SMART REVOLUTION IN POULTRY FARM

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ABSTRACT

The poultry farming industry is constantly evolving to meet the growing demand for meat and eggs. One crucial aspect of successful poultry farming is the maintenance of optimal environmental conditions within poultry houses. Temperature, humidity, and ammonia levels play a vital role in the health, growth, and productivity of poultry birds. This paper explores the concept of smart poultry farm monitoring and control systems that incorporate sensors for temperature, humidity, and ammonia monitoring. We delve into the various sensor technologies used for monitoring these parameters, along with the benefits they offer to poultry farmers. The paper also discusses the importance of data analytics and insights in optimizing poultry farm management practices. Furthermore, we explore potential future developments, including the integration of AI, enhanced sensor capabilities, and expansion to other environmental parameters. Ultimately, this paper emphasizes the significance of smart poultry farm monitoring systems in creating a conducive environment for poultry birds and improving overall productivity in the poultry farming industry.

KEYWORD - *Smart relay, Temperature sensor, Humidity sensor, Gas sensor, Water tank, Ammonia gas, Liquid ammonia, Blower, Display.*

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1. INTRODUCTION

The generation of noxious gases in poultry houses, stemming from animal metabolism and the breakdown of animal wastes, poses significant risks, potentially leading to oxygen-deficient, toxic, or dangerous atmospheres. Among these gases, ammonia (NH_3) stands out as the most common and concerning. It is a colorless, alkaline, water-soluble gas produced through the microbiological deamination or reduction of nitrogenous substances, with the primary source of NH_3 generation being the microbial decomposition of uric acid in the litter. Various factors, including litter type, litter management, humidity, pH, and temperature, exert influence on NH_3 generation and concentration levels. The impact of these factors underscores the complexity of managing and mitigating the risks associated with ammonia production in poultry houses. The generation of noxious gases in poultry houses, stemming from animal metabolism and the breakdown of animal wastes, poses significant risks, potentially leading to oxygen-deficient, toxic, or dangerous atmospheres. Among these gases, ammonia (NH_3) stands out as the most common and concerning. It is a colorless, alkaline, water-soluble gas produced through the microbiological deamination or reduction of nitrogenous substances, with the primary source of NH_3 generation being the microbial decomposition of uric acid in the litter. Various factors, including litter type, litter management, humidity, pH, and temperature, exert influence on NH_3 generation and concentration levels. The impact of these factors underscores the complexity of managing and mitigating the risks associated with ammonia production in poultry houses. The generation of noxious gases in poultry houses, stemming from animal metabolism and the breakdown of animal wastes, poses significant risks, potentially leading to oxygen-deficient, toxic, or dangerous atmospheres. Efforts to address this issue involve a multifaceted approach, encompassing considerations related to environmental conditions, waste management, and ventilation systems, with the ultimate goal of ensuring the well-being of both poultry and farm personnel while maintaining optimal production conditions.

Elevated humidity, particularly when combined with high temperatures, creates favorable conditions for bacterial proliferation, leading to the decomposition of organic material and the concurrent production of ammonia. It is imperative to maintain these environmental parameters within a controllable range, with temperatures ideally ranging from 26 to 34°C and humidity levels between 50 to 70%. Adhering to these specified ranges is crucial for mitigating the risk of excessive ammonia production and ensuring the overall welfare of the poultry, as well as the safety of the farm environment.

Ammonia gas, a natural component of outdoor air, typically exists at concentrations ranging from 50 parts per trillion (ppt) to 5 parts per billion (ppb). In contrast, indoor air in poultry houses may contain ammonia at levels considered normal, reaching around 10 parts per million (ppm). The presence of ammonia in indoor environments, particularly in poultry houses, is a result of various sources, including the microbial and enzymatic breakdown of uric acid and urea in manure. These processes contribute to the generation of ammonia, which can impact both the welfare of the poultry and the health of farm personnel. It is important to note that ammonia levels exceeding 25 ppm can have adverse effects on bird performance, worker health, and the overall environment, emphasizing the significance of effective monitoring and control measures to maintain ammonia levels within acceptable limits.

