DNS-SD): DNS Service Discovery use the normal DNS specification to surf the network for services. DNS-SD and mDNS are interdependent protocols, DNS-SD use mDNS to send DNS message packet. DNS-SD is independent where it can work with both unicast and multicast communication. Hybrid unicast and multicast DNS service discovery can help to device for wide-area service discovery. Antonio J. Jara, et al [11] proposed trivial mDNS and DNS-SD (lmDNS-SD) for IOT devices. lmDNS-SD used for resource discovery, where the device on the IPv6 or service discovery network, and functionsare provided by the devices. The Sender uses Multicast IP for naming query and it will go to all connected devices. A device is matched by name, then it sends a reply to sender name along with an IP address in multicast manner. All devices receive receiver message and update the IP address to naming which are received from the sender and stored in name cache. lmDNS-SD technique helps when IoT devices need to perform name query operation in Local Area Network (LAN). Minimum name length is also used in lmDNS-SD techniques. The Proposed approach resolves more issues in IoT environment: more number of devices adding to the network, IoT device mobility, allowing devices to sleep mode, etc.

Infrastructure Protocols

IPv6 over Low power Wireless Personal Area Networks (6LowPAN): N. Kushalnagar, et al [12] documented Request for Comments: 4919 (RFC 4919) for 6LoWPAN. The IETF 6LoWPAN team initiated to establish a pattern in IPv6 over IEEE 802.15.4 networks for transmission. 6LoWPAN is a low power wireless network, all nodes use IPv6 address to connect directly to the Internet. 6LoWPAN compress packet header to reduce packet size for IoT device communication. The IPv6 packets are transmitted and received over IEEE 802.15.4 based networks. 6LoWPAN has tiny packet size and support lesser bandwidth in star and mesh networks and the devices are enabled with batteries and long inactive time when communications interface is off to save energy. Packet fragmentation is helping to fit in an IEEE 802.15.4. Based on this approach physical layer bandwidth utilization will reduce.

Bluetooth Low Energy (BLE): Bluetooth Special Interest Group designed BLE and specification version is 4.0. BLE is not supported with previous version of the Bluetooth classic for backward compatibility and it had been mainly developed to reduce power consumption for new applications like smart healthcare, smart home, etc. The first layer of BLE's is physical layer where the bits are received and transmitted. Next layer is Link layer which provides to establish the connections, control the error and medium access. The Logical Link Control and Adaptation Protocol (L2CAP) allows channel multiplexing, larger packets are fragmented. The Generic Attribute protocol (GATT) layer which collects the efficient data from sensors. The application in Generic Access Profile (GAP) can be configured and operated in different modes such as advertisements, browsing, enrollment in connection and administration. The performance of BLE was analyzed by Keuchul Cho, et al [13]. As a result the BLE parameters helps to create great adaptability to the devices and suitable for numerous applications.

Z-Wave: Z-Wave is a wireless communication protocol, which is predominantly designed for home automation. ZenSys initially developed this protocol, then it took over by Sigma Designs. Now,Z-Wave alliance association is contributing to increase Z-Wave interoperability for any device to deploy Z-Wave. The range of Z-Wave is about 30 meters in Point to Point (PP) communication and specified for small data transmission application such as light control, fire detection, home appliance control, smart energy, and smart health care control. This architecture has two types of nodes (i) controller and (ii) slave nodes. Controller node manages the slave node and it is maintaining table for routing purposes. Source based routing method is used when controller provides a destination path inside a packet. This protocol is surveyed by Carles Gomez, et al [14] for Wireless Home Automation Networks and mentioning Z- Wave is developed for specific application like home automation and free adaptation not available because of proprietary wireless standard.

ZigBee: it is a wireless networking technology is designed by ZigBee Alliance, which is mainly developed for low-data rate and short-range applications. This is capable to communicate in the industrial, scientific and medical (ISM) radio bands like 2.4 GHz which is the worldwide availability band. The ZigBee provides security function across four main layer layers in protocol stacks: (i) the physical layer (PHY), (ii) the medium access control layer (MAC), (iii) the network layer, and (iv)the application (APL) layer. First two layers are defined by IEEE 802.15.4 standardand other layers are defined by the ZigBee alliance. Latest version ZigBee is capable to find the device types such as home automation, sensor types, energy management equipment, smart appliance, security, and health care monitoring device. TarekElarabi, et al [15] mentioned ZigBee suitable for IoT because IoT use low power and low data rate device.

