Review on IoT-Based Cattle Health Monitoring System Real-Time Detection and Alerting for Improved Farm Management

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Abstract: Automation and state-of-the-art technologies are significantly improving the productivity of farms. One of the major areas of research in farm automation is the development of systems to monitor the health of cattle. Wireless: Mobile and server networks are seamless enabling the monitoring system everywhere. The proposed monitoring system consists of the following components: infrastructure, hardware, software, and physiological instruments. Answer: Improving farm productivity largely has to do with keeping cattle healthy, especially in large dairy farms, where regular health monitoring is much more difficult. This study has very much significance for the dairy owners and local administration as well. The health monitoring system mainly aims to track the health of individual cattle over time for early diagnosis and timely treatment of diseases. Using sensor technology to measure temperature, heart rate and other important behavioral indicators, the system takes your training through a series of sessions that optimize your performance. This information is collected and sent to one central health care facility that reduces the need for constant health inspections, saving money on long-term health care for animals. Smartphone implements also allow for real-time monitoring of cattle vitals.

1 INTRODUCTION

Automation and technology are revolutionizing farm productivity, increasingly via integration of high-tech cattle wellbeing monitoring systems. Routine health monitoring is a challenge particularly in large dairy operations, which can be greatly facilitated by the integration of mobile and wireless sensor networks. This paper proposes a monitoring system that combined with various components such as Internet infrastructure, internet of things (IoT) hardware and software as well as physiological instruments measuring cattle health to enhance farm productivity. However, the main goal is to realize long-term health monitoring of individual animals, which allows for timely sick diagnosis and treatment. The system monitors key behavioral indicators like temperature and heart rate using advanced sensor technology. This data can be accessed at any time, enabling healthcare personnel to monitor patients in real time at a central health care center, thus decreasing the number of manual inspections performed over time and reducing long- term health care costs. To best serve cattle well-being, dairy owners, and local authorities, the system can provide timely health information that can both optimize practices and improve animal health across the board. These innovations will help augment farm automation to improve productivity while delivering better animal care as needed.

2 EXISTING SYSTEM

Existing work in cattle monitoring system deals with predicting the pre-disease of the cattle. In other cases, the projects only deal with milking the cattle and automated dairy farming. Farmers manually check cattle for visible signs of illness or distress, which is time consuming and may miss subtle symptoms. Health data such as temperature and feeding patterns are recorded manually, leading to potential inaccuracies and delayed responses to health issues.

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Visual Inspections: Farmers manually check cattle for visible signs of illness or distress, which is time-consuming and may miss subtle symptoms. Manual Record Keeping: Health data such as temperature and feeding patterns are recorded manually, leading to potential inaccuracies and delayed responses to health issues.

3 PROPOSED SYSTEM

Maintaining optimal health, particularly in dairy farms, the system ensures better milk production, improving farm yields. The automated system reduces the need for manual health checks, cutting labour costs, minimizing disruptions. Health data collected over time provides valuable insights that can b e analysed to optimize farm management practices, improve animal welfare. The system is designed to handle large herds, ensuring efficient management and providing individual attention to each animal as farms grow. Relying on sensor data instead of subjective observations, the system ensures more accurate, consistent, and reliable monitoring of animal health. The figure 1 shows proposed system block diagram.

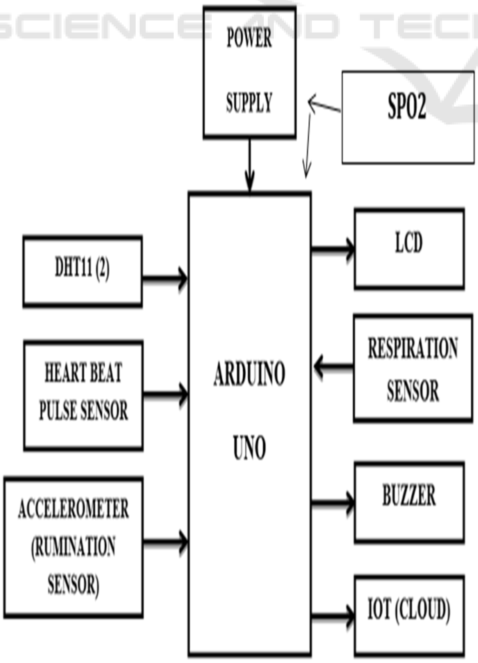

Figure 1: Proposed system block diagram.

4 PROJECT IMPLEMENTATIONS

Advancements in automation and technology are revolutionizing farm productivity, particularly through the development of sophisticated cattle health monitoring systems. In large dairy operations, routine health monitoring can be challenging, making the integration of mobile and wireless sensor networks highly beneficial.

