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Smart Sensors and their Applications in IoT

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Abstract: ***Smart sensors have a significant role to play in the Modern Era. Sensors play a vital role for effective functioning of Internet of Things (IOT) systems as they play the key role of data collection. Sensor should be Robust, Reliable, Accurate, Precise, and sensitive and for IoT specific application they should also exhibit remote operating characteristics. Emerging technologies like IoT, ML, etc.***
demand sensors that can be used for smart applications. In IoT, objects are equipped with sensors, actuators and are inter connected with computing systems.
This enables the data collection on the basis of which optimized decisions can be taken. The shift towards smart systems is of paramount importance as they show significant increase in efficiency and have contributed towards safe and sustainable solutions.
The way to increase the efficiency of IoT Enabled Systems is not only to use new generation sensors but also to implement them in a more efficient and effective manner. This paper shows how IoT is benefitting from advancements in sensor technology. In this paper we will be focussing on sensors and its types with an IoT oriented Application.
Keywords: Smart Sensors; Internet of Things; Infrared Sensor; Pressure Sensor; Temperature Sensor; Proximity Sensor; Humidity Sensor; Gyroscope Sensor.

I. INTRODUCTION

The basic function of a sensor is to covert a physical parameter like pressure, light, temperature, distance, orientation, etc. into a proportionate electrical signal. Previously sensors were able to portray characteristics like repeatability, reproducibility, resolution, range, durability, reliability, and sensitivity were considered adequate but in today's modern world sensors need to be incorporated with smart systems which demand advanced characteristics such as remote working capability, low power consumption, and sssability to connect wirelessly.

Smart systems are the combination of Artificial Intelligence (AI), Cyber-Physical Systems, Big Data Analytics, Machine Learning, and the Internet of things. In today's modern world a need for the smart system has arisen because of its ability to collect, analyze data, and take appropriate decisions. Smart systems are finding applications from Industries to personal appliances due to their versatile nature.

The important characteristic of smart systems is their ability to take a data-driven decision and that is where modern sensors have an important role to play as they facilitate effective collection and communication of this data with the system. This paper will be focussing on six different sensors with their types and application in the Smart System domain. Starting with an infrared sensor that has the dual application of temperature and position detection.

One of its IoT Applications is being used for optimizing the routes of waste collection trucks which has led to a significant reduction in resource consumption like time and fuel. The textile pressure sensor works on piezoelectric as well as capacitance principles and has found a wide range of applications from determining vascular aging, to controlling quadrotor drones and hexapod robots. This sensor achieve all this while being seamlessly integrated with textiles. Backscatter Morse Leaf Sensor is a type of temperature sensor that has been used for detecting water stress level in plants and portray characteristics like being self-powered, wirelessly connected, and cost-effective. Various types of proximity sensors have been explained mainly focussing on the capacitive type and inductive type. IoT-based application has been explained where segregation of waste into Biodegradable and Non-Biodegradable waste has been carried out with the use of a Proximity Sensor. A humidity sensor is used to detect water vapor content present in a specific environment. The humidity sensor has a wide area of application, in the below paper use of humidity sensor in the smart farming system has been explained. One of the important factors affecting the growth of crops is humidity which can be tracked using the humidity sensor. The gyroscope sensor plays important role in determining orientation and proportionally converts it into electrical signals. Gyroscope sensor has been used in IoT to enable smart helmets for construction workers to reduce deaths due to fatigue at work sites.

II. SENSOR AND APPLICATION

A. Backscatter Morse Leaf Sensor

The agriculture sector demands sensors that are low-powered, durable, and can operate wirelessly while also being considerably cheap. The need to optimize water consumption for agriculture has been felt in the past and its importance has only grown over the years with depleting water resources. With technology like IoT and a new type of sensor which detects plant water requirements from leaf temperature has led a novel way to the optimize water irrigation.

In the method proposed in [8], two different sensors are used to get a different temperature reading one reading corresponds to the temperature of a leaf while the other reading corresponds to the temperature of the air as the difference between these two readings is proportional to the water stress level in pant which dictates its water consumption requirement. When the difference between readings corresponding to the temperature of the leaf and the temperature of the air is negative or zero then the water supply is adequate but when the temperature difference is positive then water supply is required.

