A View on Sensors Used In Internet Of Things

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----------**ABSTRACT**----------

As we know the Internet of Things is one of the most advanced and important technological topics today. So this paper mainly focuses on an overview of Internet of Things, characteristics of ZigBee technology, sensors and basic types of sensors with advantages. However, this research paper will give good understanding for the new researchers, who want to do research in technology of Internet of Things. This paper also introduces typical network (Wireless Sensor Network) residing in sensing domain, then the common features of some IOT Sensors.

Keywords: **ZigBee, WSN, IoT**

I. INTRODUCTION

A. Internet of Things:

The Internet of things (IoT) is the Inter-networking of hardware devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other materials which is embedded with software and hardware, sensors, actuators, electronics and network connection which enable these objects for collection and exchange data. "This IOT technology allows objects to be sensed and IOT device will be connected to a certain IP network though via internet. By this Internet of Things creates great opportunities for various direct integration of the physical world into computer-based systems, and resulting in improved accuracy, reliable and economic benefits and also to reduce manual involvement. Big data Availability, Cloud computing and Network connectivity are some of the basic components used in this technology. Gradually, IOT ultimately provides advanced services for devices, network connectivity and this goes almost beyond machine-to-machine (M2M) communications and normally represents the different types of protocols, applications, security and domains. The ability of the IOT has been evolved due to an empowerment of lot of technologies, including embedded systems, machine learning, ubiquitous wireless communication, commodity sensors, and real-time analysis. The main backbone for implementing IOT is Wireless Sensor Networks [1].

Wireless Sensor Networks (WSN) is defined as a networking of devices which can communicate data and information through wireless connections. This data and information are forwarded through different nodes, and with help of a gateway, the data is linked to other networks like wireless topologies such as star topology, tree topology, mesh topology and hybrid topology [2]. This provide the most common services in industries and in commercial purposes because of its low usage .It is one of the most promising and rapid developing technologies for the future. This provides leading research projects, technologies, standards and platforms. Technologies and explain how this can help sensor networks achieve their full potential. The most common controller is a microcontroller, other alternatives that can be used as a controller are: a general-purpose digital signal processor, desktop microprocessor, ASICs[1, 2]. RF based communication is the most related that makes more flexible in most of the WSN applications.

B. ZigBee Technology

ZigBee is new wireless communication technology with short range, less energy consumption, less complexity, low cost, low power data rate and it follows the standard of IEEE 802.15.4. The technologies like wireless communication are quickly spreading to variety of new sectors, including the AI [Artificial intelligence], ML (Machine Learning), automation and this has the crucial use of wireless technologies in the monitoring systems, data acquisition, automation of manufacturing processes, building control will gradually evolve. ZigBee technology uses low power wireless standards and even for less cost devices in automation, computer peripherals and home controls. The standards for ZigBee software and hardware are described for the security and developing of the technology [3,4].This is high level communication protocols can be used to create PAN (Personal Area Network) such as for medical equipment, home automation and small scale products. When comparing ZigBee technology to Wi-Fi technology, it's possible that they won't be able to operate with each other. Its maximum speed is just 250kbps, much lower than the Wi-Fi and also has best quality because of its low power-consumption rate and battery life.

The technical features of using ZigBee technology also make it the great choice for wireless sensor networks and because of the small range of communication and slow data rate. In agricultural field this technology is highly suitable because it has fewer amounts of data flows. Therefore, it has the practical significance when it is applied in the crop environmental monitoring system [3, 4]. ZigBee uses a variety of power-saving modes that will definitely be used for at least 6 months to 12 months powered by double AA batteries. In addition to this, this technology also provides the mechanism of collision avoidance in CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance [4].

II. SENSORS

Sensors are the advanced device that acquires a physical quantity and converts into an electrical signal suitable for processing. Nowadays common sensors convert measurement of environmental condition into an electrical signal. Active element of a sensor is called a transducer (A device which converts one form of energy to another form). Based on the power supply requirement sensors are classified as active sensor and passive sensor.

Active Sensor – A sensor which need power supply is called as Active sensors. Example: photoconductive cell.

