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Animal Health Monitoring System Using IoT And Wireless Sensor Network

Ms. Thanushree P S
UG Student
Dept. of ETE, SSIT
Sri Siddhartha Institute of Technology
Tumakuru, India
thanushreeps2003@gmail.com

Ms. Thrupthi N
UG Student
Dept. of ETE, SSIT
Sri Siddhartha Institute of Technology
Tumakuru, India
6thrupthi@gmail.com

Ms. Meghana B S
UG Student
Dept. of ETE, SSIT
Sri Siddhartha Institute of Technology
Tumakuru, India
meghanabs2003@gmail.com

Dr. Savita D Torvi
Prof and HOD
Dept. of ETE, SSIT
Sri Siddhartha Institute of Technology
Tumakuru, India
savitadtorvi@ssit.edu.in

Abstract – **The proposed gadget addresses sustainable development goals (SDGs) along with no poverty, 0 hunger, and sustainable cities by means of enforcing a shrewd farm animal monitoring machine to enhance dairy production. Traditional farm animal's management in developing international locations faces inefficiencies due to limited technological advancements, which negatively affect productiveness and useful resource utilization. This research introduces a cost effective, clever dairy tracking gadget integrating Wi-Fi sensor nodes, the Internet of Things (IoT) and Node MCU generation. The gadget encompasses with three modules inclusive of a wise environmental tracking system, a cow collar prepared with sensors for tracking health and region, and water level indicator. Real-time information is processed and saved in a comprehensive database, enabling instantaneous signals for anomalies. The gadget enhances farm animal health and productiveness with the aid of minimizing human intervention, reducing labour fees, and automating vital functions. Its modular, plug-and-play layout offers scalability for programs in zoos and fowl monitoring, making it a sizable development in contemporary agricultural practices.**

Keywords – **Node MCU, cow collar, animal fitness tracking, Wireless Sensor Nodes (WSNs), Micro controller, Internet of Things (IoT), Sustainable Development Goals (SDGs).**

I. INTRODUCTION

The global populace surge and evolving dietary patterns have brought about an unparalleled call for dairy merchandise. This surge poses full-size demanding situations for livestock industries, especially in developing nations where technological obstacles often preclude performance and productiveness. Farmers heavily depend upon cattle health and production for their livelihoods, however environmental elements, restrained sources, and previous practices often disrupt their potential to fulfil developing needs. Diseases which include foot-and-mouth ailment, swine fever, and bovine spongiform encephalopathy exacerbate those challenges, further diminishing productiveness and growing monetary losses. To overcome these limitations and align with the United Nations Sustainable Development Goals (SDGs) consisting of no poverty, 0 starvation, and sustainable community modern technological interventions are imperative. Traditional livestock tracking and management structures depend on guide inspections that are labour in depth, susceptible to error, and frequently inefficient. Visual tests and primary equipment do no longer provide actual-time data, leaving important health problems undetected until they show up as extreme headaches. This has led to a urgent need for intelligent structures which could constantly reveal animal health and environmental conditions. Moreover, the COVID-19 pandemic highlighted the inter connectivity of fitness structures and their vulnerability to zoonotic sicknesses, underscoring the importance of proactive tracking in agriculture to mitigate dangers to each animal and human populations. Advancements in technology, mainly in Wireless Sensor Networks (WSNs) and the Internet of Things (IoT), have unlocked new possibilities for modernizing farm animal control. These Technology allow for the actual-time collection, analysis, and transmission of statistics, allowing farm owners to make knowledgeable choices remotely. This paper proposes a sensible animal monitoring system that leverages WSN, IoT, and Node MCU generation to decorate cattle fitness, reduce human intervention, and optimize useful

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resource utilization. By integrating environmental monitoring with automatic systems for water management and fitness monitoring, the proposed gadget presents a holistic approach to clever dairy farming. The gadget is designed to be fee powerful and consumer-friendly, catering mainly to the wishes of small and medium-sized farms in growing regions. Its modular architecture guarantees scalability and flexibility, making it appropriate for numerous applications including hen farming and natural world tracking. Key features encompass actual-time data collection through clever collars equipped with sensors for temperature, heart fee, and GPS monitoring, as well as environmental sensors for monitoring parameters like humidity, CO2 degrees, and air great. This integration no longer simplest enhances the performance of cattle control but additionally contributes to accomplishing sustainability through minimizing waste and improving productivity. By addressing the demanding situations of traditional farm animal control, this gadget aligns with worldwide efforts to construct resilient agricultural practices and sustainable food systems. The following sections will offer a detailed assessment of the system's architecture, implementation, and capacity impacts, demonstrating how smart technology can revolutionize the cattle enterprise and make contributions to broader societal and environmental desires.

