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An Investigation on Real Time Monitoring System for Livestock and Agriculture using IoT

S. Pragadeswaran[1], S. Vishnu[2], P. Vishnu Surya[3], Vishnu Kurup[4], S. Tamilselvan[5]
Assistant Professor, Department of Electronics and Communication Engineering[1]
UG Scholar, Department of Electronics and Communication Engineering[2,3,4,5]
Karpagam Institute of Technology, Coimbatore, Tamil Nadu, India
praga1994@gmail.com[1],vishnusurya0501@gmail.com[3],vishnu.vrap7@gmail.com[4]

Abstract: *Farmers used to calculate the soil's readiness and assess the impact of their doubts before producing a particular type of yield. A real-time monitoring system for livestock and agriculture describes the utilization of the Internet of Things (IoT) technology. The system comprises of various sensors and devices that collect data related to the environmental conditions, health status, and behaviour of livestock, as well as the soil moisture level, temperature, and humidity of crops. The data collected from these devices is transmitted to a cloud-based platform where it is processed. The system also includes alerts and notifications to farmers in case of any anomalies or deviations from the expected norms, enabling them to take prompt corrective action. Overall, the real-time monitoring system using IoT technology has the potential to improve livestock and crop management practices, increase productivity, and enhance the overall efficiency of the agriculture industry.*

Keywords: IoT, RFID, Zigbee, WIFI, GPS, Soil Moisture, Livestock, Temperature, Humidity.

I. INTRODUCTION

Agriculture has always been a vital sector for human survival and economic growth. With the growing global population, there is an increasing demand for food production, which has put pressure on farmers to increase their productivity while minimizing costs. One of the key factors that affect crop yields is environmental conditions such as temperature, humidity, soil moisture, and light intensity. IoT is a potential combination of web-connected devices with information, which is a crucial part of the long-term Internet. IoT concentrates on process automation to reduce human involvement. The emphasis of IoT in agriculture is on automating agricultural practises to make them more productive and efficient. Livestock management is also a part of farming methods, which also have many inefficiencies such as increased human interaction, labour costs, power consumption, water consumption, etc.

However, with the development of Internet of Things (IoT) technology, farmers can now use sensors and IoT-based agriculture monitoring systems to remotely watch their farms in real-time. These systems give farmers access to vital information regarding their crops and soil conditions, giving them useful information that aids in guiding their choices about irrigation, fertilisation, and other agricultural practises. Moreover, IoT-based agriculture tracking systems can offer early detection of any anomalies, such as disease outbreaks or pest infestations, enabling farmers to take preventive measures before serious harm is done. IoT-based agriculture monitoring systems have the potential to revolutionise the agriculture sector in this manner, enhancing its productivity, sustainability, and efficiency.

II. APPLICATIONS OF IoT IN MONITORING SYSTEM

IoT supports a number of uses in the field of digital agriculture, including soil and plant monitoring, crop growth observation and selection, precision agriculture, irrigation assessment support, greenhouse environment monitoring and control systems, food supply chain monitoring, etc. The following figure shows the well-known technologies that are employed in IoT uses in monitoring system:

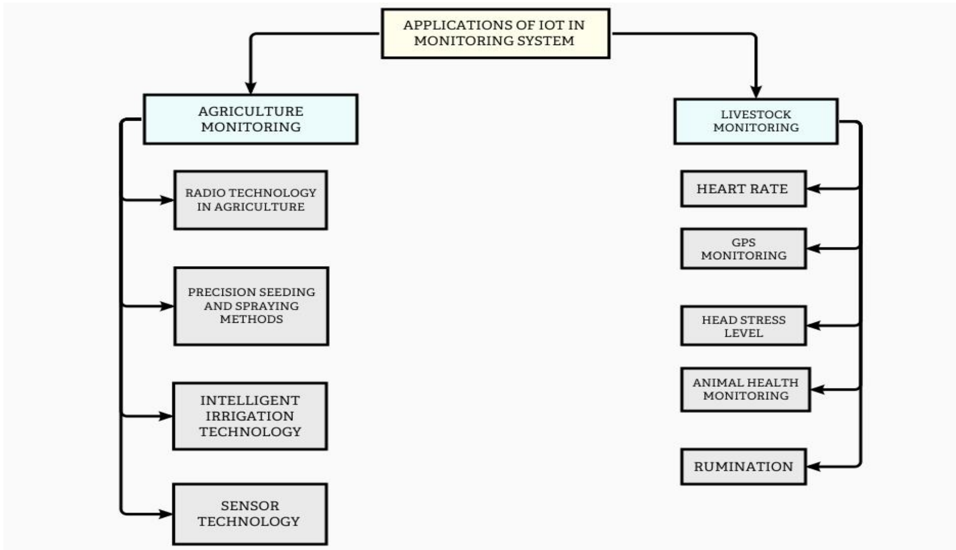

Fig 1. Block Diagram of Application of IoT in Monitoring System

2.1 Agriculture

1. Radio Technology in Agriculture: ZigBee wireless sensor networks [1] enable self-organizing wireless data transfer. It has been extensively used for data transmission in large-scale farming. It is a wireless communication technology that uses radio waves to transfer data between a reader and a tag. In agriculture, RFID can be used to track and monitor livestock, crops, and equipment. Livestock monitoring is one of the most common applications of RFID in agriculture. By attaching RFID tags to animals, farmers can monitor their movement, behaviour, and health. This information can be used to optimize feeding, breeding, and healthcare. Additionally, RFID tags can be used to track the origin and movement of animals, which is important for food safety and traceability.
2. Precision seeding and spraying methods**:** Depending on the technology combined with Global Positioning System (GPS) navigation, seeding, and fertilisation at a variable rate, it can achieve identical implementation of the spraying, planting, and fine-tuning the consumption of pesticides, seeds, and other materials. Precision seeding [1] involves using advanced technology to precisely plant seeds at the optimal depth, spacing, and timing. This ensures that seeds are planted in the right conditions for optimal growth and yield. Some common technologies used in precision seeding include GPS mapping, soil sensors, and seed meters. Soil sensors can be used to measure soil moisture, temperature, and nutrient levels. This information can be used to adjust planting rates and ensure that seeds are planted in the right conditions. Seed meters can be used to precisely measure the number of seeds planted per acre. This helps ensure that seeds are planted at the optimal density for optimal growth and yield.
3. Intelligent irrigation technology: Based on the "shallow wells underground cables + field + automatic irrigation system pipe" and satellite positioning network [2] technologies, it can collect irrigation water, irrigation, electricity, and time data to automate the irrigation of farmland and through a thorough analysis of information technology software to monitor irrigation. The goal of intelligent irrigation technology is to provide the right amount of water at the right time to crops, while reducing water waste and maximizing yield. Sensors are used to measure soil moisture, temperature, and other key environmental factors. This information is then used to determine when and how much water to apply. Automated irrigation systems can be used to apply water at the optimal times and rates. This can include drip irrigation systems, sprinkler systems, or other types of irrigation systems. Intelligent irrigation systems can be remotely monitored and controlled using mobile apps or other types of software. This allows farmers to manage their irrigation systems from anywhere and make adjustments in real-time.

4. Sensor Technology in Agriculture: A wide range of sensors are used in agricultural products, including soil moisture sensors, water-level sensors, meteorological sensors (which monitor the current state of the atmosphere), biosensors (which detect an analyte), gas sensors (which detect the presence of gas), and others. Soil sensors [2] are used to measure soil moisture, temperature, and nutrient levels. This information is used to determine when and how much to water crops, and to optimize fertilizer application. Water quality sensors are used to monitor the quality of irrigation water, and to detect contaminants and other pollutants. Crop sensors are used to measure plant growth, health, and nutrient levels. This information is used to optimize fertilization, pest control, and other crop management practices. Imaging sensors, such as drones or satellites, are used to capture high-resolution images of fields and crops. This information is used to monitor crop growth and health, and to identify areas of the field that may require additional attention.