These sensors should not be mistaken for leaf wetness sensors as the reading of those can be affected by parameters like dew, rain, and fog. In the agriculture sector expensive high power-consuming equipment which requires a wired connection are not appropriate and such types of equipment also demand high maintenance. The method addressed in [8] solves the above issues by using sensors tags that are powered by radio frequency and the same radio frequency is also used for communication.

B. Proximity Sensor

Proximity Sensors are capable of detecting whether or not a certain object is present at a certain position. Usually, this type of sensor provides binary outputs i.e. a “1” depicting “yes” and “0” depicting “no”. These Sensors have a wide area of applications in Automotive, Mechanical, Packaging, Paper Manufacturing, Beverages, and Many Industries. The capability of these sensors is to easily communicate with PLC which makes it a robust, adaptable, and accurate sensor to use in industries. There are various advantages of using proximity sensors few of them include Precise in nature, Contactless sensing of objects, Wear- Resistant Operation, and Fast Switching Characteristics which make it suitable for wide areas of Applications.

There are various types of proximity sensors that include Inductive Type, Capacitive Type, Optical Type, Magnetic Type, and Ultrasonic Type. Inductive Type of proximity sensor work on the principle of electrical inductance in which a fluctuating current generates electromotive force in the objects and detects it. These types of sensors are used to detect metallic objects. Capacitive Type Proximity Sensor uses variance in the capacitance to detect objects and is capable of detecting both metallic and non-metallic objects. An optical type proximity sensor has a light source and the transmitted light gets reflected from the object placed in front of the sensor, this reflected light is detected by the sensor, and by this mechanism, optical sensors are capable of detecting the Objects. Magnetic type sensors are capable of detecting magnetic fields and objects capable of generating magnetic fields. Ultrasonic type proximity sensors are producing ultrasonic sound waves and these waves get reflected from the object and detector mechanism detects reflected sound waves thus detecting objects in front of it.

Due to various advantages of Proximity sensors, they are been used in various IoT applications one such application is explained in this [1] research paper. The researchers have successfully utilized the sensor for the application of a Household waste management system. In this, the author has proposed a smart dustbin to segregate various household waste. Majorly Author here has proposed to segregate between Biodegradable waste and Non-Biodegradable waste also he has proposed to further segregate Non-Biodegradable waste depending upon the harmful nature of waste and to alert the authorities but this specific module will be for public places only. In this paper [1], the author has successfully shown how he used an Inductive Proximity sensor for the segregation of Metallic waste and a capacitive proximity sensor for the segregation of plastic waste.

C. Infrared sensors

Infrared sensors can be used for position detection as well as temperature detection. The two basic types of infrared sensors include Passive Sensors and Active Sensors. Passive Sensors use objects as an energy source/ Transmitter where as an active sensor consists of two basic components one component is responsible for emitting light while the other is responsible for receiving it. An object is said to have been detected when light cannot be received. In some cases for temperature detection, two piezoelectric sensors placed alongside each other are used and the change of signal between the two is used to predict temperature.

In [7] the use of an infrared sensor has been proposed to make waste collection easier by being able to detect when the dustbin is full. This has been achieved by mounting IR sensors at strategic places. For instance, the lid of the dustbin or the rim beneath the top edge. While operating this will reduce the time and resources required for waste collection.

This reduction in resources is possible as the scheduling of trips for waste collection-truck will be based on deciding what will be the optimal time for collecting waste and what route the waste-collecting truck should follow as it will be able to know which dust bins are full. This IoT system is better than other systems like GPS (Global Positioning System), GIS (Geographic Information System), and RFID (Radio Frequency Identification) as it can update data in real-time. With GPS and GIS systems it is not possible for optimization of routes as this system does not update in real time which means there is a possibility where a collection truck might have to visit a bin which is either partially or completely empty. The challenge posed by the RFID system is not only identifying each item with an individual tag but also not being able to do real-time route optimization. When this IoT system based on infrared sensors is optimized properly then citizens will not have to face the issue of an overfilled dustbin.

D. Humidity Sensor

Humidity is related to the amount of water vapor present in any specific environment or atmosphere. A humidity sensor is capable of measuring the amount of water vapor present in the environment. Humidity sensors are used in Automotive Industries, Aerospace, Home Appliances, and even in various agriculture applications. There are various mechanisms in which a humidity sensor detects humidity like Capacitive Type, Coulometer, Dew Point, Gravimetric, Infrared, Microwave, Psychometric, Radio-Frequency type, Resistance type, Thermal Conductivity type.