II. Related Work

[1] Li et al. (2018) demonstrated a system that integrates "WSNs with IoT to monitor livestock temperature and environmental factors" such as humidity and air quality, for disease prevention.

[2] Kumar et al. (2020) proposed a "wearable IoT enabled device" for cattle that tracks physiological parameters, including heart rate and body temperature. Their findings underscore the potential of such systems to improve animal welfare and productivity by enabling timely interventions.

[3] Gupta et al. (2019) developed a cost-effective and scalable "IoT based monitoring framework" that combines environmental sensors with low-power micro controllers. This study highlights how cost-efficient technologies can democratize access to advanced agricultural solutions.

[4] Ahmed et al. (2021), provide robust platforms for integrating sensors and enabling real-time data transmission to cloud-based storage, ensuring seamless monitoring and analysis. Environmental monitoring is crucial for maintaining optimal livestock health.

III. System Architecture and Methodology

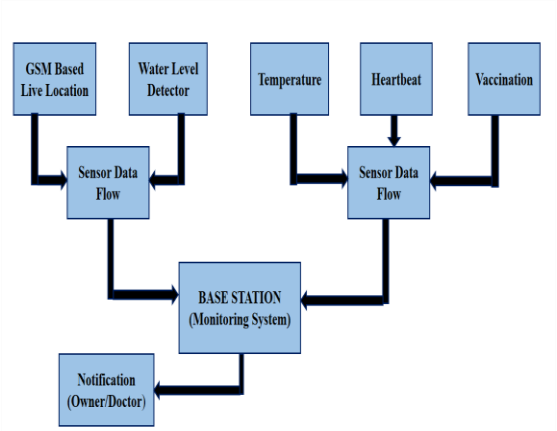

Figure 1: Block diagram of proposed work

A. Node MCU Subsystem: Sensor Integration and Environmental Monitoring

This subsystem is designed to handle the cow collor using a variety of hardware components:

- Heartbeat Sensor: A heart rate sensor, also known as a pulse sensor, is a device that measures and monitors the number of times your heart beats per minute (BPM). These sensors typically use optical methods, like LEDs and photo transistors, to detect changes in blood flow as the heart pumps, which are then converted into an electrical signal.
- Gas Sensor (MQ3): Detects harmful or flammable gases (like alcohol vapours, smoke, etc.), enabling early detection of chemical threats or hazardous environments.
- Ultrasonic Sensor: An ultrasonic sensor uses sound waves that humans cannot hear (ultrasound) to measure distances by detecting the time it takes for a pulse of sound to travel to an object and back.
- Temperature and Humidity Sensor (DHT11): The DHT11 is a basic, low-cost digital sensor used to measure temperature and humidity. It's widely used in weather monitoring systems, home automation, and IoT based projects due to its simplicity and reliability.
- Camera (ESP32): The ESP32-CAM is a small size, low power consumption camera module based on ESP32. It comes with an OV2640 camera and provides onboard TF card slot. The ESP32-CAM can be widely used in intelligent IoT applications such as

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wireless video monitoring, WIFI image upload, QR identification, and so on.

- Node MCU Micro controller: Acts as the central processing unit for this subsystem. It collects and processes real-time data from all connected sensors and actuators. It also uploads processed data and threat alerts to UBIDOTS IoT platform, enabling cloud-based monitoring and control.
- Power Source: Powered by a battery, ensuring field mobility and uninterrupted operation.
- UBIDOTS Integration & Camera Viewer Access: Alerts are sent to UBIDOTS, where they can be monitored remotely. Additionally, the system is configured with camera Viewer, allowing live video monitoring to find the animal.
- Function Summary: This subsystem is focused on environmental and cow collor (e.g., health monitoring and toxic gases), SMS and mail alerting.

