Bioscene

ISSN: 1539-2422 (P) 2055-1583 (O)

www.explorebioscene.com

Modern sensors, applications and health safety

Dr. V. Hanuman Kumar
NHCE, Bangalore-560 103

Abstract:
A sensor is device to respond to some class of an input-physical property also known as stimulus and to convert it into an electrical signal which is compatible with electronic circuits. Today's digital world needs sensors for efficiency, accuracy and safety. Some of sensor application domains, such as to detect the presence of people within the protected perimeters, process feedback control, performance evaluation, transportation traffic control, robotics, security systems, position derivatives like velocity and acceleration, kinematics, atmosphere exerts pressure on earth and mountain, flow dynamics, acoustics, humidity and moisture, electromagnetism, thermal expansion, identification and quantification of chemical species, etc.. Nowadays sensors are playing a vital role to assure safety to public health through various smart medical devices. This paper mainly addresses the major application areas of sensors with a distinguished listing and also highlights the importance of sensors to recognize the strength pollutants in environment and water to improve public health safety.

Keywords- *Health Safety, Pollutants, Sensor, Smart Device*.

I. Introduction:

A sensor is a device that detects and responds to the external senses from the physical environment. The external senses includes: motion, light, heat, moisture, pressure or any rapid changes in the environment. The output of the sensors is generally a signal which can be converted into digital form to process in required computations. All the sensors are very sensitive to minute changes.

Access to safe drinking water is important for public health. The public in rural india mainly dependent on the ground water as a source of drinking water. High rates of mortality and morbidity due to water borne diseases are well known in India [14].

The Earth is surrounded by air (made up of various gases) called the atmosphere. Any additional gas, particles or odours that are introduced into the air to distort the natural balance and cause harm to living things [15]. Primary pollutants are those gases or particles that are pumped into the air to make it unclean. They include carbon monoxide from automobile (cars) exhausts and sulfur dioxide from the combustion of coal. Secondary pollutants- When pollutants in the air mix up in a chemical reaction, they form an even more dangerous chemical. Photochemical smog is an example of this, and is a secondary pollutant.

Food contamination refers to the presence in food of harmful chemicals and microorganism, which can cause consumer illness, the chemical contamination of foods, as opposed to microbiological contamination, which can be found under food borne illness.

As India is a developing country and it has wide-spread emerging technologies, there is a need for a hybrid sensing system for timely help and to monitor major pollutants from water pollution, air pollutions and food contamination, etc., to attain public health safety. Sensor devices are the major backbone for the implementation of such hybrid pollutant sensing systems.

II. Modern Sensors:

Sensors are sophisticated devices which aid to detect and respond to electrical or optical signals. It converts the physical parameter (temperature, blood pressure, humidity, speed, etc.) into a signal that can be measured electrically.

In general sensors are categorized based on the power or energy supply requirement of the sensors, as follows: Active and Passive sensors. Active sensors are sensors that need power supply to be active. On the other hand, Passive sensors do not require power supply to work. Based on the output produced by sensors, sensors classified as Analog sensors and Digital Sensors. Analog sensors are fabricating a continuous output signal which is generally relative to the quantity being measured. Digital sensors produce a digital representation of the quantity being measured.

The sensors can also be classified based Primary Input quantity, Transduction principle, Material and Technology, Property Application and Figure-1 represents another category of sensors.

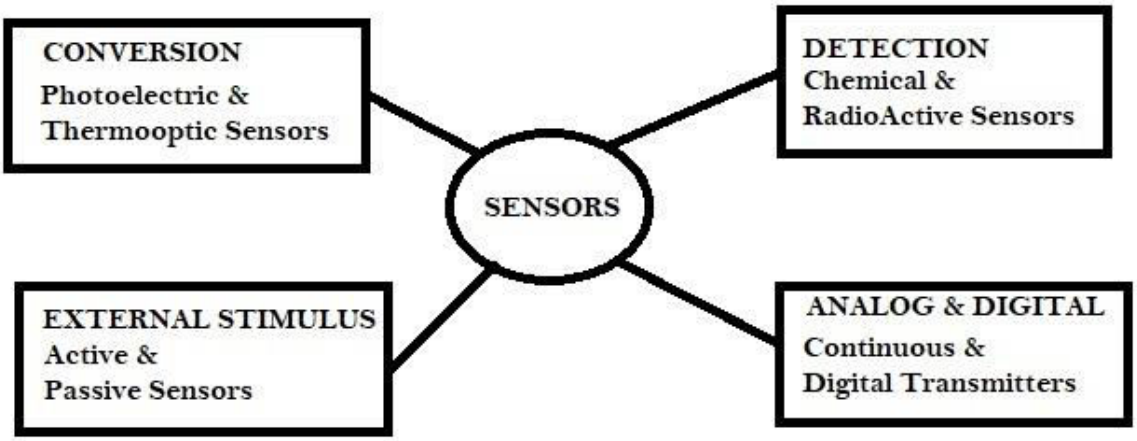

Figure- 1: Categories of sensors

Few of the sensors found in commercial markets are listed below [16-17]:

Position Sensors: Used to measure the position of the object. These sensors are available in two types: absolute and relative. They are further categorized into angular, linear and multi-axis e.g. Proximity sensors which are commonly used in mobile devices.

Occupancy Sensors: Used to signal the presence of people or animal in a surveillance area e.g. hotel room key card locks and smart meter.

Motion Sensors: Used to detect motion of any living object e.g. automatic door openers in commercial and business buildings.

Velocity and Acceleration Sensors: Velocity sensors record the speed of an object moving on a straight line or when it rotates. Acceleration sensor measures the change in velocity e.g. accelerometer, gyroscope etc.

Force and Pressure Sensors: Force sensors detect application of physical force. If detected, then it checks whether the intensity of force applied exceeds threshold e.g. force gauge, touch sensor etc. Application of force per unit area is called pressure. Thus, pressure sensors are used to detect application of force by any liquids or gases e.g. Barometer

Flow Sensors: Detects the rate at which the fluid passes through the system e.g. water meter.

Acoustic Sensor: Measures sound levels with the help of acoustic waves. These waves are passed through the material or on the surface of the material. Any change in the magnitude or characteristics of the propagated wave, helps it to determine the corresponding physical quantity to be measured and then it converts it into digital or analog data signals e.g. microphone, geophone etc.

Humidity Sensor: These sensors sense the presence of moisture in air or mass, measures and report it. Capacitive, thermal and resistive are the three types of humidity sensor e.g. moisture detector in soil

Light Sensor: Existence of visible or invisible light is detected by this electronic device. Different types of light sensors are available e.g. photo resistor in which its resistance changes when light falls on it; Charge Coupled Devices (CCD) used in digital cameras where they transport electrically charged signals.
Radiation Sensor: Detects presence of radiations in the environment e.g. neuron detector.
Temperature Sensor: Measures the quantity of heat or cold exist in a system. Temperature sensors are categorized into two types: Contact and Non-contact. The former one, must be in physical contact with the sensed object whereas the later one need not be in physical contact with the sensed object, as they can easily measure temperature using convection and radiation methods e.g. Thermometer, calorimeter etc.
Chemical Sensor: Measures the concentration of target chemicals in a system e.g. CO_2 sensor are used to sense carbon dioxide.
Biosensors: Detects chemical presence by analyzing a living organism or biological molecules, especially antibodies or enzymes e.g. blood glucose biosensor.

III. Applications:

Sensors are fundamentally important to connect the ideal devices of monitoring or control or sensing hybrid systems that were usually unconnected. The collected data by the sensor, which will be in the physical form, are converted into digital form to compute the required parameters that demands the application.
Sensors can be programmed to take measurements with changing units with large computational processes in differing aspects for multiple applications and some of those broad applications are explored and are shown in Figure-2.