In [3] author has in-depth explained various mechanism. The Capacitance type Humidity sensor works on the principle of change in dielectric constant due to the amount of water present. In the coulometer type an electrolyte is formed as the water is being absorbed and a proportionate amount of current is been generated. This generated current is further amplified and synthesized to measure humidity. In dew point type sensor works on the principle of dew point. The dew point temperature varies with respect to the amount of water vapor present in the atmosphere this is used to determine humidity. In the Gravimetric type, the moist air is exposed to a drying agent. The dry air is weighed and the difference in weights is used to determine the amount of water vapor present. In the Infra-Red type, infra-red light is used to determine the humidity. In the Microwave type, there is a change in radiation at receiving end which is detected and used to determine the humidity. In the Psychometric type, the wet-bulb temperature is determined which can be further utilized to determine humidity with the use of various psychometric relational graphs. In Radio Frequency type the function of dielectric charge similar to capacitive type is used to determine humidity. In the Resistance type, there is a change in conductance of the sensor which is further used to determine the humidity in the atmosphere. In thermal type sensors self-, heated thermistors are used to determine humidity.

Humidity sensors play important role in modern-day applications. It has gained significant importance in the agriculture field to determine the humidity in the soil to monitor various aspects of soil that can be utilized to improvise farming yields. In [2] has successfully shown how soil humidity is an essential factor in the growth of crops. Also, they have determined problems in old humidity sensors which may lead to mispleaded data collection. This may impact IoT-based smart farm systems. So the author has successfully experimented with various techniques to improve the performance and durability of humidity sensors. This shows how humidity sensors have gained importance in agriculture fields and are been actively used in smart farm systems.

E. Textile pressure sensors

Textile pressure sensors have found various applications over the years from human motion detection, health care application to drone control using gloves and controlling a robot using an integrated controller in a shirt. A Textile pressure sensor works like a force-sensitive sensor where parameters like the physical pressure of an object, the force of its weight, or the squeezing motion can act as an input for the sensor also these sensors should be accurate, especially in the low-pressure range. These sensors are made of piezoelectric materials because these conductive materials change electric resistance when any form of force is applied to them. These sensors can be made of SBS/AgNP composites that coat the Kevlar fiber or PDMS coated Kevlar fiber.

These sensors can also operate on the principle of capacitance in this operation a deformable isolation material is used for separating the two conductive materials this acts as a plate capacitor.

The distance is changed between conductive materials due to the deformable isolating material this intern affects the electric field and input is generated.

Because of their high sensitive nature these sensors can also be used to detect acoustics and vibration. As mentioned in [10] a textile sensor was used to differentiate between different type of word by mounting the sensor on persons neck. Important point to note is that isolation material reacts differently to high frequency and does not deforms as it does with twisting or bending so the distance between the conductive material increases which leads to a decrease instead of an increase.

In [6] the idea of textile sensors to be used for Human Machine Interface has been put forth by controlling a quadrotor drone with four fingers using a smart glove the drone could be successfully controlled as each sensor was able to give a distinguishable output. This technology was also demonstrated with the help of smart clothing where a hexapod walking robot could be controlled with four individual controls. Another important factor for this textile sensor technology to succeed is the durability of the sensor from washing as well as its ability to resist breaking under continuous bending cycles. All this should be achieved while maintaining softness, comfort, versatility, and convenience. In [6] to check the durability and sensitivity of textile sensors cyclic test was performed ten thousand times and the output was found to be constant. The use of these sensors for healthcare monitoring was shown in [10] were because of the high sensitivity and fast response time a sensor attached to the wrist artery was successfully utilized to determine arterial stiffness which is used for determining vascular aging.

F. Gyroscope Sensor

Gyroscope sensor measures Angular Velocity and finds application where orientation of the object needs to be measured. Gyroscopic sensors are also capable of measuring motion of the object. Gyroscope sensor uses coriolis force for measuring orientation. As mentioned in [4] Gyroscopes detects angular rate in three dimensional space without physical axis this makes it capable to be used and accommodated in various devices.