IV. Hardware and Software Implementation

A. Hardware

- Node MCU ESP8266: Manages sensor inputs and transmit data.
- Heartbeat Sensor: Normal heart rate for cow is typically 48 to 84 beats per minute.
- Temperature and Humidity Sensor (DHT11): Normal body temperature of cow ranging from 38 to 39.3 degree Celsius (100.4 to 102.8 degree Fahrenheit).
- The normal humidity range is between 30% to 60%.
- MQ3 Gas Sensor: Detects smoke/gas above 400 ppm.
- Ultrasonic Sensor: Typically rage from few centimeters to 4 meters.
- Camera (ESP32): It can achieve a range of several kilometers.
- Battery: 7V, powering all components.

B. Software

- Arduino IDE: Firmware for Node MCU.
- UBIDOTS SDK: Pushes alerts and sensor data to the cloud.
- Lua Scripting Language: It is designed to embedded into other applications.
- Live Stream: Provides live feed from ESP32 camera.

V. Results and Evaluation

The image Figure 2 shows a screenshot of a dashboard on the UBIDOTS platform, which is used for IoT (Internet of Things) data visualization and monitoring. The dashboard displays various metrics, including:

- Heartbeat: The value is 119.00. This suggests that the dashboard is monitoring the heartbeat of the cow.
- Humidity: The current humidity reading is 82.00, likely measured as a percentage. This indicates the relative humidity in the environment where the cow is located.
- Gas: A green pie chart is displayed. The chart represents the concentration of toxic gases and smoke in surroundings in that case it will turn red.
- Water: A circular gauge shows a value of 20.00. This could represent water level of the cow through its neck movements.
- Temperature: The temperature is displayed as 25.80 degrees Celsius. This is a common metric for monitoring animal conditions.

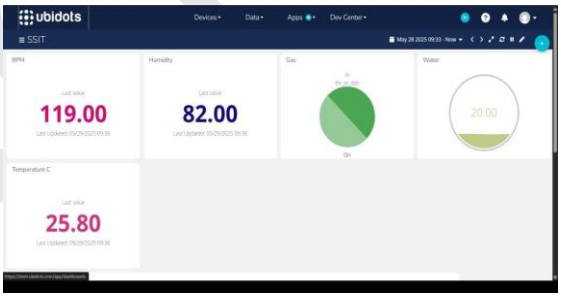

Figure 2: UBIDOTS Dashboard with Real-time data

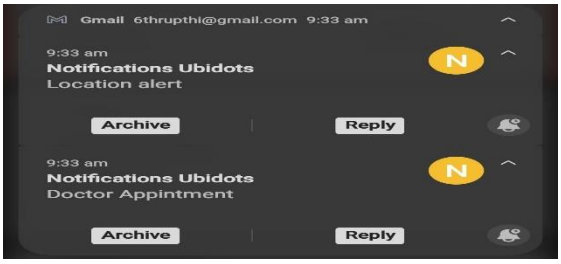

Figure 3: Alert from mail

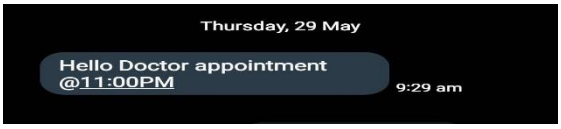

Figure 4: Doctor Appointment Notification

The UBIDOTS platform is designed to collect and visualize data from various sensors and devices, making it easier to monitor and analyse the data in real-time. The specific metrics displayed on this dashboard suggest that it is being used to monitor

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environmental conditions, possibly in an industrial, agricultural, or smart home context. The image Figure 3 shows a screenshot of a Gmail inbox on a mobile device, displaying two notifications from "Notifications UBIDOTS" at 9:33 am. The notifications are for a "Location alert" and a "Doctor Appointment." The context provided suggests that these notifications are part of a system for monitoring cow health. The "Location alert" likely relates to tracking the location of cows, while the "Doctor Appointment" notification is probably about scheduling or reminding the owner about vaccination appointments for the cows. The system allows the owner to change the date of the appointment as needed, this setup implies a use case where technology is being utilized for livestock management, specifically for health monitoring and reminders. Overall, the image illustrates how digital tools can be applied in agriculture or livestock management to improve efficiency and care for animals.