The Health and Safety Executive has established a Threshold Limit Value (TLV) of 25 ppm for ammonia exposure over an eight-hour period, with an increased threshold of 35 ppm for exposure lasting up to fifteen minutes. Despite these guidelines, prolonged exposure to ammonia levels as low as 20 ppm can lead to various health issues in poultry. Aerial ammonia in poultry housing significantly impacts bird performance, including growth rate, feed efficiency, carcass quality, and susceptibility to disease challenges. To mitigate these effects on both bird welfare and worker health, poultry producers are advised to maintain ammonia levels in their facilities below 25 ppm.

The impact of ammonia is heavily influenced by exposure duration, with effects observed at high concentrations likely to manifest even at lower concentrations over longer periods. Human detection of ammonia begins at concentrations of 25 ppm or higher, with a maximum tolerable concentration of 100 ppm over an eight-hour period. It is not uncommon for ammonia levels to exceed 25 ppm during winter months, even under typical ventilation rates. While the debate among safety experts continues, 25 ppm is frequently cited as the maximum acceptable level for ammonia. Individuals experiencing eye irritation upon entering enclosed poultry houses should anticipate ammonia levels of at least 20 ppm.

In poultry houses, it is essential to ensure that ammonia concentrations do not exceed 25 ppm, with a general limit of 15 ppm adopted for poultry. Achieving and maintaining these levels necessitates careful litter management and the implementation of adequate ventilation practices.

In order to streamline poultry farm operations and reduce human error in monitoring and controlling ammonia, temperature, and humidity levels in poultry houses, there is a growing need to upgrade the conventional supervisory monitoring systems. This study advocates for the implementation of a remote monitoring and controlling system designed to automatically and continuously assess the status of ammonia, temperature, and humidity levels using a remote smart relay system. This advancement aims to minimize human intervention, enhance accuracy, and ensure timely responses to fluctuations in environmental parameters, ultimately promoting improved welfare for both poultry and farm personnel. The proposed system aligns with the evolving technological landscape in poultry farming, offering a proactive approach to maintain optimal environmental conditions within poultry houses.

The utilization of smart relays in automation processes offers significant flexibility and cost reduction in designing and implementing monitoring and control systems, Because of their adaptable features when compared to traditional equipment. In this study, smart relays with communication interfaces have been deployed to remotely monitor and control NH_3 concentration, relative humidity (RH), and temperature in poultry houses. These smart relays enable the transmission of alert messages and receipt of instruction messages via SMS, while also facilitating data storage through IoT technology. This innovative approach harnesses the capabilities of smart relays to enhance the efficiency and responsiveness of poultry farm management, aligning with the trend towards integrated and technologically advanced solutions in agricultural settings.

2. LITERATURE SURVEY

Sitaram et al. (2018) developed a Tasks such as feeding, water supply, and cleanliness are managed through automation. Electricity is generated from methane gas produced by chicken manure.A web-based system allows remote monitoring and management of the farm.

Choukidar and Dawande (2017) developed an Automated system adjusts environmental parameters as needed. The Raspberry Pi controls sensor data transmission. Detailed records of farm conditions are maintained online.

Ahmadi et al. (2018) discuss about smart control systems for poultry farms, utilizing technologies like Zigbee, Raspberry Pi, wireless sensors, and GPRS. It highlights the system's ability to automatically monitor and control environmental factors on poultry farms.

Revanth et al. (2021) implementing IoT-based monitoring systems to automate the monitoring and control of temperature, humidity, ammonia levels, air quality, light intensity, and litter moisture, aiming to improve efficiency and productivity in Indian poultry farming.

Lashari et al. (2018) propose a software-based hardware solution capable of monitoring crucial environmental parameters in poultry houses, such as air temperature, humidity, and gas concentrations.

Manshor et al. (2019) underscore the critical importance of monitoring temperature and humidity levels in poultry houses continuously, particularly to prevent incidents caused by high temperatures.