Passive Sensor - A sensor which don't need power supply are called as Passive Sensors. Example: Radiometers [5].

Some of the commonly detectable phenomena are Chemical, Biological, Electric, Electromagnetic, Temperature/Heat, Pressure, Optical, Magnetic, that are gas, chemical, acceleration, biosensors, Radioactivity, Mechanical motion such as displacement, velocity and acceleration and some other property, application and technology. Some features are accuracy, range, cost, calibration, suited for all environmental condition, resolution, repeatability [5,6].

Based on sensors uses, we classify sensors that are industrial and non-industrial

Industrial -- process control, measurement and automation.

Non-industrial – Aircraft, Consumer electronics, Automobiles, Medical products. Sensors are embedded in human bodies, airplanes, automobiles, cellular mobile phones, radios, industrial and chemical plants and other applications [6].

A. Types of Sensors

1. **Temperature Sensor**

Temperature sensor is a low-cost but highly-responsive device to measure the temperature in the atmosphere and thus it is converted into an electrical signal, for performing this it uses a thermocouple or RTD (Resistance Temperature Detectors). This RTD is prepared by two dissimilar metals which generates the electrical voltage which is indirectly proportional to change the temperature.[7]

The measurement of the temperature sensor is about an air or an object's coolness or hotness. The working of temperature sensors is the voltage that read across the diode. If the voltage is high, then the temperature increases and when there is a voltage drop between the base and emitter of transistor terminals, they are recorded by this sensor. If the difference in voltage is amplified, the device generates analog signals and it is directly proportional to the temperature [7,8].

Advantages of temperatures Sensor

- It is a low-cost, highly-responsive sensor which are versatile to use in different sensor applications without loss of sensor performance
- The temperature sensors are used in the Defense purposes [7].
- It is usually used in the home automations like microwave Owens, refrigerators, air conditioners.
- It can also be used in the agriculture and industries like temperature sensing for good result cropping, warehouses, cultivating mushrooms.
- In thermal power plant, this sensor is used to measure the temperature of the boilers [8].

2. **Ultrasonic Sensor**

Ultrasonic sensors are device which works on emitting sound waves at a frequency which is too high to hear for humans. It holds two main components they are Transmitter (Tx) and Receiver (Rx). The frequency is sent by Tx and then waits for that sound to be reflected back to the Rx, based on the time taken the distance is calculated. This is same as radar that measures the time by using radio waves to return after hitting an obstacle. This sensor provides approximate distance measurements with 3meter range. Even in the surface of the water, this sensor has the ability to properly detect the obstacle by reflecting a portion of the sound and produces an echo that ultimately helps in detecting the objects under water. An ultrasonic sensor for in-air applications has been fabricated using ferroelectric polymer technology. Transceivers that is transmitter and receiver generally plays a very important role is distance calculation [9].

Range direction magnitude is made complicated by expanding the sensor signal's beam. This direction could be reduced by raising the sensor's frequency. A method is introduced for getting the right direction to a planar surface using 3 sensors. A transformation that is applied to the sensor specification that are described to ultimately reduce the complexity [9,10]. This UV sensor has advanced features and more flexible with the range over Infrared sensor. The main crucial principle of Ultrasonic sensor are detection of obstacle and water level, distance measurement with the distance of about 3cm to 4m.

Advantages of Ultrasonic Sensor

Ultrasonic sensors have attracted scope and attention in the robotics field because of its low cost. Ultrasonic measurements work in any lighting condition, making this a better option to use this sensor and supplement infrared obstacle detectors. It is used in the major fields like UV Tracking, UV Astronomy, Night vision devices and metro and rail safety. This sensor can also be used by the elder people and people with vision defects. The prototype testing has developed to detect objects and shows accuracies of 90%-99% for distance measurements. The UV sensor also demonstrates good detection for different obstacle materials such as wood, concretes, plywood, plastic and mirror and also detects different colors. The system detects the obstacle with the minimum size of 5cm x 5cm.

