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A Robotics-Based Surveillance System for Livestock Well being and Early Disease Detection in Poultry Farms

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Abstract: This paper presents a smart surveillance system using robotics for analysing the wellbeing of the livestock and early detection of disease in poultry farms. The current system often identifies infections too late, resulting in mass culling of flocks. The proposed solution is to use disease control through vaccination as an alternate approach. The proof of concept for this paper was implemented using the Raspberry Pi 4 along with Arduino IDEs, which was adapted to better suit the needs of the paper. The system was able to collect data from sensors measuring variables such as Ammonia, Carbon Dioxide, temperature, and humidity. The wellbeing of the chicken can be monitored through the environmental variables being sensed. Based on studies, deviations in these variables from the baseline can indicate the presence of disease. Some systems also listen to sounds to understand if illnesses are prevalent. The data will be passed through a series of conditions to determine the probability of infection within the farm. Experimental analyses through simulations were conducted with the mobile robot connected with sensors. Based on the significant deviation of sensor outputs from the benchmark values, the presence of disease in the livestock was detected in the early stages.

I. INTRODUCTION:

By the implementation of a smart surveillance system using robotics for early detection of diseases in poultry farms, the paper aimed to reduce losses in terms of stock, resulting in an increase in availability. Additionally, by using disease control through vaccination as an alternate approach, the cost of purchasing from the stock was projected to reduce, as mass culling of flocks will not be necessary.

Poultry comprises of 40% of the meat consumed across the world, and losses within this fast-growing industry are due to the increasing susceptibility to highly infectious diseases on farms. Two approaches of disease control are commonly taken mass vaccination of uninfected birds or mass culling of the entire flock when the percentage of infected birds exceeds a certain threshold. Although both approaches lead to increased investment, the latter approach positively affects the availability of stock with The Arduino IDEs along with the Raspberry Pi 4 will be utilized for the proof of concept of this paper. Readily available microelectronics such as gas sensors and MQ7 sensors can be used to read the environment within the farm. The primary programming languages used for the prototyping of the ideas presented in this paper were Embedded C. The proposed solution utilized robotics in smart surveillance of chicken farms to provide early disease detection measures for early intervention and prevention of widespread infection. The robots were mainly used to increase access to ground level environmental information which is closer to the living conditions of the livestock. The use of temperature sensors was predicted to enable the identification of living or dead chickens to measure the rate of death.

A robotics-based system can be efficient in identifying infected birds and preventing the spread of disease in poultry farms. Some of the common diseases include Fowl Pox, Avian Influenza and Swollen Head Syndrome. By using robots to collect data from sensors measuring variables such as ammonia, carbon dioxide, temperature, and humidity and using temperature analysis to identify sick or dead birds, the system can be more efficient and accurate in detecting infections. The system can also be further developed to perform tasks such as cleaning the chicken coop, feeding the birds, and monitoring the overall health of the flock. This approach can speed up the latency between initial infection and Diseases.

II. SCOPE OF THE PROJECT:

The scope of the project for a Robotics-Based Surveillance System for Livestock Well-being and Early Disease Detection in Poultry Farms includes several key components focused on improving poultry health, farm efficiency, and early disease detection. It begins with the design and development of robotic hardware equipped with various sensors (such as temperature, motion, and heart rate monitors) to continuously gather data on the poultry's vital signs and behavior.

The system also involves developing software and artificial intelligence (AI) algorithms capable of analyzing this data to identify early signs of disease or stress, triggering real-time alerts for farm managers.

To enhance efficiency, the project includes automation features such as automated responses to adjust environmental conditions (e.g., temperature or humidity) when abnormalities are detected, reducing the need for constant manual intervention. The data collected will be stored securely and analyzed for trends, with tools developed for farm operators to make data-driven decisions on poultry management, including adjustments.

The system will also integrate seamlessly with existing farm management platforms, providing a user-friendly interface for real-time monitoring and alerts.