IEEE 802.15.4: The communications protocol IEEE 802.15.4 is determined by the IEEE for Low Rate Wireless Personal Area Network (LR-WPAN) device usability. In IEEE 802.15.4 protocol standard protocol function of the PHY is determining the frequency, power, etc., of the link.Media access control (MAC) layerwhich is determining the format to handle the datafor LR-WPAN. Some of the low power application: IoT, M2M, and WSNs use IEEE 802.15.4 protocoldue to low energy depletion, low data rate, and high data throughput. This also provides a trustworthy communication to be operated on different platforms and capable of handling large number of nodes. It also provides a high security, encryption and authentication services and main disadvantage is it not capable to provide QoS guarantees. The collision can be avoided by using CSMA/CA protocol.

APPLICATIONS OF IOT

IoT Application in Agriculture

Smart farming system leads to efficiently utilize resources like: water supply, from lands, seeds, fertilizer, etc. IoT applications in agriculture, increase the quality, quantity, sustainability and cost effectiveness of agricultural production and also provide quickly delivering to market. In this section, IoT based smart agriculture models are reviewed.

Ciprian-Radu rad, et al [16] proposed precision agriculture or satellite, forming prototype in monitoring potato crops vegetation status based on Cyber-Physical System (CPS). CPS model is most of the time based on IOT, WSN, M2M technologies. CPS architecture has four and they are (i) sensing layer, (ii) network layer, (iii) decision layer, (iv) application layer. In physical layer potato crop vegetation status information is collected through different types are likes sensors, human, multispectral terrestrial mobile mechatronics system, multispectral autonomous a real mobile mechatronics system. In network level wireless communication is used for connecting the sensing device into a decision layer. In decision layer process spatial information of farm for monitoring input and output of the crops. In the application layer gives a solution for the crop problems. Based on this approach to human workers will reduce for potato crops monitoring and productivity will increase. Xiangyu Hu, et al [17] model is the Crop Growth Model (CGM) for IOT based agriculture. CGM is a software approach at the application layer of the IOT technology. WSN collect crop and farm condition, in network layer base station receive WSN output and transfer to the application layer database system.CGM access the stored data to process. GCM module has CGM algorithm to find time to irrigate and fertilize and also Alarm mechanism. Irrigation model helps to find the future water consumption of crop based on stored farm land condition data and daily weather data. Fertilize model also like irrigation model. Suppose crop face unappropriated environment to grow alarmed mechanism intimate the situation to former. To better solution from CGM model more number of input parameter are used from agriculture.

Novel technique of smart beehive is proposed by Fiona Edwards-Murphy, et al [18]. Wireless Sensor Networks (WSN) are used to develop smart beehive. WSN helps to find beehive internal condition and bee colony activates without beekeeper interaction. In system design ZigBee enabled wireless sensor nodes are fixed inside the beehive. Each sensor node is connected to the base station to transmit collected data into the cloud for predicting the condition of the individual beehive. Two types of sensor nodes are used: Gas Level Node (GLN), General Condition Node (GCN). GLN monitor air contamination and GCN monitor temperature, humidity, acceleration of the beehive. Author proposed two algorithms and they are Threshold Based Algorithm (TBA) and Decision Tree Algorithm (DTA). TBA is used for beekeeping and biological analysis. DTA is used for classifying the condition of the beehive based on collected beehive status data. Proposed techniques help for automatic maintenance the bee colony. Authors, TanmayBaranwal, et al [19] work in IOT based smart security for agriculture. Agriculture level security are likes prevent from insects, rodent attacks in farm or grain stores. Smart security architecture is classified into three layers. In perception layer different sensor and web camera are used for finding agriculture attack. Heat sensor identifies the motion of the rodent and URD sensor calculate the distance of the rodent and activate the web camera for snapshots. Network layer transmits raw data to the application layer. After processing the data in application layer it finds the attacked object likes human, rodent, mammals. After finding object repelled, will activate for preventing from rodent and also notifying the attack event to user through SMS.