Figure 2: Project implementation.

This proposed monitoring system combines infrastructure, hardware, software, and physiological instruments to enhance farm productivity by focusing on the health of cattle. The core objective is to provide continuous health tracking for individual animals, enabling early diagnosis and swift treatment of illnesses. The figure 2 shows Project implementation. By utilizing advanced sensor technology, the system monitors critical behavioural indicators such as temperature and heart rate. This real-time data is transmitted to a central healthcare facility, reducing the need for frequent manual inspections and thereby lowering long- term healthcare costs. The system's ability to provide timely health information not only supports the well-being of the cattle but also benefits dairy owners and regional authorities by optimizing management practices and improving overall animal health. Through these innovations, farm automation is poised to enhance productivity while ensuring more efficient and effective animal care.

4.1 Internet of Things

The Internet of Things (IoT) is a network of interconnected physical devices embedded with sensors, software, and other technologies that enable them to collect, process, and exchange data over the internet. This technology seamlessly bridges the physical and digital worlds, revolutionizing various aspects of daily life and industries. IoT devices range from household gadgets like smart thermostats and fitness trackers to sophisticated industrial equipment and urban infrastructure. The primary goal of IoT is to enhance efficiency, enable automation, and provide data-driven insights for better decision-making. The IoT ecosystem operates through a cycle of sensing, communication, data processing, and action. Sensors in devices capture data such as temperature, motion, or location. This data is transmitted through communication protocols like Wi- Fi, Bluetooth, or cellular networks to centralized or edge- based platforms for processing. Users interact with the system through mobile applications or dashboards, enabling informed decisions and intelligent automation.

4.2 Cloud Computing

Cloud computing is a technology that allows individuals and organizations to access computing resources such as servers, storage, databases, software, and networking over the inter- net, rather than relying on local infrastructure. By utilizing cloud services, users can store and process data remotely and access applications without needing to install or maintain them on local devices. This approach offers significant benefits, including cost efficiency, scalability, flexibility, and accessibility. Instead of investing in expensive physical hardware, businesses can leverage cloud providers' resources on a pay-as-you-go basis, scaling up or down as needed to match demand. The three primary models of cloud computing are Infrastructure as a Service (IaaS), where users rent virtualized computing resources; Platform as a Service (PaaS), which provides a platform for developing and deploying applications without managing underlying infrastructure; and Software as a Service (SaaS), where users access fully managed applications through the web, such as email services or CRM systems. Cloud computing also supports hybrid and multi-cloud strategies, allowing organizations to mix public and private clouds to meet specific security, performance, and compliance needs.

5 HARDWARE IMPLEMENTATIONS

5.1 Arduino Uno

Figure 3: Arduino Uno.

The Arduino Uno is a widely used microcontroller board based on the ATmega328P chip, making it one of the most popular development platforms for beginners and professionals in embedded systems. It features 14 digital input/output (I/O) pins, out of which 6 can be used as PWM outputs, allowing for fine control over components like LEDs and motors. Additionally, it includes 6 analog input pins, enabling the board to read sensor data, potentiometers, and other analog signals. Operating at a clock speed of 16 MHz, the board ensures smooth execution of programs and accurate timing for various tasks. The presence of a USB connection allows users to upload code, communicate with a computer, and power the board, making it convenient for both programming and serial communication. The power jack supports external power sources, such as an AC-to-DC adapter or a battery, which is particularly useful for standalone applications that do not rely on a computer for power. The figure 3 shows Arduino Uno.

5.2 DHT11 Sensor

DHT11 Temperature and Humidity Sensor: The DHT11 (Digital Humidity & Temperature sensor) is a very low cost and commonly used digital sensor that measures temperature and humidity in its surrounding area. It functions within a temperature scale of 0◦C to 50◦C with an accuracy of 2◦C, and a humidity scale of 20% to 80% with an accuracy of ±5%.

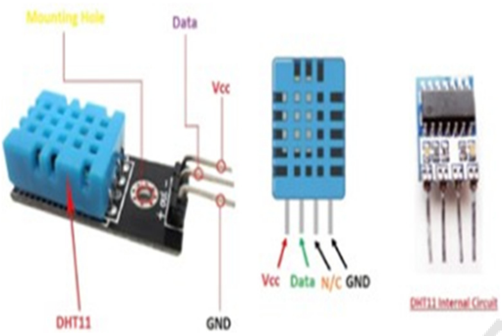

Figure 4: DHT11.

Using a digital output over a one-wire interface, the sensor makes it a very easy pulg-and-play functionality with any microcontrollers and IoT systems. The figure 4 shows DHT11.