III. PROPOSED SYSTEM

The proposed solution is to use disease control through vaccination as an alternate approach. The proof of concept for this paper was implemented using the Raspberry Pi, which was adapted to better suit the needs of the paper. The system was able to collect data from sensors measuring variables such as Ammonia, Carbon Dioxide, temperature, and humidity. The wellbeing of the chicken can be monitored through the environmental variables being sensed. The use of artificial intelligence techniques with advanced computer vision techniques offers great potential for non-invasive health assessments in the poultry industry. Evaluating the condition of poultry by monitoring their droppings can be highly valuable as significant changes in consistency and color can be indicators of serious and infectious diseases.

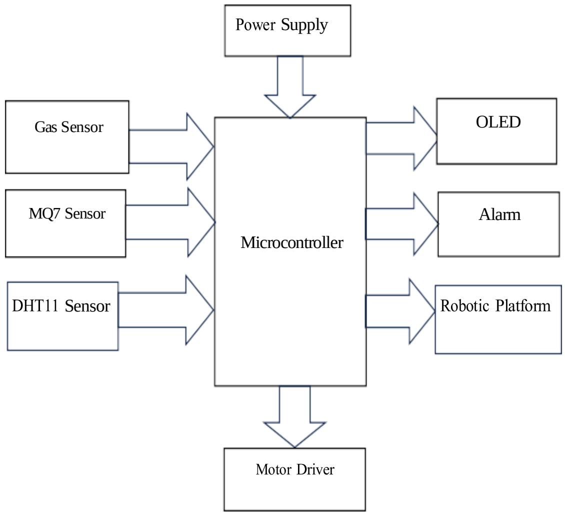

Fig1: Block Diagram of A Robotics-Based Surveillance System for Livestock Well being And Early Disease Detection in Poultry Farms.

Power Supply:

The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or voltage variation. A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load

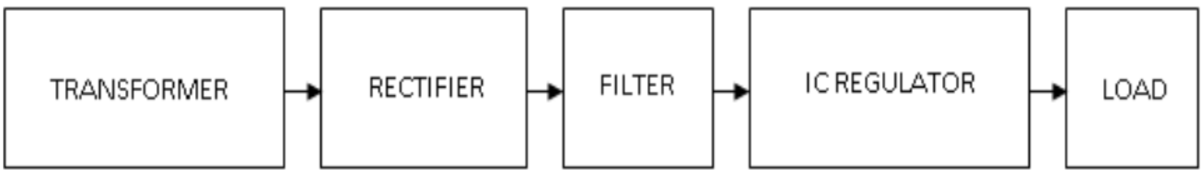

Fig 2: Block Diagram of Power Supply

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connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

Raspberry Pi Pico:

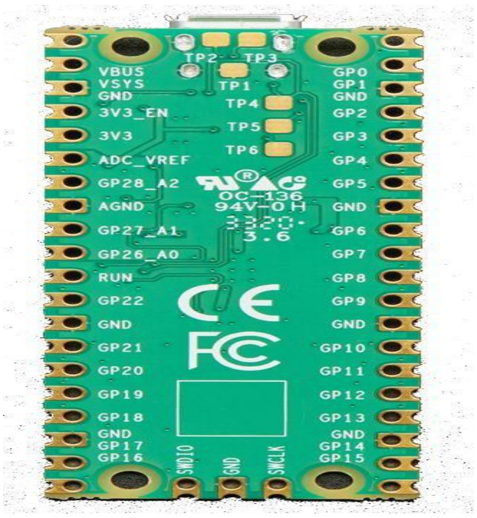

Fig 3: Raspberry Pi Pico Module

The Raspberry Pi foundation changed single-board computing when they released the Raspberry Pi computer, now they're ready to do the same for microcontrollers with the release of the brand-new Raspberry Pi Pico. This low-cost microcontroller board features a powerful new chip, the RP2040, and all the fixin's to get started with embedded electronics projects at a stress-free price.