3. Infrared Sensor

Infrared (IR) sensor is commonly used as proximity sensors and mainly for obstacle avoidance in defense and robotics fields. It offers less cost and frequent response time than the UV sensors. The infrared sensor provides the non-linear reflectance of surrounding objects,

this behavior of measuring the distance is based on the intensity of the back-scattered IR light have a great precise for measuring range and IR sensors are mostly been used as proximity detectors in remote controlled robots, in addition to this infrared red sensors provided the measuring range of the medium resolution at long ranges that is about 5cm-10m of distances. Using reflected light intensity to estimate the distance from an obstacle aren't common [11].

Infrared sensor usually contains two main components that are Transmitter (Tx) and Receiver (Rx), this is basically used for obstacle detection. The working of IR sensor is, initially Tx sends the frequency (about 1m) that cannot be seen through our naked eyes, thus this frequency returns back to the Rx when no obstacle is detected. The ultimate use of infrared red sensors in the field of robotics is mainly for obstacle avoidance. Generally, their accurate and reliable responses are much more attractive for implementing the real-time operation of a mobile controlled robot. IR sensor based on the light intensity scattered back from obstacles can measure the distances up to 10 meters [2]. The reflected response amplitude of IR sensors will depends on object's surface structure and ha will non-linear. Also, this sensor is generally describing the expected errors in distance estimates are modelled and analyzed [11].

Advantages of Infrared sensors

This type of sensor is developed and has been tested for detecting obstacles and this displays speed and accuracy of 90%-99% for distance measurement [11]. The systems prototype thus even provides the great detection for various obstacle materials such as wood, concretes, plywood, plastic and mirror and also detects different colors. The system detects the obstacle with the minimum size of 10cm x 10cm. Infrared sensors are majorly used in fields such as Tracking nano particles, Infrared Astronomy, metro and rail safety, water analysis and in Anesthesiology testing [12].

4. Gas sensor

Wireless Gas Sensors helps in measuring the presence of concentration of Carbon dioxide (CO2) and Sulphur oxides (Sox), Carbon monoxide (CO) concentration in air, so that we could control the air pollution. This Wireless gas sensor has been used in variety of fields because of its high accuracy with good performances. They are used in various agricultural and industries ranging from aerospace to medicine. Various technologies are used to measure Gas concentration such as infrared semiconductors, catalytic, oxidation etc. [12].

Sensing technology has been popularly used for gas detection and even by using this sensor we could identify person who consumed alcohol. Due to the different limitations and applicability of other various gas sensing technologies, researchers are focusing on various scenarios with gas sensor calibration. A different types of sensing technologies are been introduced on the basis of electronic and electrical method. Methods based on other kinds of variations such as optical and calorimeter is presented in a common way. Wireless moisture sensor along with active RFID (Radio Frequency Identification) are originally been used in the proposed wireless soil sensor system for monitoring the pollution of vehicles using Internet of Things concept in real applications. While location monitor, we use the RFID reader where the microcontroller is integrated with the wireless gas sensors [12,13].

Advantages of Gas sensors

Gas sensors are majorly used in environment monitoring and in food and medical fields.

- To check the air quality that is in automotive engines.
- Can be used in security control of explosives, fire services and drug dealings.
- Control in industries such as detection of combustible or toxic gas, in chemical laboratory research, in Gas and Oil industries, in manufacturing of Petrochemical, rubber, paints, pharmaceutical etc. [13].

5. **Accelerometer Sensor**

Accelerometer sensors have been introduced for the measurement of acceleration in a variety of applications such as automobile airbag crash, mobile phones (sensing vibration, tracking orientation, media player) and for measuring involuntary hand motion of human. Acceleration is basically defined as the measurement of the change in velocity, or speed divided by time [14].

These Accelerometer sensor three single-axis accelerometers fabricated at the Microsystems Technology Laboratory (MTL). The mass and size of the sensor were limited to avoid altering hand movement which is to be being measured. These MTL accelerometer sensors have a mass restricted to movement along a single axis. Acceleration sensor calculates the displacement, forces and mass using differential capacitors. The accelerometer was packed in LCC (Leadless Chip Carriers and this Leadless Chip Carriers were arranged in a configured 3-axis. A circuit is constructed to convert the differential capacitor's signal into an analog signal and then converted it into a digital signal. This converted digital signal data allows us real-time analysis of the acceleration data, this shows the working of Accelerometer sensor [14].

