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The Analysis of Different Types of IoT Sensors and security trend as Quantum chip for Smart City Management

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Abstract: *The life on earth and the sense of the change in surroundings is highly depends on each other. So sensors have become part of our daily life. Recent years witnessed tremendous advances in wirelessly networks and its sensors. Wireless sensor nodes are typically low-cost, low-power; small devices equipped with sensors, data processing and wireless communication capabilities. Day by day, these are becoming smaller, cheaper, while more powerful and more pervasive. Sensors of all types try to mimic certain sense organs of living beings gifted by nature in order to connect with the environment[3]. The sensors can provide the emerging issues that are linked with health care. Sensor technology represents one of the emerging areas of physics, electronics and biotechnologies, and is the one that has most greatly exploited by the innovations in the individual microelectronics, optical and computer sciences technologies. Recently sensors have been considered as a highly potential field of scientific research. However, biosensors also have emerging now days. The IoT sensors can be effectively used for water ,Transport, Garbage, Environment etc. management in Smart cities*
Keywords: *Internet of Things, IoT Sensors, Smart cities*

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I. Introduction

The words 'sensor' and 'transducer' are both widelyused in the description of measuring systems and IoT's(Internet of Things).A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example a thermocouple [1], Which converts temperature to the output voltage which can be fed to an IoT system. A sensor is a device that receives a stimulus and responds with an electrical signal.

The stimulus is the quantity, property, or condition that is received and converted into an electrical signal. Some use a different term, measurand, which has the same meaning, however with giving stress on quantitative characteristic of sensing. The purpose of a sensor is to respond to some kind of an input physical property, called stimulus, and to convert it into an electrical signal using electronic circuits. The word 'sensor' is derived from the word meaning 'to perceive' and 'transducer' means 'to lead across'.

1.2 Sensors

A dictionary definition of 'sensor' is a device that detects a change in a physical stimulus and turns it into a signal which can be measured or recorded. Another corresponding definition of 'transducer' is 'a device that transfers power from one system to another in the same or in the different form [2]. A sensible distinction is to use 'sensor' for the sensing element itself and 'transducer' for the sensing element with the associated circuits. All transducers would thus contain a sensor and most of thesensors also transducers. In general terms, the transduction process involves the transformation of one form of energy into another form. A sensor is a device that detects or measures an external stimulus and records, indicates or otherwise responds to it [3]. According to the nature ofexternal stimulus sensors can be of two basic types viz. physical sensor and chemical sensor.All electrical transducers are broadly classified under two categories, viz. active and passive. Active transducers are self-generators, operatingunder energy conversion principles. They generate an equivalent electrical output signal without using any external energy source. Hence, sensor can be defined as a device that receives a signal and converts to the electrical form which can be further transformed by electronic devices. [2].A sensor's sensitivity indicates how much the sensor's output value changes when the input quantity changes. For instance, if mercury in a thermometer moves 1 Centimeters when the temperature changes by 1 °Celsius, the sensitivity is 1 cm/°C. Sensors that measure very small changes needs to be very high sensitivities.A sensor produces a measurable response to a change in any physical condition like temperature or thermal or a change in chemical concentration. Sensors are particularly useful for making in situational measurements such as in industrial process control.[2].Sensors are an important part of any measurement and automation application. The sensor is responsible for converting any physical phenomenon into a quantity measurable by a data acquisition

system.Passive transducers operate under energy controlling principles. They depend upon the change in the electrical parameter like resistance, inductance or capacitance excitation and requires secondary electrical energy from an external source. Some of the more common transducers are discussed in below sections.