The Raspberry Pi Pico is a microcontroller board based on the Raspberry Pi RP2040 microcontroller chip. Like Raspberry Pi computers, Raspberry Pi Pico features a pin header with 40 connections, along with a new debug connection enabling you to analyse your programs directly from another computer (typically by connecting it directly to the GPIO pins on a Raspberry

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Raspberry Pi Pico is a brand new, low-cost, yet highly flexible development board designed around a custom-built RP2040 microcontroller chip designed by Raspberry Pi.

Raspberry Pi Pico – ‘Pico’ for short – features a dual-core Cortex-M0+ processor (the most energy- efficient Arm processor available), 264kb of SRAM, 2MB of flash storage, USB 1.1 with device and host support, and a wide range of flexible I/O options.

Gas Sensor:

A gas detector is a device which detects the presence of various gases within an area, usually as part of a safety system. This type of equipment is used to detect a gas leak and interface with a control system so a process can be automatically shut down. A gas detector can also sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave the area. This type of device is important because there are many gases that can be harmful to

organic life, such as humans or animals.

Fig 4: Gas sensor

This adsorption creates a potential difference on the element which is conveyed to the processor unit through output pins in form of current.

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MQ7 Sensor:

MQ7 Gas sensor is another one of Metal Oxide Semiconductor (MOS) type Gas Sensor of MQ Gas Sensors family involving MQ 2, MQ 4, MQ 3, MQ 8, MQ 135, etc. It is mainly used to detect Carbon Monoxide. This sensor contains a sensing element, mainly aluminum-oxide based ceramic, coated with Tin dioxide (SnO_2), enclosed in a stainless-steel mesh. Whenever CO gas comes into contact with the sensing element, the resistivity of the element changes. The change is then measured to get the concentration of the gases present. The MQ7 Sensor has a small heating element present which is needed to preheat the sensor to get it in the working window. It can detect Carbon Monoxide Gas in the range of 20 PPM to 2000 PPM in the air. It finds uses in Alarm application in case of CO gas concentration build-up in the home or your car as CO is a very harmful gas and can kill a person if present over 300PPM. To use the Sensor Module, you have power the device with 5V supply and the Power LED will start to glow. To power it, you can use external supply or connect +5V and GND pin of Arduino.

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You should give it some preheating time before start reading the output.

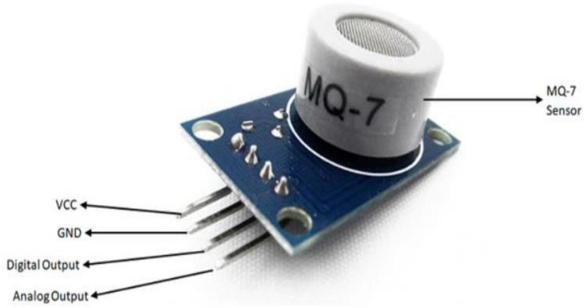

Fig5: MQ7 Sensor Module

DHT11 SENSOR:

The DHT11 sensor can either be purchased as a sensor or as a module. Either way, the performance of the sensor is same. The sensor will come as a 4- pin package out of which only three pins will be used whereas the module will come with three pins as shown Below.

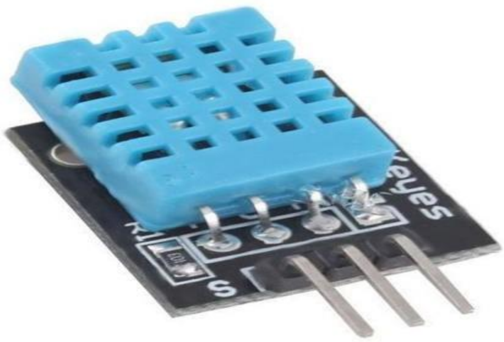

Fig6: DHT11 Sensor Module

The only difference between the sensor and module is that the module will have a filtering capacitor and pull-up resistor inbuilt, and for the sensor, you have to use them externally if required.