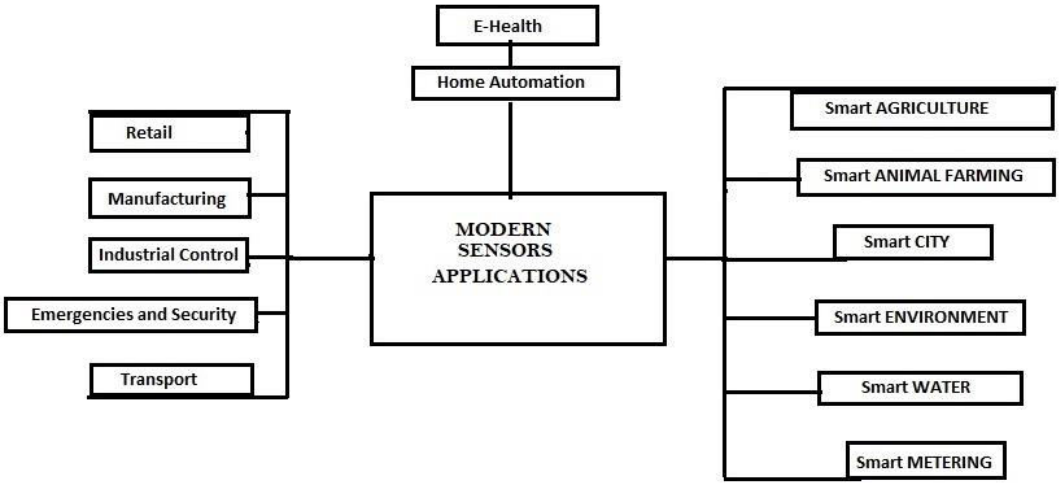

Figure-2: Applications of Modern Sensors

E-Health-A distributed application centric networking the processes data was just unimaginable, in healthcare that was impossible in recent past. Nowadays *E-Health* Consist of patient's surveillance, assistance to elderly or disabled independent people, self-monitoring wearable devices - for exercise tracking, for monitoring our heart rates and quality of sleep e.g. fit bit and the Nike Fuel Band.
Smart cities- consist of smart parking, structural health monitoring of buildings, bridges and historical monuments, Smartphone detection, traffic congestion, smart lighting, smart roads etc.
Smart environment- consists of fire detection, natural calamity early detection, air pollution monitoring etc.
Smart water- consists of river flood detector, chemical leakage detection in rivers, potable water monitoring etc.
Smart agriculture- Monitor required climatic conditions for maximization of production. In dry zones, it helps in selective irrigation to reduce the water resources where not needed, moisture detection in soil etc.
Smart animal farming- Consist of animal tracking, toxic gas level detection, offspring care etc.

Home automation- Consist of remote control applications, water and energy usage monitoring, intrusion detection systems etc.
Retail- Retailers were mostly reluctant in implementing internet into their strategies, but with sensors the power to encourage them to hyper-locally promote the business in a time specific, targeted way. Moreover, it is also used to gather intelligence about the user. It also consists of monitoring of storage conditions, tracking products etc.
Transport- Intelligent transport are abundantly found around almost all industries and are found in the following- Inventory and supply chaining, Reservation and ticketing, Smart vehicular application. The sensors are vital devices integrated with the security and surveillance systems of industries. In Logistics- Fleet tracking – monitors followed routes for delivery of valuable goods like drugs, jewels etc.
Manufacturing- Before advent of advanced sensors, manufacturers should have fewer interactions with customers and was also a time-consuming process. With sensor enabled internet based products and services provide constant data along with the genuine feedback. The innovative applications that have moved the world to digital world based environment are smart watches and modern refrigerators.
Industrial control- Consists of auto diagnosis of machine and assets control, observing useful and toxic gas levels, temperature etc. in indoor environments.
Smart metering- consists of energy consumption monitoring, tank level monitoring, water flow monitoring etc.
Emergencies and security- consist of monitoring restricted area access, detection of presence of liquid in data centres, warehouses etc. to prevent breakdowns or corrosion, monitoring gas levels and leakage detection in the industrial environment or nuclear power plants etc.

IV. Health Safety:

1. Architecture:

Sensors play an important role in enhancing safety and improving the quality of life in the healthcare arena due to their inbuilt accuracy, intelligence, capability, reliability, small size and low power consumption, all of which are expanding their use in health safety applications.
Sensor based health safety systems architecture comprises sensor unit, process unit and health safety control or monitor sub-systems as shown in figure-3.