1.2.1 Physical sensor

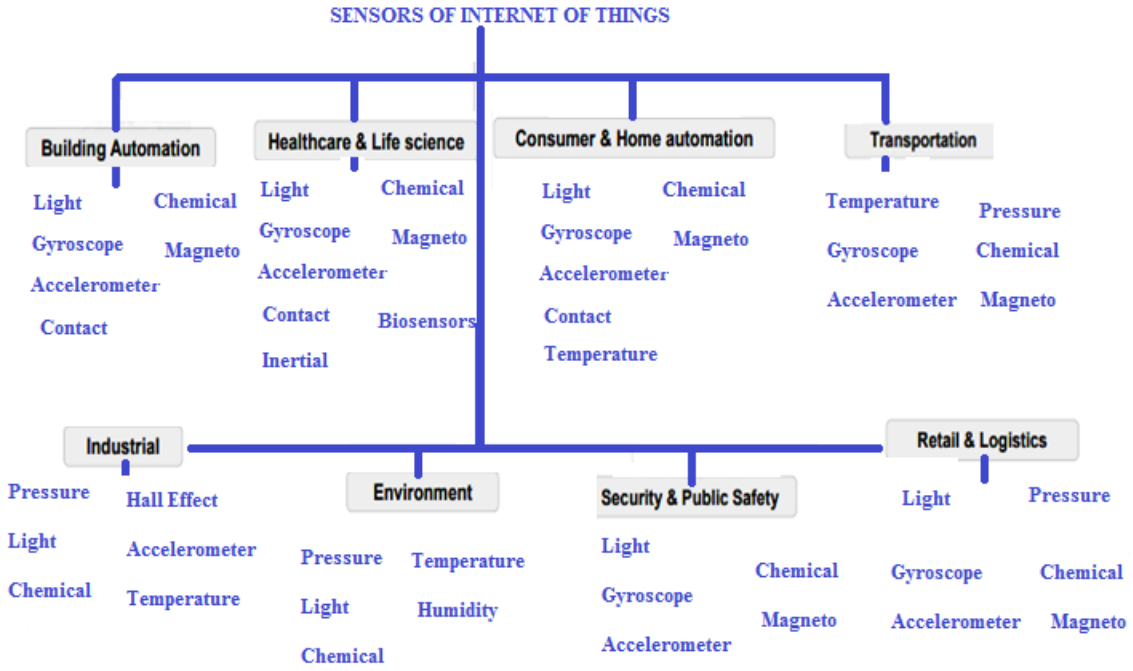
Physical sensor are generally measuring for physical quantities such as length, temperature pressure, electricity, weight, sound etc. It can be defined as a device which respond to physical property, called stimulus, and produce a correspondingmeasurable electrical signal [4, 5].

1.2.2. Chemical sensor

A device which responds to a particular wayby a chemical reaction andthat can be used for the quantitative or qualitative determination of the change is called chemical sensor. Such sensor is concerned with detecting and measuring a specific chemical substance or set of chemicals [4].

1.3 Biosensor

Biosensor is subset of chemical sensor but is often treated as a separate area. It is an interdisciplinary area with exact limits cannot be defined easily [3]. Basically the biosensor is a self-contained analytical device which responds selectively and reversibly to the concentration or activity of chemical species of biological samples, which means any sensor physically or chemically operated in biological samples can be considered as a biosensor using living components or a product of living things for the measurement or **Fig.1 Classification of Sensors using in Internet of Things**



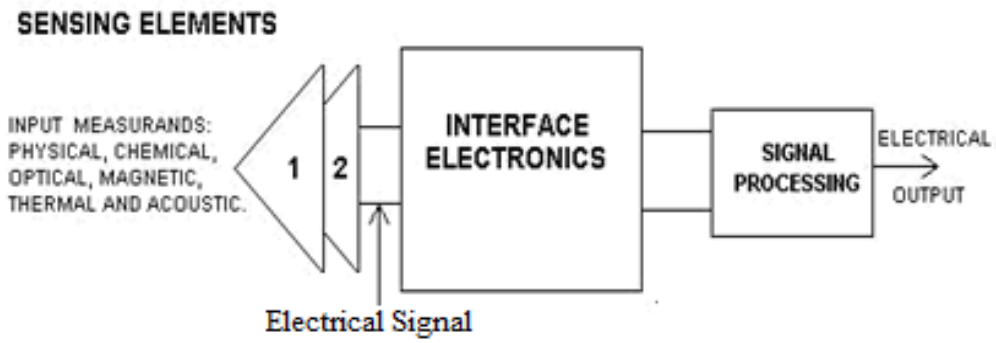


Fig.2 -Sensing elements and corresponding electrical signal

Sensor range can be from very simple to the complex. They are classified based on their properties that what it measures, what are its specifications, what physical phenomenon it is sensing, what conversion method is employed, what material it is made, and what is the field of application [3].