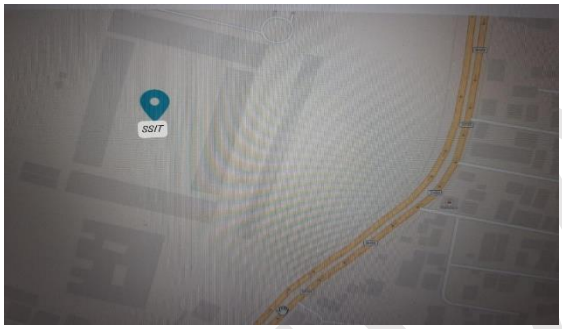

Figure 5: Location displayed in UBIDOTS

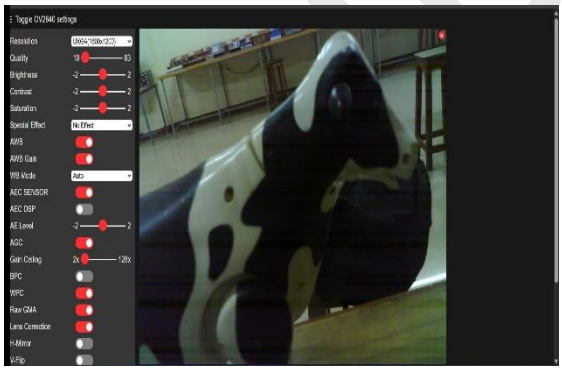

Figure 6: Visuals of cow through ESP-32 camera

The image Figure 5 shows a screenshot of a location tracking interface, likely from the UBIDOTS platform, which is used for IoT (Internet of Things) device management and data visualization. The screenshot displays a map with a blue location marker labelled "SSIT." The context provided suggests that this location tracking is part of a cow monitoring system, utilizing a Node MCU board equipped with an inbuilt GPS module. The Node MCU is a popular IoT development board based on the ESP8266 Wi-Fi module, often used for various IoT projects due to its ease of use and Wi-Fi connectivity. The use of such technology can be beneficial for farmers or researchers to monitor the movement and location of cattle in real-time, enhancing the management of grazing areas, monitoring health, and potentially reducing the risk of cattle getting lost. The image in Figure 6 shows a visual displaying a cow monitoring system using an ESP32 camera attached to the cow's neck. The camera is capturing the cow's surroundings, and the feed is being displayed on the laptop screen. This model suggests that the system is being used to monitor the cow's behaviour, movement, or environment, possibly for agricultural or research purposes. The use of an ESP32 camera, which is a relatively low-cost and compact device, makes it a feasible solution for attaching to a cow's neck.

Some potential applications of this technology include:

- Monitoring cow behaviour: The camera can provide insights into the cow's daily activities, such as feeding patterns, social interactions, and resting habits.
- Tracking cow movement: The camera can help track the cow's movement and location, which can be useful for monitoring grazing patterns or detecting any potential health issues.
- Environmental monitoring: The camera can capture images of the cow's surroundings, providing information about the environment and any potential factors that may be affecting the cow's health or behaviour.

Overall, the image suggests that the ESP32 camera is being used to develop a low-cost and effective cow monitoring system, which can provide valuable insights for farmers, researchers, or animal welfare organizations.

SMS and Email Notifications

One of the key features of this system is the automatic alert mechanism through SMS and email notifications. Whenever a critical sensor threshold is reached, the system immediately sends alerts to predefined recipients. The SMS notifications include precise details such as the detected parameter (e.g., smoke or fire), the exact value (e.g., "Smoke was 718.00"), and the timestamp of detection. These text messages confirm prompt threat communication. Similarly, email alerts are generated with subject lines like "Smoke Alert!" and

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provide detailed sensor readings, ensuring that recipients are informed of any hazardous changes in the environment. These notification systems utilize platforms such as UBIDOTS to ensure seamless, real-time communication, enhancing the project's effectiveness in threat prevention and rapid response.

Figure 7: Animal health monitoring system model

Figure 8: Real-time implementation in farm

The IoT-based advanced monitoring system for animal health has numerous benefits, including early disease detection, improved animal welfare, increased efficiency, remote monitoring, and data-driven decision-making. The system provides real-time monitoring of vital signs, activity levels, and environmental conditions, ensuring that animals are kept in optimal health and welfare conditions. It automates data collection and analysis, reducing the need for manual monitoring and increasing the efficiency of animal care. The system allows animal owners and veterinarians to monitor animal health remotely, reducing the need for in- person check-ups and visits. The use of Node MCU and temperature sensors provide a reliable and cost-effective solution for real-time monitoring of animal health. Overall, the IoT-based advanced monitoring system has the potential to improve animal welfare, reduce costs, and enhance the overall efficiency of animal care. As technology continues to advance, there is immense potential for further development and refinement of the system to better meet the needs of animals and their caregivers. Figure 7 shown the circuit design of Animal Health Monitoring System and Figure 2 Display the results in UBIDOTS Display. The system has the potential to revolutionize the way we monitor and care for animal health, improving animal welfare, reducing costs, and enhancing the overall efficiency of animal care.