Mondol et al. (2020) IoT-based weather monitoring system utilizes DHT11 sensors to collect data, which is then transmitted to a cloud-based server for analysis and comparison with threshold values, triggering alerts to smartphones and buzzers when necessary, ultimately enhancing farm management and productivity.

Gunawan et al. (2019) developed a smart chicken poultry farm using IoT technology and a real-time operating system (RTOS) on Arduino, with sensors monitoring levels of ammonia, carbon dioxide, humidity, and temperature. Experimental results demonstrate the effectiveness of RTOS on Arduino in managing tasks and maintaining optimal environmental conditions, showcasing its potential for improving poultry farming practices.

Jebari et al. (2023) propose a system, Poultry-Edge-AI-IoT, which integrates AI, IoT, and Edge Computing to monitor and predict poultry barns' environmental conditions in real-time.Utilizing a Deep Learning algorithm called E-GRU, the system effectively gathers, stores, filters, and transmits data from wireless sensors, allowing for the detection of potential stress and harmful gas concentrations while predicting future environmental conditions.

Balachandar and Chinnaiyan (2020) emphasize the importance of leveraging advanced analytics, such as imagery analytics, to remotely monitor bird health and recommend appropriate medicine dosages.By storing poultry images and metadata in an unstructured data store and utilizing algorithmic imagery models, deficiencies can be identified and dosages recommended based on color and stains observed on the birds' bodies, showcasing the practical application of technology in enhancing poultry farming practices.

Park and Zammit (2023) show that the digital livestock system significantly improves behavior indicators such as drinking, eating, and resting scores, as well as animal welfare scores.Additionally, the system enhances the fatty acid profile of eggs, with increased levels of beneficial oleic acid and unsaturated fatty acids, and decreased levels of saturated fatty acids and n-6/n-3 fatty acid ratio, suggesting its potential for improving both production and quality in laying hen farming.

Mahale and Sonavane (2016) highlight the need for technology-based solutions to ensure cost-effective, asset-saving, and quality-oriented management of chicken farming, aiming to meet the rising demand for safe and high-quality chicken food.The study proposes utilizing an Intelligent System with an Embedded Framework and Smart Phone for monitoring and controlling environmental parameters in chicken farms using smart devices and technologies, showcasing the potential for modernizing poultry farming practices.

Ramteke and Dongre (2022) propose an Intelligent Automated Poultry Management System using IoT technology to address these challenges, including monitoring bird health, controlling food and water supply, and managing environmental factors such as lighting and hygiene.By utilizing sensors and automation, the system aims to streamline poultry farm management, enhance productivity, and reduce the burden on farm owners, showcasing the potential for technology to revolutionize the poultry farming industry in India.

Goyal et al.(2023) Utilizing Raspberry Pi 4 as an edge device and a lightweight deep learning algorithm, the proposed model achieves high performance in anomaly detection, outperforming existing methods with low inference time.Additionally, a novel sound-based architecture is proposed to enhance bird movement inside the farm, ultimately improving bird health, highlighting the potential of technology-driven solutions in poultry farming.