2.2 Livestock Management

The productivity of animals is negatively impacted by ideal environmental conditions or weather conditions that absorb excessive amounts of climatic conditions [3], which is a significant concern for many researchers. Precision livestock is also regarded as a significant concern due to the demand for high-quality dairy products. Ranchers lose a lot of money every year as a result of animal sickness. But IoT-based livestock management tools aid farmers in enhancing agricultural practises, livestock conditions, and dairy products [4]. Similar to crop monitoring sensors, various livestock monitoring sensors are also affixed to the animals to track their performance in the logging. Livestock depending on the types of animals being monitored, such as the conductivity of milk, insect attacks and the standard of the water.

1. Heat stress: Due to heat stress, cows produce less milk with the same dietary input, which causes farmers to experience production expense problems. Summertime's low moisture level is caused by animals stress levels rose as a result, which increased the likelihood that an animal would perish.
2. GPS Based Monitoring: The specifications of the farm are obtained using a GPS system, and a wireless sensor network is used to transmit the monitored parameters to a central monitoring centre. Using wireless technologies like Zigbee, WIFI and LoWPAN, a repelling system has been created to protect animals from theft, wild animal assaults, and weather conditions.
3. Heat Stress Level: Due to heat stress, cows produce less milk with the same dietary input, which causes farmers to experience production expense problems. In the summer, moisture content drops, which causes animals' tension levels to rise and ultimately cause their death.
4. Animal Temperature Monitoring: The primary role of animal health surveillance is the identification of disease symptoms and prevention. Cows and canines both have normal body temperatures between 38.5 and 39.5 degrees Celsius. When the body temperature deviates from the usual range, it's a sign that the animal is ill with some sort of disease.
5. Rumination: Rumination monitors the food that an animal has digested, and it is discovered by mounting a tracking device in the animal's (in this case, a cow's) nose. A farmer can accurately assess the health of the animals in this manner.

III. BENEFITS OF IOT IN AGRICULTURE

The Internet of Things (IoT) is a technology that connects devices and sensors to the internet, allowing them to collect and share data. Using IoT in the agricultural industry has many advantages and benefits, some of which are as follows:

1. Effectiveness of feedback: It will increase the effectiveness of agricultural products like soil, such as water, fertilisers, and pesticides.
2. Improved efficiency: IoT sensors can provide real-time data on soil moisture, temperature, and other environmental factors, allowing farmers to make more informed decisions about irrigation, fertilization, and pest control.
3. Reduced waste: By providing precise information on crop and soil conditions, IoT can help farmers reduce waste and optimize resource use, such as water and fertilizer.
4. Cost savings: By using IoT devices and sensors, farmers can reduce waste, improve crop yields, and save money on resources such as water, fertilizer, and pesticides.

5. Improved animal welfare: IoT devices can be used to monitor the health, location, and behaviour of livestock, enabling farmers to identify and address potential issues early, leading to improved animal welfare and productivity.
6. Profitability: Farmers will become more profitable as a result.
7. Environment protection: It is crucial to protecting the ecosystem.
8. Greater visibility and transparency: IoT sensors can track the movement of crops and livestock from farm to market, providing greater visibility and transparency in the supply chain. This can help farmers to improve product quality and increase profitability.

IV. REVIEW OF LITERATURE

The paper [5] combines fuzzy theory to process data from the agricultural Internet of things in order to lessen the uncertainty associated with that data processing. After enhancing the fuzzy algorithm, this paper develops an intelligent model, constructs the framework for the crop growth monitoring system in accordance with the actual requirements for crop growth monitoring, sets up and evaluates the environmental parameters, and develops the crop growth monitoring system from various angles.

The goal of the paper [6] is to create an effective and precise system that can accurately choose a crop for maximum yield using IoT devices and machine learning (ML) algorithms. In contrast to outdated manual laboratory testing systems, which are susceptible to human error, such a system is dependable. Smart Crop Selection (SCS), which is founded on information about soil and meteorological factors. These variables include temperature, soil humidity, nitrogen, phosphate, potassium, CO_2, pH, EC, and rainfall.