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8- bit microcontroller to output the values of temperature and humidity as serial data.

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The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

OLED Display:

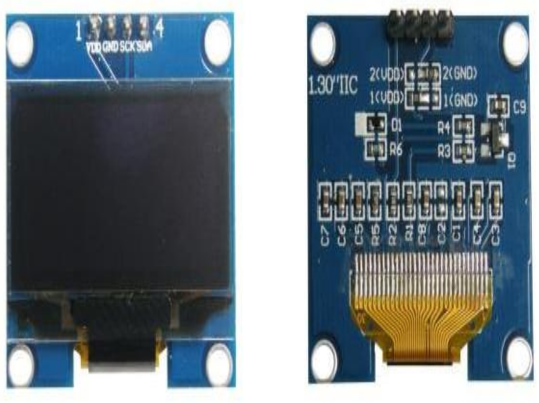

Fig7: OLED Display

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

OLED displays are not just thin and efficient - they provide the best image quality ever and they can also be made transparent, flexible, foldable and even rollable and stretchable in the future. OLEDs represent the future of display technology.

BUZZER:

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows. It most commonly consists of a number of switches

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or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sound
warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker.

Fig 8: Buzzer

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IV. RESULT:

As a result, the threshold value of Gas sensor is 540 ppm, when it exceeds the buzzer gives a sound and OLED displays "MQ2 is Leaked". The Threshold value of. The Threshold value of MQ7 Sensor is 350ppm, when it exceeds the buzzer gives a sound and OLED displays "MQ7 is Leaked". In DHT11 Sensor, the threshold value of temperature is 45 degrees when it exceeds the buzzer gives a sound and OLED displays "Temperature is Abnormal!!!", the threshold value of humidity is 80%RH when it exceeds the buzzer gives a sound Abnormal!!!". By using this robot we can perform early disease detection and take preventive measures to save the chickens in poultry farms This type of visualisation was able to allow for constant monitoring of the farm and alert necessary individuals to make the necessary arrangements to prevent widespread diseases from affecting the general efficiency of the farm.