3. BLOCK DIAGRAM

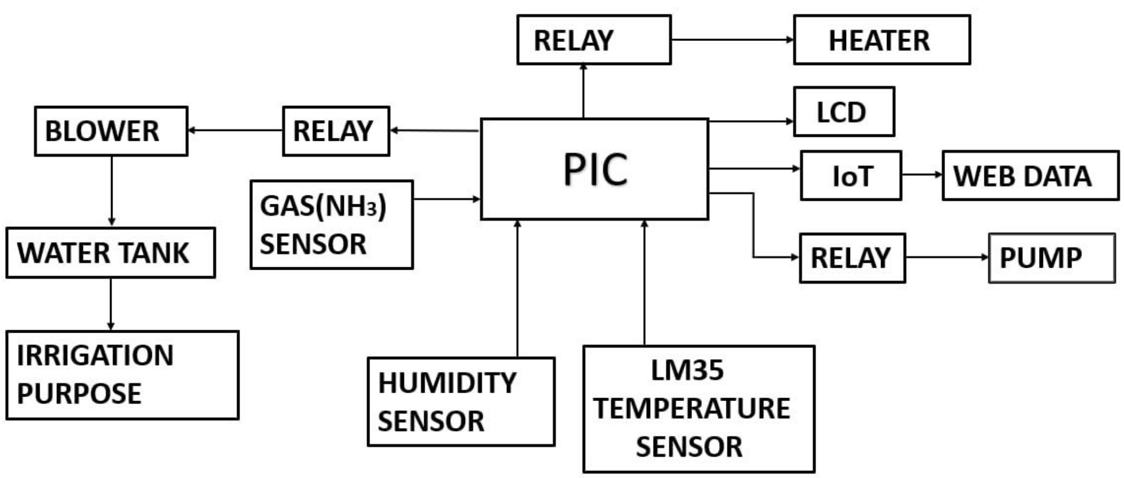

Fig 1: Block diagram of the proposed system

The block diagram of proposed system is depicted in Figure 1. The developed system utilizes IoT technology to monitor and control different parameters like humidity, temperature, ammonia gas level inside the poultry farm providing an efficient automated poultry system.

The prototype hardware encompasses several components:

1**. Temperature Monitoring and Control System**: The temperature sensor namely LM35 is used to constantly monitor the ambient temperature within the poultry housing. This sensor is strategically placed to accurately capture temperature variations and fluctuations. The system is equipped with a relay-based control mechanism that dynamically adjusts the temperature based on the preset values of 25-45°C. When the temperature deviates from the desired range, the corresponding actuators such as heater and pump are activated to regulate the temperature. When the temperature falls below the preset value, the heater will be turned on. On the contrary, when the temperature rises above the preset value, the pumps are activated to sprinkle the water. The smart poultry farm system is integrated with IoT technology, allowing for remote monitoring and control of the temperature parameters. This enables farm managers to make timely adjustments to maintain optimal temperature conditions for the poultry.

2. **Humidity Monitoring and Control System:** The Perimeter Capacitive Humidity Sensor continuously monitors the moisture levels within the poultry housing. This sensor is integrated with IoT technology, thereby providing real-time data on humidity variations and fluctuations.The system is equipped with a relay-based control mechanism that activates the humidity regulation components, such as pumps and air-cooling systems, to adjust the moisture levels based on the preset values. This automation ensures that the humidity remains within the desired range to support the health and comfort of the poultry. Pumps are utilized to regulate the humidity levels within the poultry housing. These pumps are activated based on the data received from the humidity sensors, allowing for precise control of moisture in the environment. When the temperature shoots above 45°C, the humidity level falls off. In such case, the pump is activated so as to spray water inside the poultry farm. On the other hand, if the temperature drops below 25°C, the humidity level rises. In such a case, the heater which is an integral part of the air-cooling system is turned on to control the humidity. The smart poultry farm system leverages IoT technology to enable remote monitoring and control of humidity parameters.

3. **Ammonia Gas Monitoring and control System:** The ammonia gas sensor namely the MQ2 sensor continuously monitors ammonia levels in the environment .When the sensor detects elevated ammonia level of 80 ppm the PIC controller triggers the relay, which in turn activates the blower to absorb excess ammonia and route it to water tank. Due to chemical reaction of ammonia and water, liquid ammonia is formed, which can be used as fertilizer for irrigation purposes.

4**. Data base system:** In this proposed system, all the collected data from various sensors is stored in Thing Speak with the IoT technology. These stored data can be used for monitoring all the parameters, namely humidity, temperature, ammonia gas level, from remote location.

5. **Display Unit:** LCD is used to display the current data acquired from the three sensors.

4. PROTOTYPE HARDWARE

Figure 2 portraits the developed prototype hardware for automatic monitoring and control of temperature, humidity and ammonia gas in the poultry farm with the aid of IoT Technology.