Gyroscope sensor converts angular motion into electrical signals. With advancement in technology more accurate, reliable and small gyroscopic sensors are manufactured and are integrated with various devices for smart application. Gyroscope sensors are divided based on their sizes. Vibration gyroscope sensor is small and easy to use and most popular. Vibration Gyroscopes are low cost and low accuracy gyroscope sensors. The accuracy of vibration gyroscope is based on the material of stationary element present in the sensor and structural difference so various manufactures try to improvise accuracy by emphasizing on these parameters. Ring Laser Gyroscopes have very high accuracy but are expensive and are large in size. Other types include liquid rate gyroscope and Fibre-Optic Gyroscope.

Gyroscope has wide variety of applications such as Aerospace Industry, Industrial Robotics, Automotive Industry and also used in Space Industry into Rockets. In traditional applications like Aerospace Industries High Accuracy Gyroscopes are being used but compared to recent advancements, smart systems gyroscopes now have now been integrated in various home appliances and also in automotive industry. So now micro-gyroscopes have found significant importance in today's modern word.

In [5] Author has shown how a gyroscopic sensor can be used in IoT based Smart Helmet System. In India Infrastructure is playing important role as more and more industries are coming up in India which has led to building of support infrastructure. Construction plays important role and safety of construction workers has to be given utmost importantance. To curb the death rates due to accidents in construction sites author in his paper [5] has successfully implemented IoT in Helmets. In this device author has used gyroscope sensor to determine the orientation of the worker wearing the helmet. In case of any fall due to fatigue the sensor will detect and will sent immediate alert message to the contractor. This will allow immediate and much needed help to reach the construction worker in shortest period of time thus reducing death tolls.