Any electrical transducer is a sensing device that a physical, mechanical or optical quantity to be measured and transformed directly with a mechanism to an electrical voltage or current that is proportional to the input measurand.

1.3 Commonly used sensors in Internet of Things (IoT)

The largevarieties and type of sensors available in the market at present day. They are used for the improvement of quality of human life style. The importance of IoT rises day by day, a sensor in its part is designed the measurement of physical external stimulus and records, indicates or responds to it that can be read by a user or another device. The most commonly used sensors in Internet of things are described in the following.

Temperature sensors

These are one of the commonly using sensors that measure the temperature or heat of a given medium. These sensors uses a number of methodsfor determine and quantify the temperature of any object. Some of theTemperature sensors required a physical contact with the object while other types do not require contact as they can detect liquid or gases that emit radiant energy like spike in heat or temperature.Highly sensitive semiconductors available in market which are capable enough to monitor and display slight variation in temperature [9,10]

Proximity sensors

Proximity sensors are the best to detect any type of motion. They are widely using in applications such as security, safety, or efficiency. These sensors are used to avoid obstacles in navigating to a crowded place or any complex route as best possible sensor forthe mapbuilding. Proximity sensors uses electromagnetic radiation like radar signals to detect motion or habitation.Proximity sensors have best use in many typesindustry [10,11]. The retailers use proximity sensors to find out vicinity of the customers once they are near to their premises by sending them some offers on their IoT devices. It also can be used in parking systems, museums, airports, etc.

Pressure sensors

Pressure sensors are used for measuring pressure of any type of gas or liquid. Pressure sensors converting the physical power into an electrical signal. They are also can be effectively used for measuring other variables like speed and altitude or similar situation in some way. Barometers and pressure gauges are the common using pressure sensors used for IoT system. Barometers are helpful in weather forecasting as it can give accurate measurement of ambient air. Pressure gauges are mostly used in industrial sites as it is good for the monitoringof pressure in closed environments.Pressure sensors are ultimate solution for IoT devices as it can be used for various areas such as touch screen devices, bio medical devices, automotive systemsand manufacturing industry.Micro pressure sensors are type of small size sensors forthe measurement of pressure. The first micro sensor was developed and used by industry piezoresistive pressure sensor to reduce fuel consumption by maintaining a tight control ratio between air and fuel and other is disposable blood-pressure sensor to monitor the corresponding status of the patient during operation. The market available products are usually either piezoresistive or capacitive. Micro pressure sensors work on the principle of mechanical bending of thin silicon diaphragm by the contact air or gas pressure. This physical movement is converted into electrical output [9]

Optical Sensors

Optic sensing technology is used to detect electromagnetic energies like light.It utilize concept of the photoelectric effect, says that there will be an ejection of electrons, when a negatively charged plate of some appropriate light-sensitive material, is strike by a beam of photons. The electrons can then be made to flow as a current from the plate feed as a signal. The magnitude of the electric current produced is directly proportional to the light intensity or number of photons [9,10]. They can emit, receive, and convert light energy into electrical signal. The fiber optic sensor IoT interface is connected to internet and can collectsvarious information for monitoring different parameters .These optical sensors widely use in different types digital cameras which act as one of the major physical devices of an IoT system.. As they are passive to all forms of electrical interfaces, they are considered as the much loved sensors for IoT. Optical sensors are very good for energy, health care, aerospace, chemicals, environmental IoT systems. Optical sensors can be ideal for environments such as oil refineries, mining operations, pharmaceutical companies, and chemical industries due to its norisk components.