The pump is mounted on the PVC pipe, where the pipe is used to store water. PIC controller is placed in the center of the developed prototype hardware to receive data from all the three sensors and activate the appropriate relays to maintain the ambient condition in the poultry farm. All the sensors are placed near the LCD unit in the developed prototype hardware. The node MCU for monitoring the data from remote places is placed on the right side of the PIC controller in the hardware. The power supply unit for powering all the devices is placed on the left side of the PIC controller in the developed system. From Figure 2, it is revealed that LCD unit displays the data received from sensor.

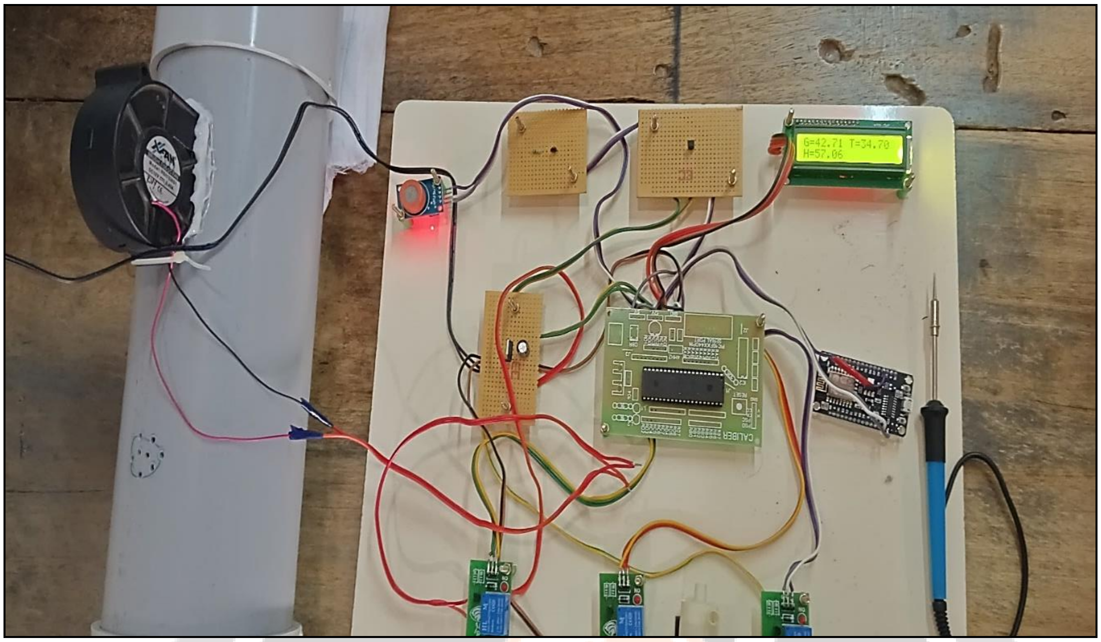

Fig 2: Hardware setup of proposed system

5. RESULTS AND DISCUSSIONS

Figure 3 shows the output from the three sensors (ammonia gas, temperature, humidity) plotted against time.