In the paper [7], a gateway for monitoring the environment of crop growth is designed using edge computing technology. Long-range wide-area network (LoRaWAN) server, pest detection, and environmental information data fusion functions are packaged into images using virtualized container technology. It creates an integrated method of operation for various agricultural functions.

Smart agriculture tracking systems are presented in paper [8] for Internet of Things (IoT) applications. To identify and measure vegetables from the agricultural area, the CHT has been used. Vegetables with defects have also been found using colour thresholding and colour segmentation methods. The CNN is the best method in this research work when compared to the conventional methods, outperforming the previously created algorithms with an accuracy of more than 90%.

A professional method is used in the paper [9] to make 50% of the decisions, with the remaining 50% depending on sensor data values. The ultimate decision is derived from this decision from the ontology and the sensor values as a consequence of a machine learning algorithm (KNN). Additionally, a new edge server is added in between the GSM modem and the primary IoT server. This method integrates the Internet of Things with a sensor network in order to nimbly track all data, evaluate it at the edge server, and send only specific data to the main IoT server.

The paper [10] takes a practical strategy to managing field-specific challenges. IoT aids in the collection of data on factors such as atmosphere, protection, temperature, and soil output. For farms, IoT advancement can lower costs and boost the effectiveness of routine creation.

The goal of the paper [11] is to develop a new Smart Internet of Things platform with machine learning capabilities that will properly serve the agricultural field. In order to continuously watch the crops on the agricultural field, an Intelligent Crop Monitoring Device (ICMD) is developed in this paper. The production and service quality of agriculture as well as related goods are improved by these monitoring tools.

In the paper [12], an intelligent system for monitoring and scheduling precision irrigation is proposed. It makes use of the Internet of Things, a LoRa-based wireless sensor network, and machine learning. The soil and weather conditions are used in the proposed system to forecast the crop's water needs. The proposed system has the ability to anticipate the need for irrigation thanks to the use of machine learning algorithms.

In order to improve the social welfare of the Indian agricultural system and to provide sufficient irrigation in a specific region, the paper [13] uses ARM7 and GSM. The system uses a 32-bit microcontroller called the ARM7TDMI core. The connection between the ARM CPU and centralised unit is made by GSM, which runs through SMS. The brain of the device is an advanced microprocessor called ARM7TDMI.

In the paper [14], sensors are used to gather and communicate data using parameters like temperature, humidity, and heart rate before sending the information to an Arduino Uno. As a result of receiving the sensor's data, the Arduino Uno sends the appropriate content. The data will be transferred to the tracking website by the gsm sim module. The computer monitor, which also uses a global positioning system to track the livestock's present condition and location, will display the results from all the hardware and sensors.

According to paper [15], the applications examined in this study include those for crop sensing, mapping and tracking the pattern of croplands, managing and controlling with the aid of radio frequency identification, and real-time environmental monitoring. Complicated software needs to be fixed in order to activate the IoT network. In order to enhance crop farming, production, and quality, software must be made to be user-friendly. Security is the main threat to IoT applications. Improved security requires proper access control, data privacy, and user identification. Technical proficiency is essential for farming because it helps with problem-solving, organisation, and many other aspects of farming. The right supporting infrastructure can be developed with adequate internet bandwidth and accessibility. operational effectiveness, enhanced communication and low power wireless sensors.

In the paper [16], smart objects are used to gather data from the development environment, analyse it, and carry out the necessary actions. People will be able to live prosperous, intelligent lives thanks to benefits made possible by the Internet of Things. Due to the potential applications, IoT (Internet of Things) has become a significant field of scientific study. Applications of the Internet of Things (IoT) to agriculture and forestry have been researched and analysed in this paper. It has also succinctly introduced the IoT technology, agriculture IoT, a list of some possible application domains, advantages of IoT in agriculture, and more.