Fiber optic sensors

Most remote sensing systems are designed to measure photons. The detector is most critical component in any optical sensing system. It utilize concept of the photoelectric effect, says that there will be an ejection of electrons, when a negatively charged plate of some appropriate light-sensitive material, is strike by a beam of photons. The electrons can then be made to flow as a current from the plate feed as a signal. The magnitude of the electric current produced is directly proportional to the light intensity or number of photons. The kinetic energy of the released photoelectrons varies with frequency of the incident radiation. But, different materials has a threshold wavelength at which the phenomenon starts and a longer wavelength at which it ends.**[13] .** The past two decades have seen a growing interest in the field of fiber-optic sensors. This trend created by the advances made in the related fields like opto electronics and optical signal processing and the widespread use of optical fiber communication devices in the telecommunication industry caused reduction in optical fiber sensor cost. So the optical fiber sensors have been developed for a variety of applications in industry, medicine, defense and research [14].Optical fiber sensor system consists of optical source, sensing element and optical detector [4]. Information about the measurand is mainly conveyed in all optical fiber sensors by a change of either polarization, phase, frequency, intensity or can be combination of the above. The measurand like temperature, displacement, or strain, etc. can alters one or more optical parameters of the light such as intensity, phase, and amplitude. A returning fiber guides counter propagating light to an optical detector. This is then signal processed to provide the value of the measurand.

Humidity sensor

Humidity is the presence of water in air. The amount of water vapor in air can affect human livings as well as many manufacturing processes. The presence of water vapor also influences various physical, chemical, and biological activities and its measurement in industries is critical because it may affect the quality and cost of the product, the health and safety of the personnel. So humidity sensing is important in the control systems for industrial processes and human livings [8]. Controlling or monitoring of humidity is of important in many industrial,agriculture and domestic applications. In semiconductor manufacturing process, the humidity or moisture levels needs to be properly controlled and monitored while wafer processing. In medicalscience humidity control is required for respiratory supporting system, sterilizers, incubators, pharmaceutical processing and many other biological products. Humidity sensor is also necessary in chemical gas purification, dryers, ovens, paper, textile production and food processing industry. In agriculture measurement of humidity is important for plant protection, suchas dew control, soil moisture testing and monitoring. Domestic applicationsrequires humidity control for living environment in buildings and for microwave ovens, etc. So humidity sensors are employed to provide critical services

Accelerometer and gyroscope

Accelerometer is used to detect vibration,tilt and linear acceleration. It is used for implementation of pedometer,levelling,vibration alert,anti-theft and more. Gyroscope is used to measure angular velocity. Gyroscope is mainly used in 3D mouse,games and athlete training [9].It has been widely using for detecting any tilt in the position in the field such as Robotics and Industrial automation.

Micro sensors

Micro sensor is an extremely small device capable of picking up and relaying environmental information. Such devices can measure biological, thermal, chemical, and other forms of data and send them to a processor, which then converts the information into a meaningful form to allow access to it for a variety of uses [8]. The various Microsensor devices types of accelerometers, gyroscope sensor, combo sensor, pressure sensor, proximity sensor, humidity sensor and magnetic sensor etc available in market for IoT.

1.4. Choosing a sensor

Factors that has to be considered when choosing a sensor [9,10]

- Accuracy - The statistical variation from the exact reading.
- Calibration - Required for most measuring systems since their readings will drift over time.
- Cost
- Environmental - Sensors typically have temperature and/or humidity limits.
- Range - Limits of measurement of the sensor.

1.5Application of IoT sensors for Smart city Management

Environmental monitoring: Sensors are critical in environment monitoring. There are sensors to detect temperature, humidity, carbon monoxide (CO), carbon dioxide (CO2), dust, gas, VOC, etc. and its values indicate pollution level

Sensors used for Motion sensing & Security : Sensors contribute very much in the field of motion sensing and security with sensors for vibration, collision, beacons, and door sensors.