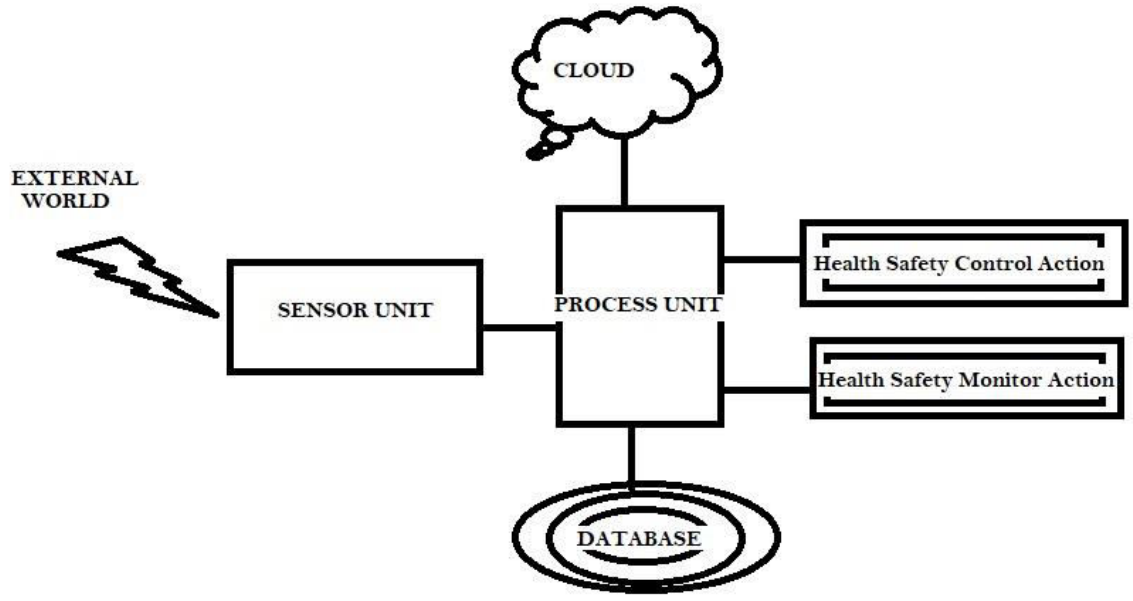

Figure-3: Sensor based Health Safety System Architecture

Data Collection: Through *sensor unit* parameters are collected from external world and stored in the local-controller with the advent of process unit.
Data Transmission: Once the local controller receives the data; it then transferred to the cloud for analysing the data for further computation as per safety application requirement by using *process unit*.

Data Management: Cloud storage acts as a bridge between data transmission layer and the data management layer. Through Cloud storage, the data will be transferred to the end system to attain the *safety monitor or control action.*

2. Pollutants:

Public Health Safety assured by controlling or monitoring the pollutants of air, water and toxins of food, etc...

Water Pollutants-The chemical, physical, and biological conditions of water represent its quality [18]. Even miniature changes in these characteristics can impact wellness of people. To preserve its quality, monitoring water parameters such as conductivity, pH, salinity, temperature, dissolved oxygen, chlorine residual and turbidity is crucial. For the same reason, water quality sensors have become common in most modern distribution systems.

Chlorine Residual Sensor - Measuring chlorine residual in drinking water treatment plants and distribution systems is a common process and has been necessary as long as chlorine has been used in water treatment. Chlorine sensors measure free chlorine, monochloramine, and total chlorine.

TOC Sensor - Total organic carbon (TOC) is an important parameter for water quality analysis. It is used as a direct indicator and a surrogate for many water quality purposes.

Turbidity Sensor - Turbidity sensors measure suspended solids in water, typically by measuring the amount of light transmitted through the water.

Conductivity Sensor - Conductivity measurements are carried out in industrial processes primarily to obtain information on total ionic concentrations (e.g. dissolved compounds) in aqueous solutions.

PH Sensor - pH is an important parameter to be measured and controlled. The pH of a solution indicates how acidic or basic (alkaline) it is.

ORP Sensor - ORP sensors measure the Oxygen-Reduction Potential of a solution. Used in tandem with a pH sensor, the ORP measurement provides insight into the level of oxidation/reduction reactions occurring in the solution.

Air Pollutants- If we think of polluted air, first our minds often imagine about big factories pumping out smelly clouds or old cars wheezing out grey exhaust. However, indoor air pollutants can be even more dangerous than outdoor air pollution. The first step to keeping your home and family safe is learning more about the problem. This paper will help by presenting common indoor air pollutants are

Carbon monoxide is an odourless, invisible gas. It's produced by the incomplete combustion of fossil fuels.

Radon is an odourless, colourless gas that is found everywhere in low levels. It is made naturally as the uranium in the Earth breaks down.

Nitrogen dioxide (NO2) is a common oxide of nitrogen. It is a toxic and corrosive gas.

Second hand smoke, also called environmental tobacco smoke, comes from incompletely burned tobacco products. According to the Environmental Assistance and Protection Department of Forsyth County, second hand smoke contains over 4,700 chemical ingredients.

Lead is a natural, soft metal that is very toxic if consumed. Lead was widely used in house paint until it was banned in 1978. Lead particles and dust can become airborne, leading to dangerous indoor air pollution.

Asbestos is the name used for a group of minerals found naturally all over the world. The U.S. Environmental Protection Agency declared asbestos unsafe in 1971, listing it as a hazardous air pollutant. Although asbestos is not hazardous when intact, disturbing asbestos fibers causes them to become airborne, where they could potentially enter the lungs.