Advantages of Accelerometer sensor

Micro-electro-mechanical systems (MEMS) accelerometer sensors has been the heart of applications that include the automotive, aerospace, computer manufacturing and home entertainment which includes consumer electronics devices such as personal computer game controllers (Nintendo games), mobile phones (e.g. android, iPhone) and in mobile media players. In the notebook computer, they are being used by many manufacturers to detect free-fall in order to shut down hard-disk operations ultimately to prevent potential disk crash [14].

Some of major applications are these sensors are used in Counting goods transported in trains and how much ships in sea, used in analyzing swimmers performance and also to check the Impact force of a football [14].

6. **Humidity Sensor**

Humidity sensor checks the presence of water vapor in atmosphere and if it is more it affects human comfort as well as many manufacturing processes in agriculture as well as in industries. Humidity sensor has been mainly focused to monitor conditions of environment. The presence of water vapor also has the constraints on various chemical, physical and biological processes. A humidity sensor should be in contact with the processing environment and hence with the help of humidity sensor it is easy to implement.

There are various ways to detect the humidity or moisture depending on industries, agriculture and in other fields. Like moisture in liquids can be found, moisture in solids can be found, moisture in gases can be found and thus they can be expressed in different measuring units. However, for conditions of the environment, the temperature effect can be neglected without compromising the speed with the accuracy of measurements [15].This humidity sensor the water vapor in air and then converts into electrical motion. The basic concepts in humidity and the various approaches can be defined by many alternative ways such as Relative Humidity, Specific Humidity, Absolute Humidity, dew point humidity [15].

Advantages of humidity sensors

Industry: Humidity control in factories, Electric device managing, Web printing, motor assembly line, Clean room and ESD control, textile spinning, Dehydration of food.
Agriculture: Crop management by checking humidity, stocking of cereals and forcing culture.
Automobile: Car windows.
Electric appliances: Microwave ovens, clothes driers, Air conditioner systems.
Community safety: Humidity in boilers, Nuclear power reactor.
Measurements: Hydrometer, thermal-hydrostatic meter.

7. Motion Detection Sensor

Motion detection sensor normally over area with electronic field and receive the movement of electronic field and usually helps in human motion including body movement, typing, breathing and speech by converting the mechanical motion into electrical motion [16], this also involves object tracking and movement control system of temperature sensors for measurement of temperatures over range of objects having thermal gradients, this temperature sensors of the thermal sensing unit that are arranged to form a 2D temperature sensing array, with the help of this 2D temperature sensing array allows to calculate the centroid of temperature based on 2D temperature gradient information derived from sub region objects temperature, This accelerometer was firstly been introduced in Apple iPhone for screen tilting, screen orientation of the mobile. Some of the types of movement of that object detection sensors are Infrared motion detector sensor, Ultrasonic motion detector sensor**,** Microwave motion detector sensor [16,17].

Advantages of Motion Detection Sensor

The main advantage of motion detection sensor is low cost, easy to maintain and has the scope of human motion detection including detection of body movement, typing, breathing and speech, other major applications of this sensor is that Home automation, intruder detection, medical alerts after continuous observations of the patient, detection of gas, water and fire and this sensor is used in detection of anti-theft protection [17].

8. Optical Sensor

An optical sensor is a device which is used to converts light rays into electronic signals. This me assures the physical quantity of light and then is converted into the machine readable form. This sensor measures the changes from one or more light rays and alters the intensity of the light, so this helps to protect the air, water, microorganisms, environment, tissues from animals and plants are analyzed. In the medical field, samples of physiological fluids and body tissues are analyzed on a routine basis to provide information on patients for diagnosis and monitoring purposes.These optical sensors commonly generate the remote operation over many kilometers without any sensitivity of lead (Ideal for deployment in measurements in environmental hazardous) [18].