MinwooRyu, et al [20] proposed smart farm with the help of IOT technology. IOT helps to connect farm into internet to build automated farm system. Two major infrastructure component is used in smart farming: &Cube, Mobius. &Cube is the IOT gateway software and Mobius is the IOT service platform. In farm land sensor used for monitoring.The Output of the sensor data will collect by IOT gateway. Wireless communication is used for sending data into Mobius. Mobius uses Representational State Transfer (REST) interface. Users use smartphone to controller the farm through Mobius service. Automated, controlled farming system consists of controller likes intake fan and exhaust fans, an air conditioner with heating and cooling, an irrigation and nutrient management system.Benefit of developing the connected farms (Smart farm) prevent from decease of one farm to another in the animal forming level.In paper [21] JunhuRuan, et al, provide an IOT based framework for monitoring and control fruit freshness in the e- commerce delivery. The framework consist of eight modules and they are farmed module, vehicle module, Local Processing Center (LPC) module, End Distribution Center (EDC) module, customer module, communication module, server module, terminal module. All modules come between the two extreme ends: farms and the end customer. These modules are involved in collecting data regarding farm land conditions, fruit freshness, fruit location, etc. to help of specialized sensors and IOT devices. Prediction and assessment technique is based on four attributes: fruit, operation, environment and time. Fruit represent values of perishability and pressure resistance, operation represent what operations are present between farm and customer like transport to LPC, transport to EDC, environment about transit level and time about how much time taken for each operation. Based on the above attributes, new fruit environment is constructed and gives an optimal solution for controlling the freshness of the fruit.

IoT application in smart home

Few branded smart home devices are only currently occupying our homes: nest learning thermistor, Philips smart home lighting, and air quality egg, etc. But in the near future, home refrigerator sends message to homeowners and intimate to purchase unavailable food item. Bedroom Television shows kitchen automated cooking device status and television remote can provide an option to control for kitchen device. Smarthome system savestime, energy and money for homeowners. In this section, IoT application in smart home models is reviewed.

(CLP-i-smart Home)[22] context- aware low power intelligent Smart Home is proposed smart home architecture model for IOT. CLP-i-smart Home is an internet centric approach where the data are stored, processed, visualization of output, and analytics are performed in cloud.CLP-i-smart home consist of three units: (i) application unit, (ii) data analysis unit, and (iii) visualization unit. Application unit represents the smart homes, personal health care system, etc. In personal health care application unit, multiple sensor will be attached over the different parts. Among them a coordinator node is alone capable of communicating with the primary mobile device (PMD). For end to end communication each sensor node at smart home level and PDM at personal health care level have a Global unique device identifier (GDDI).For device connectivity two communication models are used and they are: (i) BLE and (ii) ZigBee. The BLE is choice for communication within a room, the entire home is covered by ZigBee. Sensor and actuator devices can be controlled from outside the home using 3G/4G networks. Thus CLP-i provided a new framework for device connectivity in a Home automation system. In [23] Collatta, et alhave proposed a new energy aware scheduling of field device in the home automation applications. In general, Bluetooth Low Energy (BLE) works in the optimized way compared to the Bluetooth mechanism. In this work, further the energy saving techniques of BLE are enhanced using Fuzzy Logic approach. In the proposed techniques all the field devices (FD) have to report its status like remaining energy and TH/WL (ratio of throughput and work load) to the centralized master node. The master node calculates the sleeping time of each field device using the Fuzzy logic where devices remaining energy and TH/WL are the inputs and the sleeping time is the output. Thus, based on the above factors, each and field device will be activated to conserve the energy of the networked device