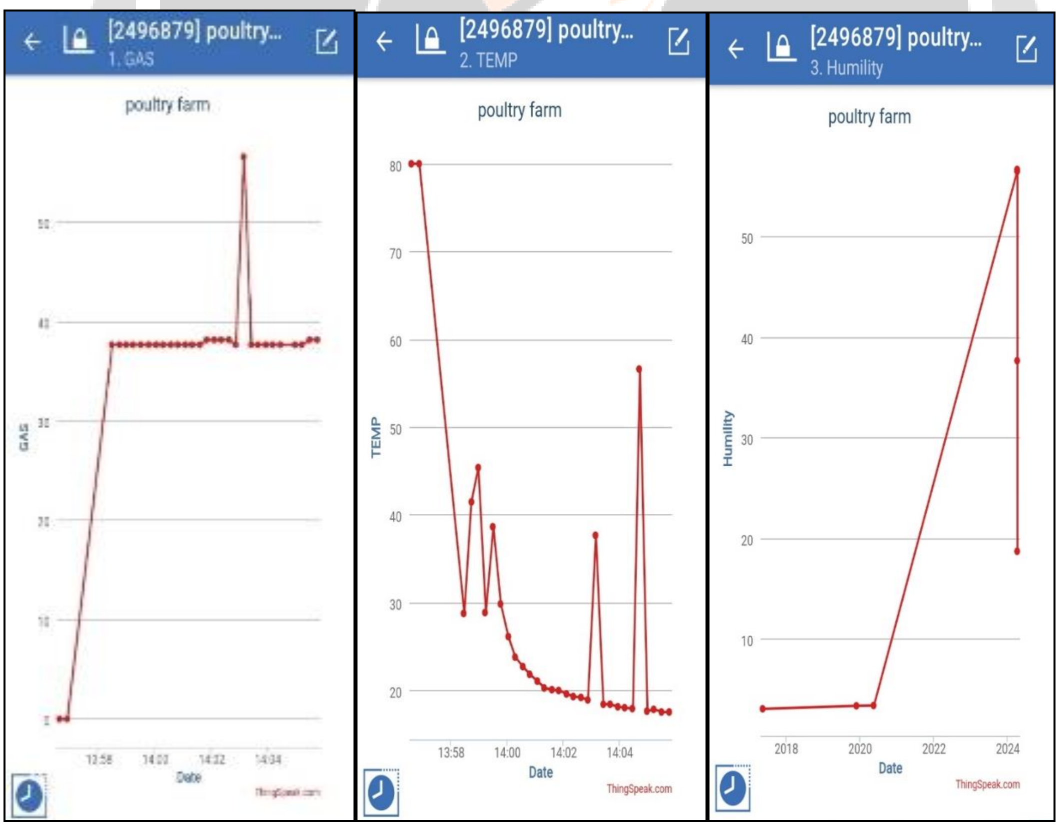

Fig 3: Sensors results monitored in ThingSpeak with IoT

From Figure 3, it is revealed that even though the operating conditions of the poultry are beyond the prescribed limits, they are brought to the desired level with the help of all three controlling units of the prototype hardware. Hence, these results authenticate the efficient operation of the prototype hardware in maintaining the ambient conditions inside the poultry.

6. FUTURE SCOPE

- **IoT Integration and Smart Farming Applications:** The future of poultry technologies is expected to witness continued advancements in IoT integration, cloud-based technologies, and smart farming applications, leading to improved efficiency within the poultry sector.

- **Affordability and Accessibility:** The future enhancement of smart poultry farming systems aims to make these technologies less expensive and more accessible, not only for large-scale poultry operations but also for small and backyard chicken farmers, potentially leading to increased profitability and ease of management.

- **Incorporation of Additional Features:** Future enhancements may involve the integration of additional features such as fire alarm systems, automated fire extinguisher systems, and comprehensive information management systems, including reminders for vaccination and worker-related information.

- **Artificial Intelligence and Robotics:** The application of artificial intelligence and robotics in poultry farming is anticipated to play a significant role in farm management, data collection, and process optimization, potentially leading to improved efficiency and profitability.

7. CONCLUSION

The proposed system converts a traditional farm into a smart farm. It provides quicker and more accurate information about different parameters to poultry owners. The system is less expensive and affordable for not only the poultry owners but also for those who look up poultry farming as their side business. Production and health of poultry products get improved due to smart monitoring and control of different parameters of temperature, humidity, ammonia gas .Cleanliness of the farm becomes easier. Poultry farming has been practiced for a very long time, not only in India but across the whole world. But in the last few years, it has been practiced in a scientific manner. The backyard poultry has turned in to commercial poultry farming and a gainful and dignified business enterprise in India and elsewhere in the world.

Since poultry farming can be practiced as a supplementary or second income generating mechanism, landless laborers and small farmers find a support in this business. In fact, poultry farming has become an indispensable component of the agricultural industry in India. Thus, the proposed project design provides an efficiently automated monitoring system. A traditional poultry farm can be converted into a modern and automatic poultry farm using IoT. This automated poultry farm is used to improve the health and growth of the chickens. So, poultry owners can make a huge profit and earning a lot from poultry farming business.

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