Physical monitoring: There are various sensors used for physical monitoring . It can be used for physical monitoring of various parameters water, noise, camera, and power and connect to the IoT system[4,9,10]

S.No.	Sensors	Application
1	Air Pollution	Monitoring of of CO2 or CO emissions of factories , Vehicles and toxic gases generated in farms.
2	Forest Fire Detection	Monitoring of combustion gases and fire conditions in Forest areas to define alert zones
3	Sportsmen Care	Vital signs monitoring during performance Athletic/Sports centres and fields
4	Structural Health	Monitoring of vibrations and other material conditions in buildings ,bridges and other monuments
5	Agricultural Engineering	Monitoring soil moisture and Humidity and Temperature for healthy vegetation
6	Offspring Care	Control of growing conditions of the offspring in animal farms for its better survival and health
7	Water Quality	Analysis of water quality and suitability in rivers and the sea for fauna and checking for drinkable
8	Quality of Shipment Conditions	Monitoring of vibrations ,Cracks, strokes, containers opening or cold chain maintenance
9	Waste Management	For better waste management and optimize the trash collection routes
10	Smartphones Detection	Detection of smartphones or any devices and in general any device which works with Wi-Fi or Bluetoothinterfaces for Schools or Hospitals etc.
11	Perimeter Access Control	Access control for restricted areas and detection of people in non-authorized areas
12	Electromagnetic Levels	Measurement of the energy radiated by Radio stations or Cell towers and Wi-Fi routes
13	Traffic Congestion	Monitoring of vehicle traffic and pedestrian crossings to optimize driving and walking routes
14	Smart Parking	Monitoring of vehicle parking spaces availability in the city and congestion avoidance
15	Radiation Levels	Measurement and analysis of radiation levels in nuclear power stations surroundings to generate any leakage alerts
16	Water Leakages	Detection of liquid presence roads, Tanks, Pipe leak and canal overflow etc.

Table -1 IoT sensor and Application in smart City Management

1.6 IoT security with quantum cryptography chip

The SK Telecom Company Limited ,South Korea,has developed a tiny chip that could revolutionize security of communication scenario on different portable electronics and IOT devices. This chip is only 5 Millimeter square sizeand has the capacity of generating mathematically provable random numbers. The random numbers, which are using as fundamental Unit of security encryption systems by producing them in a tiny package has not ever been possible before this development .The chip have demonstrated in Mobile World Congress in Barcelonaand would be gone for a sample production soon with low cost as a few dollars.The research on quantum cryptography is critical for future fully secured communication needs and IoT networks .The quantum encryption can create codes that are unbreakable with non-interceptablequantum key distribution schemes. Because of this feature quantum encryption systems is considered as more secure and safer .Security experts are predicting that Quantum cryptography can replace the existing security solutions in all areas at risk of data hacking, including national defense, finance, autonomous vehicle and the Internet of Things (IoT), with the potential to complete safety[17].SK Telecom's Quantum number generator IoT chip provides non-deterministic true random numbers.Inside the chip two LEDs produce photons that bounce off by the inner walls of the chip and then detected by a CMOS or CCD sensor that's also built inside the chip.

Fig 3 Quantum Chip for Security of Future IoT Systems

Random numbers are critical for generate encryption keys for cryptographic systems .If the numbers are not created bya complete random process then experienced crypto analysis could be used to guess the actual number and break the encryption schemes.The ability to generate a random numbers inside such a small chip package could significantly improve security of future IoT devices

II. Conclusion

The IoT sensors can be effectively used for water, Transport, Garbage, Radiation, etc. management in Smart cities [16] as given in Table 1.Sensor technology will find many more application in Smart city management in future. So this area requires further research in IoT sensors and connectivity. Sensors are one of the emerging areas of physics, electronics and biotechnologies, and is the one that has most greatly exploited by the innovations in the individual microelectronics, optical and computer sciences technologies. Recently sensors have been considered as a highly potential field of scientific research. However, biosensors also have emerging now days.

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