Author of [24] proposes IoT based smart home design for energy and security management. Architecture is implemented based on three elements: sensors, single board computer, and smartphone. Three types of sensors are used and they are temperature sensors, smoke sensor, and Passive Infrared (PIR) motion sensor. An Ethernet based Intel Galileo 2nd Generation Board is used for connecting sensors into internet for monitoring and it use relay module to control home devices. Sensed data are send to the server for user view the energy usage of home device via smartphone application. Smartphone application can switch off or switch on home device through voice command or touch the control buttons. The smoke sensing unit is helping to fire alert to the home owner on internet. Based on this approach home device lifetime will increase and maintenance risk will reduce. Leandro Y. Mano, et al[25] proposed IoT based smart home for healthcare monitoring system. Smart Architecture for In- Home Health care (SAHHc) consist of two component: sensors and decision maker. Wearable sensors are used for monitor patient health and cameras are used for home ambient monitoring, etc. SAHHc levels are divided into three, in level 0 embedded devices are used for patient identification, measure the patient face expression, etc. in level 1 local server is used for decision making for sensed data. In level 2 cloud server is used for process and storage balancing for local server. When a person enter into home SAHHc detect whether resident person, next the entered person is patient SAHHc monitor health condition otherwise ignore. Visual-based resident tracking technique is used for monitor face expression and find the current status of the patient health. Decision maker use the technique and send intimation to patient helper (nurse) via mobile notification. Based on this approach home healthcare system get smarter.

Intelligent Self-Learning System (ISLS) [26] for home automation. Sensors are used for collect monitor home appliances: light sensor, temperature sensor, etc. collected information are send to home PC, it analysis data and based on that it control home appliances through driver control. Suppose any device fault is occur home PC send information to server for data mining. In remote server, particular service provider is choosing and send mobile SMS or email to them. ISLS system automatically find fault home appliances and send notification to service provider. Service provider will directly visit to home for service without resident contribution. Dongyu Wang, et al [27] reviewed IoT based home appliances monitoring and controlling system in home automation technique. System consist of three component: environment sensor, user controller, user interface. Sensors are used for measure home temperature,Luminance,Flow Velocity, Humidity, etc. sensors data are send to single board controller for processing data and provide interface for control home appliances. Smart hand held devices (smartphone) are used to control the home appliance manually. User can set task based environmental changes, single triggering action can control multiple home appliances. Home user no need to worry about appliances operation. In [28] IoTbased smart homes with Low Power Wireless (LPW) technology had proposed. In that architecture is classified into five component: sensor devices, ZigBee module, control module, Local Area Network (LAN), internet server, smartphone application. LPW ZigBee module is used for communication between sensors and control modules. ZigBee module connect with LAN to send data to server. Internet server store received data and process it for provide information to user. ZigBee connect with different sensors and home appliances control units: Air Quality sensor, Gas Sensor, fan control, etc. Based on this approach home automation monitoring and control module power consumption will reduce.

IoT application in smart industry

IoT played major role in Fourth industrial revolution (industry 4.0). Because of automation, industrialdata exchange becomes smarter in smart industries. Some of the benefits of using IoT in industries are efficiently utilize machinesand workers, it keep worker safety, worker can easily handle machine, etc. In this section, IoT application in smart industry models are reviewed.

Navroop Kaur, et al [29] proposed cognitive decision making based employee evaluation in smart industry. Manual decision making in employee evaluation is with lot of error and less accurate. In the proposed work employee evaluation is automated here with help of the IOT devices. In the industry prototype, the working environments are monitored with IOT sensing devices and the location of the employee is tracked with the help of GPS. The sensors placed at the work place sends the report about the employee involvement in each task to the Information processing system (IPS). Then in IPS the employee involvement in the task or particular work is evaluated. IPS is made up of data conversion block (DCB), employee evaluation block (EEB) and decision making block (DMB). DCB classify the employee activities into positive, negative, natural from different kind of employee activities. Based on these activities, profit and loss of the industries is calculated. EEB helps to find the relation between particular activity and employee. DMB use game theory model weather the employee is qualify for getting rewards or not. At the end, cognitive decision making system provides greater accuracy compared to manual decision making system in employee evaluation. WesamAlmobaideen, et al [30] discussed IoT technology in tourism industry. IoT is helped to build smart tourism, which is Convenience and Accessibility based Smart Tourism-destination Approach (CASTA). Three main components are used: wireless sensors, control unit, Hand Held Device (HHD). Wireless sensor are used for monitor tourism site like air quality, visitor's numbers. Sensed information are send to sensor gateway, then it will transferred to Control Unit (CU). CU store received data into Tourism Location Database (TLD). TLD is one of the database among the geographical and transportation database, the network coverage database, which are connected to CU for computation. CU is enabled at cloud and process based on tourist request. GPS enabled HHD (smartphone) is used on tourist side for communicate in CASTA. Tourist send message request about particular tourism site to CU. CU send appropriate information likes shortest path to reach the destination, transpiration information to tourist.