Utilizing cutting-edge IoT technology, this paper [17] suggests a clever method for geofencing and livestock monitoring. Cattle can easily be monitored and managed remotely, negating the need for direct physical farmer involvement in livestock administration. The smart device keeps tabs on the livestock's location, condition, and health. This livestock management strategy could lower farming costs, allow remote monitoring, and aid in halting COVID-19's spread. The grazing, sleeping, and play patterns of different types of cattle in a paddock are genetically distinct. Goats and sheep are more active than cows and buffaloes and have unique digestive and food intake processes. The vast bulk of livestock management systems currently in use rely on IoT and GPS sensors connected to satellite and GPRS for communication.

This paper [18] takes into account the relationship between the number of livestock units and the agricultural and forestry employment, as well as information on the current agricultural and forestry occupation and the conversion of livestock numbers into normal heads. The weight of each livestock class is determined using a dynamic process with two phases that is based on a generalised maximum entropy model and a crossentropy minimization model. A standard livestock measurement called "normal head" enables dealing with various livestock categories according to species and age in the same units. We can successfully address the issue of data scarcity for the major breeds of breeding livestock thanks to the approach we've used.

It has been demonstrated that dynamically adjusting agricultural production is an efficient method to increase overall agricultural yield. This paper [19] aims to gather environmental data of crop growth. Traditional agricultural IoT could partially meet the service needs of small-scale agricultural production situations. Nevertheless, as higher-layer applications require high-quality data services, the situation for emerging applications in the agricultural environment is becoming increasingly complex, and the number of data nodes in the underlying access to the IoT backend system is considerably increasing. As a consequence, conventional architecture-based (i.e., centralised cloud computing) IoT systems find it difficult to provide high-quality services at the network's edge due to problems with limited network coverage, data security, and limited power supply time.

With multiple algorithms for detection, quantification, ripeness checking, and the detection of infected vegetables, this paper [20] aims to propose an IoT-based smart agriculture monitoring system. The CHT has been used to identify and quantify vegetables from the agricultural region. Utilizing techniques like colour thresholding and colour segmentation, vegetables with flaws have also been discovered. Each algorithm was developed and implemented using a machine learning approach called convolutional neural networks (CNNs). A comparison between traditional methods and CNN has been simulated in MATLAB to ascertain the best method for CNN's application in this agricultural monitoring system.

Generalized Procrustes Analysis is a technique used in this paper [21] to examine the effects of the finishing feed diet (1.5 kg versus 3.0 kg of commercial feed during the finishing period) and the livestock production system (Freedom

Extensive System (FES) versus Semi-Extensive System (SES)) on the sensory qualities of foal meat (GPA). In order to minimise differences due to individual testers, the data was evaluated using a GPA. Semi-Extensive System foals were usually associated with highly prized sensory characteristics (odour intensity, red colour, marbling, and juiciness). The three research groups, however (FES, 1.5SES, and 3SES), could be clearly distinguished by panellists and labelled on the consensus configuration.

Crops must be dried in order to increase their quality and to guard against numerous undesirable factors, such as moisture, insect and pest assaults, and wildlife. Crops must be dried in order to preserve food for a long period; traditional methods are still used to do this. Indirect solar dryers' operating principles are described in this article [22], which also introduces an IoT-based system to regulate and track the solar dryer's temperature in accordance with the needs of a particular crop. The solar dyer's main body is constructed out of plywood, and the entire system, including the drying chamber and solar collector device, is mounted on an iron support. River stones and bits of cut-up iron are used as solar-ray-blocking rods.

This paper [23] presents the domain's Use Cases (UC) and conducts evaluations under various operating and real-world-scenario-like circumstances. The technical use-case uses the IOT stack and appropriate sensors to determine geographic boundaries, assets, interoperability, reusability, and functionality. It is described in terms of entity/informational model, deployment view, functional view, and business process hierarchy. The length of time that each bovine spends grazing outside is monitored by an IOT-enabled sensor that is attached to its individual identification number. The sensor provides the lat/long coordinates of the calf when it moves. By applying algorithms to the data that are sent to the Central Application server for storing, insight data is produced for the application.