Molds are types of fungi that grow indoors and outdoors. Some types of mold are harmless, while others are dangerous.

Air pollution sensors are devices that detect and monitor the presence of air pollution in the surrounding area. They can be used for both indoor and outdoor environments. These sensors can be built at home, or bought from certain manufactures. Although there are various types of air pollution sensors, and some are specialized in certain aspects, the majority focuses on five components: ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrous oxide.

Food Toxins- There are three main classifications of toxicants present in food. They are

- Naturally Occurring Toxicants
- Toxicants from Microorganisms
- Toxic Chemicals, Pesticides and Insecticides

A biosensor is an analytical device that converts a biological response into a detectable measurable signal. The food industry needs suitable analytical methods for process and quality control. The determination of chemical and biological contaminants in foods is of paramount importance to the health of food because, unlike the contamination of a physical nature. Apart from a few important analytes, such as sugars, alcohols, amino acids, flavours and sweeteners, food applications mainly focus on the determination of contaminants. Therefore, it is necessary to invest in the development of biosensors to the analysis of the quality of food, since they have proven to be an extremely viable alternative to traditional analytical techniques such as chromatography. However, very few biosensors play a prominent role in food processing or quality control. Considerable effort must be made to develop biosensors that are inexpensive, reliable, and robust enough to operate under realistic conditions [19].

V. Conclusion:

The main purpose of this work is to exemplify the role of sensors for the betterment of health safety in order to obtain a hygienic public environment. This paper gives a clear view about what is a sensor, different types of modern sensors and its applications in various domains. The food and drug administration (FDA) has performed admirably in protecting the consumer from exposure to toxins in food with its judicious use of warning labels, action levels, tolerances, specifications, prohibitions. This paper also addressed the pollutants in water, air and toxicity of food processing, explored list of sensors to control or monitor pollutants to assure public health safety.

VI. References:

1. Ryser, P. and Pfister, G. Optical fire and security technology: Sensor principles and detection intelligence. In: *Transducers'91. International conference on Solid State Sensors and Actuators. Digest of Technical Papers*. IEEE, NewYork, 1991, pp. 579–583
2. De Silva, C.W. *Control Sensors and Actuators*, Prentice-Hall, Englewood Cliffs, NJ, 1989
3. Jacob Fraden, Modern Sensors, Physics, Design and Applications, Third Edition, Springer 2003
4. Articolo, G. A. Shock impulse response of a force balance servo-accelerometer. In: *Sensors Expo West Proceedings*. Helmers Publishing, 1989
5. Yates, B. A keyboard controlled joystick using force sensing resistor. *Sensors Magazine*, 39–39, 1991.
6. Benedict, R. P. *Fundamentals of Temperature, Pressure, and Flow Measurements*, 3rd ed. JohnWiley & Sons, New York, 1984.
7. Hellbaum, R.F. et al.An experimental fiber optic microphone for measurement of acoustic pressure levels in hostile environments. In: *Sensors Expo Proceedings*, Helmers Publishing, Peterborough, NH, 1991.
8. Quinn, F. C. The most common problem of moisture/humidity measurement and control. In: *Moisture and Humidity, Proceedings of the 1985 International Symposium on Moisture and Humidity*. Chaddock, J. B. ed., ISA, Washington, DC, 1985, pp. 1–5.
9. Fraden, J. Active infrared motion detector and method for detecting movement U.S. patent 4,896,039, 1990
10. Benedict, R. P. *Fundamentals of Temperature, Pressure, and Flow Measurements*, 3rd ed. JohnWiley & Sons, New York, 1984.
11. Blum, L.J., *Bio- and Chemi-Luminescent Sensors*,World Scientific, River Edge, NJ, 1997, pp. 6–32.
12. Sberveglieri, G. (ed.). *Gas Sensors: Principles, Operations, and Developments*, Kluwer Academic, Boston, MA, 1992, pp. 8, 148, 282, 346–408.
13. G. Vijaya, Dean R&D Kalasalingam Institute of Technology, Krishnankoil – 626126 | Email:viji.pooshan@gmail.com, Role of Sensors for monitoring Water Quality to improve the Public Health, CSI-communications, April 2018
14. Central Ground Water Board (2017). Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India. cgwb.gov.in
15. eschooltoday.com
16. w w w . r c r w i r e l e s s .com
17. www.c-sharpcorner.com

18. www.uky.edu
19. Luong JHT, Groom CA, Male KB.The potential role of biosensors in the food and drink industries. Biosens. and Bioelectron. (1991). , 1991(6), 547-554.