(CCS) [31] Cold Chain management System for food industry. Wireless Sensors (WS) are used for monitoring the temperature of frozen food from cooking point to delivery point. CCS framework also helps to find whenfood product changes from frozen storage to cool storage. Four types of sensors are used in making braised pork. Portable wireless sensors, wire thermocouple sensors, needle thermocouple sensors, and environmental wireless sensors. In different stages temperature is monitored for food quality and they are in cooking, ambient, cool-storage warehouse, tally process, cabinet and vehicle deliveries, and re-cooking process. Proposed system provide benefit for some company's business models: (i) cold chain home delivery service, (ii) CVS direct and indirect delivery, (iii) flight kitchen service. In [32] IOT based chemical industrial park for integrated management. IOT based Industrial Information Management (IIM) provides pre and post-accident warning and rescue, necessary service support and decision-making support can be achieved easily. IIM framework is partition into three: (i) sensing level,(ii) network level,(iii) cloud computing level. In sensing level different sensing devices are used liker RFID, infrared sensor, etc. network level for data transfer to cloud through wire and wireless communication. In cloud computing level compute collected data into information for different user interface application like environmental monitoring, logistic management, emergency rescues, etc. all application are handle by park administration center, government surveillance department for take necessary action based on industrial park condition information. Based on this approach industry management level will improve.

Hyunjeong Lee, et al [33] summited IOT framework for energy management system in smart factory. Smart factory consist of sensor, meter, controller. Sensor collect environmental data and meter for energy consumption data, all data send to database via IOT gateway. Factory Energy Management System (FEMS) has Four different Database (DB) and they are Energy DB for store sensed raw data , Context DB used for store energy information, profile DB for store factory profile, rule DB for store control information. IOT gateway send energy consumption data to FEMS framework in periodic interval of time. FEMS framework analysis it with previous energy measured information or factory energy profile information to find abnormal state in energy consumption. Based on the result CEO or energy manger can alter energy consumption level in factory. (SHIP) [34] Supply Hub in Industrial Park, IOT enabled SHIP model consist of three level: (i) Physical Asset Service System (PASS), (ii) Information Infrastructure (II), and (iii) Decision Support Systems (DSS). PASS provide different physical assert and services likes warehousing, transportation for enterprises customers based on rental. In II has four layers: (i) RFID-enabled smart assets layer for collect real time information, (ii) gateways and Gateway Operating System (GOS) layer for transfer collected information to Management Platform Layer (MPL), (iii) MPL for management like service, data, network, and (iv) applications layer for provide interface to user for access SHIP information. DSS is used for prizing the services for enterprises, allocate product in storage space, etc. IOT SHIP provide automatic check in and out to warehousing and transportation for member enterprises. Real time route optimization in SHIP transport vehicles. SHIP provide accurate monitoring about stocks, vehicle status and also provide real time information among different participated enterprises. Liu, et al [35] recommended a cloud based temperature control system in a data center (DC) using IoT devices. The proposed system is based on energy efficient multi-level temperature cooling system and cloud based data management and analysis. The sensor nodes are attached at ease in various parts of the DC and connected to the central monitoring node using ZigBee technology. By using the different temperature threshold levels, the ventilation system between computer center, maintenance center and natural environment is activated. When the temperature reaches above the maximum threshold level of DC the air-conditioning system will be activated. Using various control levels, the DC is made energy efficient using well-built IoT devices.