This paper [24] develops a paradigm for identifying and categorising intrusions into agricultural IoT networks. All applications of the Internet of Things, including those used in agribusiness, pose significant privacy and security risks. This framework uses the NSL KDD data set as an input data gathering. All symbolic features in the NSL-KDD data gathering are first converted to numeric features as part of the preprocessing stage. To find characteristics, principal component analysis is used. Machine learning algorithms like support vector machines, linear regression, and random forests are used to categorise a preprocessed data gathering. Metrics for recall, precision, and accuracy are used to evaluate the performance of machine learning algorithms. The linear dimensionality reduction strategy of PCA may be advantageous for data storage and analysis.

V. CHALLENGES OF APPLYING IoT IN AGRICULTURE

The Internet of Things (IoT), which offers real-time tracking and analysis of crops, soil, weather, and other important factors that affect farming, has the potential to completely transform the agricultural sector. Before IoT can be completely utilised in agriculture, there are a few issues that must be resolved. The major obstacles are as follows:

1. Connectivity: To send data to a centralised system for processing, IoT devices need dependable connectivity. However, a lot of rural places don't have good network coverage, which makes it challenging to set up IoT devices there.
2. Cost: Many farmers, particularly those in developing nations, may find the cost of IoT devices and related infrastructure to be excessively expensive. As a result, IoT usage in agriculture is constrained.
3. Data security and privacy: IoT devices produce a lot of data, so it's crucial to make sure that this data is kept private and safe. A breach of security or improper use of agricultural data could have serious repercussions.
4. Integration with existing systems: Integrating IoT systems with existing agricultural management processes and software can be difficult, particularly if these systems are out-of-date or incompatible with new technology.
5. Lack of technical knowledge: It's possible that many farmers and agricultural employees lack the knowledge necessary to set up and run IoT systems, which could impede adoption.
6. Power supply: The majority of IoT devices need a constant power source, which can be difficult in places without easy access to energy.
7. Maintenance: Updating and maintaining IoT devices on a regular basis is necessary to guarantee their correct operation. Farmers may find this challenging because they lack the time, resources, or technical knowledge to complete these duties.

For the Internet of Things to be successfully implemented in agribusiness, these issues must be resolved. To make sure that IoT is available, cheap, and simple to use, cooperation between technology providers, governments, and farmers will be necessary.

VI. CONCLUSION

A potential answer to the problems the farm sector is facing is a real-time monitoring system for livestock and agriculture using IoT technology. its capacity to deliver timely information to producers in an accurate manner. The system gathers real-time data using sophisticated sensors and devices, which are then processed and evaluated in the cloud-based platform. In order to make prompt and informed choices, farmers need to have access to current information about the health of their crops and livestock. Additionally, the system offers alerts and notifications in the event of any anomalies, ensuring that farmers are quickly informed of any problems that need to be fixed. The wellbeing of animals may also be improved. Farmers can spot problems with their animals by continuously observing their health and behaviour.

Farmers can also provide a more comfortable and conducive atmosphere for their livestock, enhancing their welfare, by keeping an eye on environmental factors like temperature and humidity. It is now crucial to implement cutting-edge technologies to boost the efficiency of the agriculture sector due to the rising demand for food production. In order to help farmers make wise decisions and act quickly to address any anomalies, the real-time tracking system offers them invaluable insights and information about the health status, behaviour, and environmental conditions of livestock and crops. Farmers can also increase output, lower costs, and make the best use of their resources thanks to the system. In conclusion, the IoT-based real-time monitoring device for agriculture and livestock is a game-changer for the agriculture sector.

In conclusion, the use of IoT technology in a real-time monitoring system for agriculture and livestock has the ability to completely change the way farming is carried out. The system equips farmers with in-depth knowledge and information about the health, behaviour, and environmental factors affecting their crops and animals, enabling them to make informed choices and take prompt corrective action in the event of any anomalies. Farmers can maximise their resources, reduce costs, and increase output thanks to the system. A game-changer for the agricultural industry, the IoT-based real-time monitoring system for agriculture and livestock has the potential to significantly increase field operations' productivity, sustainability, and profitability.

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