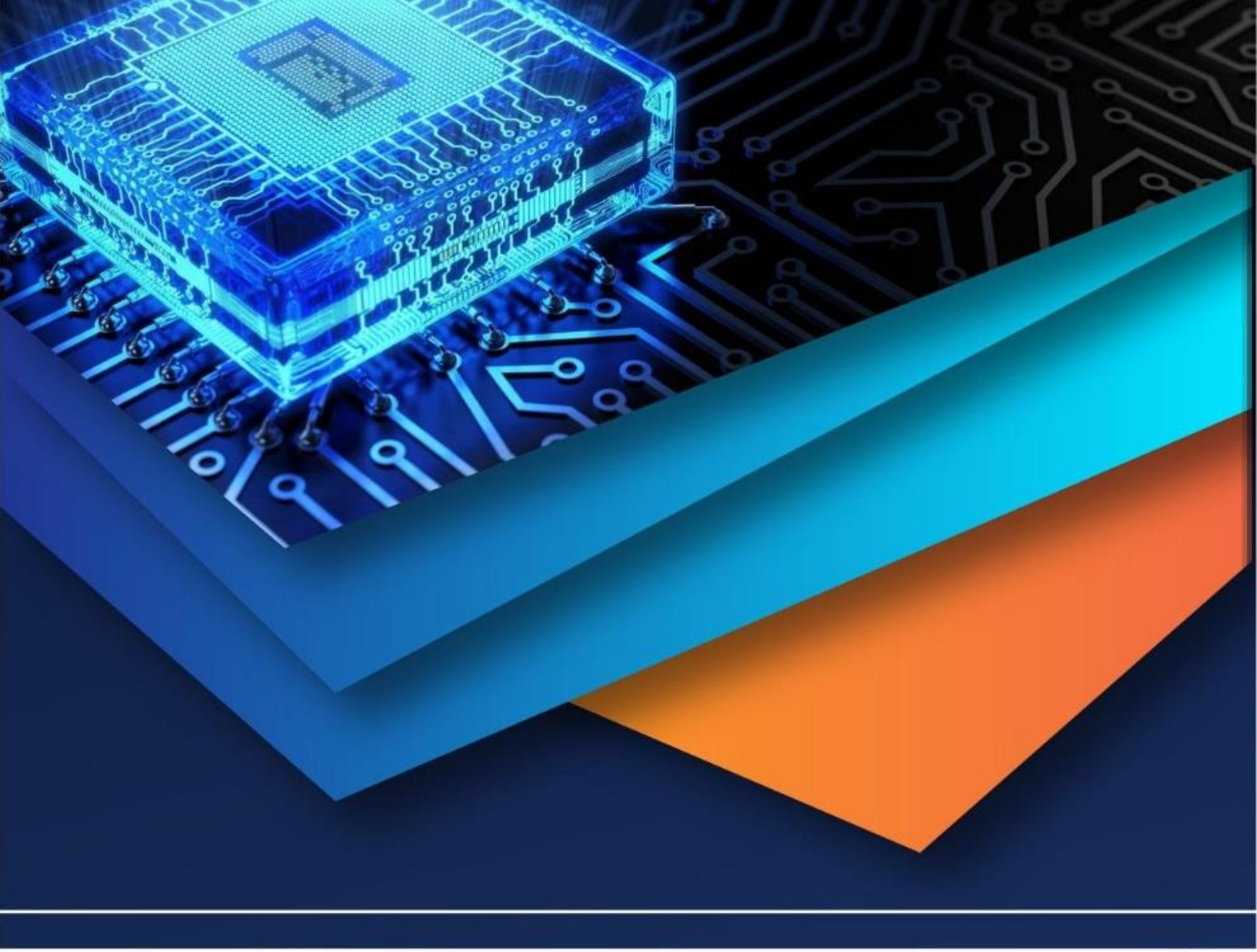
III.CONCLUSIONS

In this paper, we have successfully listed various types of sensors that have found applications in IoT systems. Sensors provide data much needed for Analysis and decision making in Smart Systems. The sensors have successfully helped in reducing resource consumption, increasing safety standards, and helped in optimizing traditional processes. The above examples portray how sensors have positively impacted sectors like Agriculture, Waste Management, Smart textiles and also have provided new human-machine interfacing solutions. Multiple Research Projects are currently being carried out for developing next-generation sensors that can be integrated with smart systems. With the ever-improving network connectivity systems and with better ways to integrate artificial intelligence, The IoT enabled systems will be able to make accurate decisions more quickly.

REFERENCES

[1] Sonali Dubey, Pushpa Singh, Piyush Yadav, and Krishna Kant Singh, "Household Waste Management System Using IoT and Machine Learning," International Conference on Computational Intelligence and Data Science (ICCIDS 2019)
[2] Young Ju Jeong, Kwang Eun An, Sung Won Lee, and Dongmahn Seo, "Improved Durability of Soil Humidity Sensor for Agricultural IoT Environments," IEEE International Conference on Consumer Electronics (ICCE). 2018.
[3] Anuradha Yadav, "Classification and Applications of Humidity Sensors: A Review," International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 6 Issue IV. April 2018.
[4] Kenjiro Takemuraa,, Shinichi Yokota, Mamoru Suzuki, Kazuya Edamura, Hideo Kumagai, and Tsunehiko Imamura, "A liquid rate gyroscope using electro-conjugate fluid," Elsevier B.V, 2008.

[5] V. Jayasree and M. Nivetha Kumari, "IOT Based Smart Helmet for Construction Workers," IEEE 7th International Conference on Smart Structures and Systems ICSSS, 2020.
[6] Jaehong Lee , Hyukho Kwon , Jungmok Seo , Sera Shin , Ja Hoon Koo , Changhyun Pang , Seungbae Son , Jae Hyung Kim , Yong Hoon Jang , Dae Eun Kim , and Taeyoon Lee, "Conductive Fiber-Based Ultrasensitive Textile Pressure Sensor for Wearable Electronics," 2015.
[7] Abhimanyu Singh , Pankhuri Aggarwal , Rahul Arora, "IoT based Waste Collection System using Infrared Sensors," 2016.
[8] Spyridon N. Daskalakis, Student Member, IEEE, George Goussetis, Senior Member, IEEE, Stylianos D. Assimonis, Member, IEEE, Manos M. Tentzeris, Fellow, IEEE and Apostolos Georgiadis, Senior Member, IEEE, "A uW Backscatter-Morse-Leaf Sensor for Low-Power Agricultural Wireless Sensor Networks," 2018.
[9] Chandra Krintz, Rich Wolski, Nevena Golubovic, and Fatih Bakir, "Estimating Outdoor Temperature from CPU Temperature for IoT Applications in Agriculture," 2018.
[10] Mengmeng Liu, Xiong Pu, Chunyan Jiang, Ting Liu, Xin Huang, Libo Chen, Chunhua Du, Jiangman Sun, Weiguo Hu,* and Zhong Lin Wang, "Large-Area All-Textile Pressure Sensors for Monitoring Human Motion and Physiological Signals," 2017.



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