Advantages of optical sensor

- For monitoring the changes in environment, in explosive environments and over conventional electronic sensors Fiber optic sensors offer excellent use.
- Ideal for microwave environment such as Resistant to chemically reactive environment, high temperatures embedding and mounting of surface.
- In the medical applications like intra-aortic balloon pumping.
- As optical sensor has great bandwidth instead of wired cables, this optical sensor can able to transmit lot of data's and information over other transmission media.
- This can even monitor a long range of chemical and physical parameters.
- This has the potential to sense high sensitivity, high resolution, high rangeand high electrical insulations [19].

9. Soil Moisture Sensor

Soil moisture sensor is commonly used for the sake of testing how much moisture is present in the soil. In the field of agriculture and industries, soil moisture sensor plays a very crucial role. In the field of agriculture, this sensor has become a major challenge for new farmers. The water management is one of the part of management challenges for establishing farming technology and to build a soil moisture measurement system due to soil moisture sensor [20]. The main crucial role of soil

moisture sensor is that it is used in developing the weather patterns, gardening, and hydrology and water evaporation in farming sector. In addition to this amount of irrigation and the visualization of results is performed which is based on the measurement data can be done.

When there is water shortage in the soil, the soil moisture sensor gradually helps in indicating the scenario that is, it shows the module output is at high level, else the output is at low level. By using this soil moisture sensor we can automatically water the crops and plants in agricultural fields with the help automatic watering technique. Digital output is simple, Module triple output mode, analog output more accurate, serial output with exact readings. This Sensor recognizes capacitance to measure the moisture in soil that is when the soil is dry or in wet state. Just by inserting this soil moisture sensor into the soil we can identify at what condition the soil is, and the water volume content of the soil is reported in percentage format [20].

Advantages of soil moisture sensors

Soil moisture sensor is easy to use, inexpensive, simple rapid and commonly used in Agriculture like for irrigation and automatic watering purpose [21]. It can be used to obtain data during freezing conditions,other majorly uses of this soil moisture sensor is that it is used in fixed bolt hole and convenient for installation. Even the threshold level can be configured.

The sensitivity for soil moisture detection can be adjustable. Digital output is simple, Module triple output mode, analog output mode, serial output with exact readings [20].

10. Gyroscope Sensor

For measuring angular rotational speed, angular rotational axis and angular velocity sensors with the help of earth's gravity, thus this determines the orientation of the earth's gravity [22]. It has been extensively used in recent years for monitoring and measurement of performances in many different sports, tells the aircraft's, car's gravity direction and even can sense the orientation and for acceleration of the phone.

Gyroscopes are the devices that is mounted on a frame and can be able to sense an angular velocity if the frame is rotated. Circular video games motion and phone's vertical and horizontal orientation can be recognized with the help of this gyroscope sensor. Gyroscopes can be included in large complex system like navigation System. Some of the types of gyroscope sensors are optical gyroscopes, mechanical gyroscopes, fiber optic gyroscopes, laser ring gyroscopes and Micro-electromechanical system (MEMS) gyroscopes have been considered by principles and variety of improvements in commercial architectures [23].

Advantages of gyroscope sensors

A **low**-cost, higher accuracy gyroscope has a phase detecting sensor that is majorly recognized in with a functional electrical simulation (FES), this FES are introduced for the handicapped foot-walking people. These gyroscope sensors are popular because of its reliability and for its high accuracy. This detection sensor is completely embedded inside the shoe insole and detects in real time, ultimately this will be majorly used in Robotics, Ships and train stabilizers, artificial autopilots, racing motors bikes and racing cars, computer cursor movements and anti-roll devices like top spinning[24].

III. CONCLUSIONS

IoT has been becoming a great technological changes in our daily lives that really makes our daily life more comfortable and simple, even if we have other variety of technologies. Even though IOT has lots of benefits, there are some cons in implementation of IoT. Also there is much more importance on working on this research paper lies in the practicality. With the scope of rapid evolution and with high security of the technology, this becomes highly strong in home automations and in Artificial Intelligence.

Due to the emergence of increasingly complex technologies and among other factors, the need for new types of sensors is becoming more crucial and more critical than ever. Hence the IOT has high increase in availability of information, and it's also been transforming organizations, companies and every industry around the universe.

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