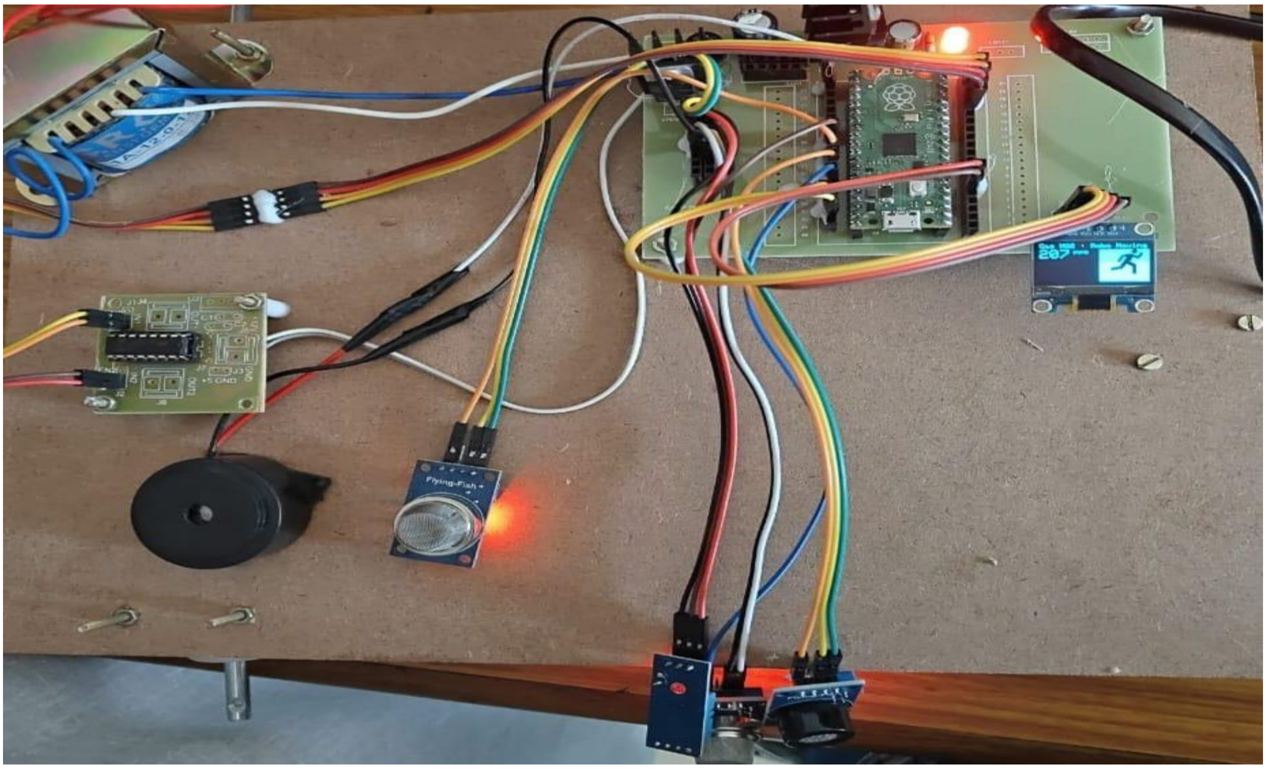

Fig 9: Hardware setup

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V. CONCLUSION

The proposed system is efficient at analysing the ground level environmental data to identify the wellbeing of livestock using sensor outputs. Also, this method is efficient at replacing some of the methods that are aimed at being replaced are the manual counting of the infected chicken, manual reading of the ground-level sensory data within the farm. This should result in lowered costs with regards to mass culling of the flock. Furthermore, the proposed methodology can be able to promote increased profitability at the farm due to increased rate of survival of the livestock. In conclusion, the use of such a system is effective at increasing the efficiencies of processes at farms using less labour-intensive methods. This type of visualisation was able to allow for constant monitoring of the farm and alert necessary individuals to make the necessary arrangements to prevent widespread diseases from efficiency of the farm.

VI. FUTURE SCOPE

The future scope of a robotics-based surveillance system for livestock well-being and early disease detection in poultry farms is extensive and promising. With the integration of advanced technologies such as artificial intelligence (AI) and machine learning, the system can evolve to not only detect diseases but also predict potential outbreaks based on behavioral patterns, environmental data, and historical trends. Enhanced imaging and sensing technologies, such as thermal cameras and gas sensors, can enable more accurate health assessments by identifying signs of fever, respiratory issues, or harmful environmental conditions. The use of autonomous robots and drones can further improve surveillance coverage and efficiency, especially with advancements in path planning and swarm robotics. Additionally, the incorporation of Internet of Things (IoT) technology can facilitate real-time monitoring and cloud-based data storage, allowing farmers to access and respond to alerts from mobile devices. This system can also be linked with veterinary and farm management platforms to maintain detailed health records, automate treatment protocols, and improve overall farm productivity.

Integration of AI and Machine Learning

1. AI and Machine Learning Integration:

   Predict disease outbreaks based on historical and behavioral data. Enable intelligent behavior recognition for early illness detection.

2. Advanced Imaging and Sensing:

Use thermal cameras to detect fever or inflammation. Deploy gas sensors to monitor harmful gases like ammonia and CO_2.

3. Autonomous Robotics and Drones:

   Implement path-planning for efficient movement in poultry houses. Explore swarm robotics for wider and faster coverage.

4. IoT and Real-Time Monitoring:

   Enable real-time data collection and cloud-based access. Allow remote monitoring through mobile apps or dashboards.

5. Integration with Farm Management Systems:

   Maintain digital health records of individual birds. Automate alerts for quarantine and treatment recommendations.

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