VI. Applications and Advantages

A. Applications

- Livestock Health Monitoring: The system can be used to track vital parameters like body temperature, heartbeat, and vaccination schedules, ensuring timely detection and management of health issues.
- Environmental Monitoring: It maintains optimal environmental conditions (temperature, humidity, and air quality) in barns and sheds, preventing diseases caused by adverse environmental factors.
- Water Resource Management: Automated water level detection and control systems ensure continuous water availability, minimizing wastage and improving resource utilization.
- Real-time Location Tracking: The GSM-based live location tracking is particularly useful for monitoring free-ranging animals or large herds, preventing loss or theft.

B. Advantages

- Real-time Monitoring: The system provides continuous, real-time monitoring of livestock health metrics, such as temperature, heartbeat, and location, enabling early detection of diseases and abnormalities.
- Automated Resource Management: The inclusion of water level detectors and environmental sensors ensures optimal resource utilization, reducing waste and improving cost-efficiency.
- Improved Animal Welfare: By maintaining stable environmental conditions and tracking vital health parameters, the system promotes better animal welfare, reducing stress and enhancing productivity.
- User-friendly Interface: The centralized monitoring platform offers easy access to data through mobile or web applications.

VII. Conclusion

In conclusion, the proposed intelligent livestock monitoring system provides a comprehensive, cost-effective, and scalable solution to address the

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challenges faced in traditional livestock management. By leveraging advanced technologies such as Wireless Sensor Networks (WSNs) and the Internet of Things (IoT), the system ensures real-time monitoring, resource optimization, and early detection of health issues. The integration of environmental, health, and resource data empowers farmers to make informed decisions, enhancing animal welfare, improving productivity, and reducing operational costs. The system's ability to automate routine tasks and provide real-time alerts contributes to minimizing livestock mortality and resource wastage, making it particularly beneficial for small and medium-scale farmers in both developed and developing regions.

Looking ahead, the future scope of this system includes integrating machine learning (ML) and artificial intelligence (AI) for predictive analytics. This will enable the system to anticipate disease outbreaks, identify behavioural anomalies, and provide actionable insights for preventive healthcare. By expanding the system to include advanced robotics for automated feeding, cleaning, and other farm operations will further reduce manual labour and increase efficiency. The incorporation of blockchain technology for data transparency and traceability can also enhance trust and accountability in the livestock supply chain.

Future systems can utilize cloud platforms for real-time data storage, analysis, and access from anywhere, facilitating multi-location farm management and remote veterinary consultation. Development of more advanced, miniaturized, and energy-efficient sensors will improve accuracy, battery life, and comfort for the animals.

REFERENCES

[1] Li et al. (2018) demonstrated a system that integrates “WSNs with IoT to monitor livestock temperature and environmental factors” such as humidity and air quality, for disease prevention.

[2] Kumar et al. (2020) proposed a “wearable IoT-enabled device” for cattle that tracks physiological parameters, including heart rate and body temperature. Their findings underscore the potential of such systems to improve animal welfare and productivity by enabling timely interventions.

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[4] Ahmed et al. (2021), provide robust platforms for integrating sensors and enabling real-time data transmission to cloud-based storage, ensuring seamless monitoring and analysis. Environmental monitoring is crucial for maintaining optimal livestock health.

[5] Zhang et al. (2017) emphasized the correlation between environmental factors, such as CO2 levels, humidity, and temperature, and the prevalence of respiratory and metabolic diseases in dairy cattle. Their work demonstrated the effectiveness of automated systems in regulating barn environments, thereby reducing disease incidence.

[6] Patel and Singh (2020), have proven efficient in integrating water management systems, automatically refilling water troughs when levels drop below a threshold. Such innovations ensure animal welfare while minimizing water wastage.

[7] Wang et al. (2019) have developed geofencing applications that alert farmers when animals stray beyond predefined boundaries. These systems, combined with health monitoring features, offer comprehensive solutions for managing large herds.

[8] Chen et al. (2020), enables predictive analytics for detecting early signs of diseases, further reducing veterinary costs and improving overall productivity.

[9] Park et al. (2021), offer promising alternatives by enabling low-power, long-range communication and localized data processing.