IoT application in smart vehicle

IoT application in automobiles is emerging technology, in future internet enabled vehicles create big revolution on the road side.Author, Mahmoud Abuelela, et al [36] proposed Vehicular Ad Hoc Networks (VANETs) applications are connect to cloud forimproving driver'ssafety, traffic update,emergency warning, and road assistance. In this section, IoT application in smart vehicle models are reviewed. Neeraj Kumar, et al [37] suggested IOT based healthcare services in traveling, which is called Internet of Vehicle (IoV). IOV system architecture is consist of two layers: Acquisition Layer (AL), and Communication and Computation Layer (CCL). In AL each vehicle is represented in game theory, learning algorithm (Learning Automata) is used for interacted with environment or other vehicle. Vehicle and patient are enabled with sensors for collect body and environment data. Sensed data are send to Road Side Unit (RSU), which is mobile cloud. RSU is connected with centralized cloud (CC). Shot range communication techniques are used for communication between RSU and other vehicles such as ZigBee, BLE, etc. vehicles create connection like peer to peer or vehicle to vehicle communication for send and receive data. RSU measure payload value for provide services. Suppose payload has value, that task will execute with help of CC. some patient information data are also stored in RSU cloud for provide faster request service. Handoff technique is used resolve mobility problem in Virtual Machine (VM) level. Wu He, et al [38] propound Vehicular Data Cloud (VDC) for provide intelligent transportation services. There are two services are developed: Intelligent Parking Cloud Services (IPCS), and Vehicular Data Mining Cloud Services (VDMCS). In IPCS each and every parking lot is monitored with different sensing devices for parking lot availability, miss parked cars, etc. Sensed data are send to cloud for process and storage purpose. In VDMCS, road side infrastructure are connected to cloud such as traffic control signals, surveillances cameras, etc. each vehicle also connected to cloud. The collected data provide solution for driver behavior monitoring, road situations, etc. automobile industries can easily get feedback for product from user. For improving performance two data mining models are use service: Naive Bayes Model and Logistic Regression model. Based on the author approach road safety will increase, easy to maintain and traffic control system and vehicles.

In [39] authors postulated smart management system for transport vehicle with integration of smart bikes. Proposed framework consist of seven layers: (i)application layer, (i) sensing layer, (iii)communication layer, (iv)operating system layer, (v) middleware layer, (vi) external services layer,(vii) safety services layer. Wi-Fi, Dedicated Short Range Communication (DSRC) are used for communication. Bike safety, security operation (BSSO) model has two communication infrastructure: Bike to Vehicle (B2V), Bike to Infrastructure (B2I). BSSO always connect with biker and travelling vehicle through gateways for provide information. Each bike is monitored to collect data about misbehavior riding, collision detection and collected data are send two security support authority unit or IoT gateway. For warning purpose vehicle on board device or mobile phones are used. Misbehavior detection (MD) and Collision Perdition and Detection (CPD) schemas are developed for analysis collated data. Based on the above approach biker speed will easily monitor unwanted human dead will reduce. Chatrapathi. C, et al [40] discussedIoT based smart accident management framework for vehicle user. four major units (i) vehicular unit, (ii) central processor, (iii) Road side Unit, and (iv) Hospital. Each vehicle is enabled with biomedical sensors for monitor user health and mechanical sensors for detect vehicle accident. Sensed data are send to centralized server via Vehicle Area Network (VANET). Ambulance, Road Side Unit (RSU), VANET are connected with centralized server. Centralized server send information about accident to ambulance. Ambulance use the server information for service and send patient monitoring detail to server. Server send received information to hospital for monitor patient condition before patient arrive. Based on this approach timely provide first aid services to patient. Smart e-bike Monitoring System (SEMS) [41] has IOIO microcontroller board is used for connect android mobile phones to use GPS, accelerometer. Sensors are used to collect e-bike user trip situation. IOIO board analysis collected data and analysis it before send to handlebar assistant control device and mobile phone. Collected data are stored into server for analysis. Each e-bike trip is documented and also can share to social media easily by user.

IoT Application in healthcare

Electronic devices are smarter, althoughatthe hardware level like flexible electronics, Sam Lemey, et al [42] studied flexible RFID Tag for human wear. In future all wearable devices become this kind of device, because easily fixed in the body or clothes. IoT healthcare applications, wearable device make a major role, it allows you to stay better engaged with your environment. IoT makes smarter all healthcare environments like: kind of doctor works, hospital, ambulance, etc. in this section, IoT Application in health care are reviewed.

In [43] Hyun JungLahave developed a framework for IOT based personal health care system. Five types of disease diagnosis schemes are introduced and they are: (i) Range-based diagnosis, (ii) Abruption-based diagnosis, (iii) Pattern matching-based diagnosis, (iv) Abnormality frequency-based diagnosis, (v) Abnormality persistency-based diagnosis. All these diagnosis are based on trajectories model. Based on the above five schemes, Disease Diagnosis Knowledge Base (DDKB) is designed and implemented in the IOT environment. DDKB is the source which has diagnosis research articles, physician's knowledge about disease, etc. By using DDKB, machine readable schemes are formed and used for diagnosis. A Smart Toilet System (STS) is used for demo purpose. In that, STS client (i.e.) smart IoT devices collect data of Personal Health Care (PHC) device measurement values and sent to the STS server. Then the diagnosis scheme unit in STS server analyzes the STS client data to identify disease. Using Bayes machine learning algorithm, the accuracy of the diagnosis is improved by comparing the diagnosis result with different disease parameters. Benefits of IOT based PHC are early detection of ongoing diseases without frequent clinic visits, frequent monitoring of health condition, continuous assessment is done over out health condition. Elisa Spano, et al [44] proposed remote healthcare platform in ECG monitoring System. IOT platform for ECG monitoring system consist of three part and they are Wireless Sensor Network (WSN), IOT server, user interface. In WSN chest belt type ECG monitor sensor is used for monitor human health and send collected data to IOT gateway via wireless communication (ZigBee). IOT gateway compress sensed data to reduce bandwidth utilization without any data loss before send to IOT server. IOT server is middleware between WSN part and user interface (internet application) part. IOT server process received raw data and visualize it to user through web interface and also get command from user for alter WSN works flow likes monitoring time interval. Benefit of the platform is reduce health care expenditure.

Sung-Min Seo, et al [45] designed food contamination via Internet of Things (IoT) with help of packet sized immune sensor system (PSIS). PSIS consist of two major part Elisa on Chip (EOC) and CMOS Image Sensor (CIS). PSIS test with contaminated food sample with help of EOC reader to find pathogen. Suppose analysis result is positive PSIS generate light signal, when the light signal is captured by CIS and Wi-Fi module enabled send test result to smartphone. Smartphone is used for control PSIS and send analyzed report to centralized server. In server hosting service is used for send warning about contaminated food product to consumer before purchase it. IOT based PSIS is helps to reduce the time for advertising about condition of the tested food in global space.JacekJarmakiewicz, et al [46] proposed IOT based healthcare network in Nano sensor level. Nano sensor are implanted in human body for monitoring health is called Implanted Body Area Network (IBAN). Nano sensor are capable to communicate with outer device for transmit sensed data. Two kind of links are used for communication between device and Nano sensor and they are magnetic coupling and radio communication. The outer device send collected data to server for user used personal device (smartphones) for view the own body information.

Smart Hospital System (SHS) [46] designed with Ultra High Frequency(UHF) RFID and WSN. The combination of UHF RFID and WSN is called Hybrid Sensor Network (HSN). Architecture is classified into three part and they are (i) HSN, (ii) IOT smart gateway, (iii) user interface. HSN is used for collect hospital environment details like temperature, ambient light condition and also patient location, then all data send to IOT gateway. The 6LoWPANtechnology is used in HSN level for communication. Monitoring application is used for analysis the received data form IOT gateway and stored into database. Internet based user interface or special mobile application are used for control HSN and view the monitoring or historical data of patient. Before access the data doctor or hospital staff are authenticated because of the security purpose. ByungMun Lee, et al [48] suggested smart healthcare device for chronic decease. Self-management is most important factor for chronic decease, it had achieved here through IOT devices. Separate IOT devices are fixed for risk factor of metabolic syndrome. IoT Blood pressure meter value is used for find hypertension, likewise IoT glucose meter for diabetes and IoT weight scale for obesity. All individual IoT device output will send to IoT server for process and server add patient general information like age, family history, etc. The proposed system working based on collaborative manner and event derive application used self-management.

CONCLUSION

In future,IoT will change a person's lifestyle from the current scenarios. A huge number of things will connect to the internet, which will produce rich information. Based on that, new services will be provided, however new services must satisfy security and privacy**.** There are lot of startup companies already started working to develop the resources for various IoT applications. Many researchers have developed IoT platforms suitable with the end application. This paper presented different dimension of the IoT technology, basic architecture and familiar protocols in IoT. Finally reviewed IoT applications in different domains.

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