5.3 LCD Display

LCD means Liquid Crystal Display; LCD screen is an electronic display module and find a wide range of applications. The 16x2 (16 columns and 2 rows) LCD display is one of the very basic modules and is widely used in many devices and circuits. These modules are more preferred than the seven segments and other complimentary multi segment LEDs. And the reason is that LCDs are cheap, are easily programmable, have no restriction of showing special & even user defined characters (as opposed to seven segments), animations, etc. So, a 16x2 LCD refers to 16 characters per line and 2 such lines. The figure 5 shows LCD Display.

Figure 5: LCD Display.

5.4 Heartbeat Sensor

Heartbeat is detected using high intensity type LED and LDR. The finger is placed in between LED and LDR A photo diode or a photo transistor can be used as sensors. Detection using transmitted or reflected light can illuminate skin with visible (red).

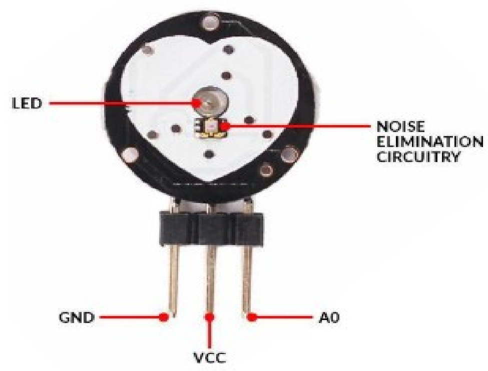

Figure 6: Heartbeat sensor.

The minuscule difference in reflectivity and in transmittance resulting from the changing blood content of human tissue is nearly imperceptible. Some noise sources can generate disturbance signals whose amplitude is equal to or greater than the amplitude of the pulse signal. The figure 6 shows Heartbeat sensor.

5.5 ESP-12E Based NodeMCU

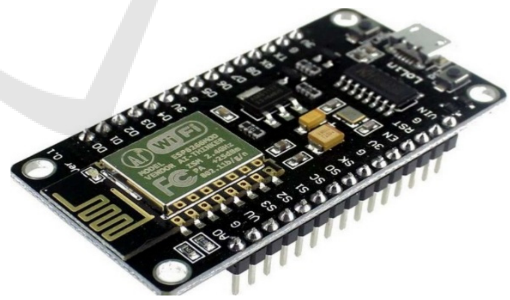

Figure 7: NodeMCU.

Ai-thinker Team Develop ESP-12E Wi-Fi MODULE. module encapsulated with smaller ESP8266 core processor ESP8266 is an industry-leading ultra-low power 32 ADDC, integrated MAC/BB/RF/PA/LNA and built-in antenna. IEEE802 standard is supported by the module. When it comes to Wireless Connectivity: 802.11 b/g/n compliant, and full TCP/IP Protocol Stack. The add mod- ules can be integrated into an existing device network- ing, or implement a separate network controller. ESP8266 is a high integration wireless SOCs, designed for the space and power constrained mobile platform designers. It has the best ability to integrate Wi-Fi ability into other systems, or to act as a stand-alone application, at the lowest cost, and requiring the least amount of area. The figure 7 shows NodeMCU.

6 RESULT

Real-time monitoring of health information aids in the early detection of nasty diseases, enabling timely action to prevent disease outbreaks, decrease health concerns, and enhance cattle well-being and retention [165]. Healthy cows are more productive, especially in dairy farms, where milk production is directly related to their health. Automated monitoring systems keep the animals in optimum health and promote yield and profit with minimal manual 'health checks' required leading to a reduction in labour costs and a minimisation of disruptions. Timely diagnosis reduces treatment costs and minimizes losses from untreated diseases. This not only ensures animal welfare, but also allows farmers to provide timely care by constantly tracking their vital signs, temperature and heart rate. One further use case is the collection of important health data that can be studied over time to better inform farm management. The larger the farms scale up, the more robotic systems become important for smart herd management and providing individual attention to cows. The reliance on objective sensor data rather than subjective observation minimizes human gaps and results in more accurate, consistent monitoring. Pathogen Management for Modern Dairy Farming: Improving Efficiency and Prosperity in the Industry This technology is vital to contemporary dairy farming.

7 FUTURE SCOPE

There are multiple improvements in the cattle health monitoring system, that can help in the system to pursue its goals effectively. Utilising sophisticated machine learning models and AI might allow the system to identify potential health patient issues, prior to their critical stage by studying historical comparative datatics. The integration with other sensors, including those for measuring blood glu- cose concentration or rumination frequency, could provide a more holistic health profile for cattle. Upgrading with advanced analytics and data visualization tools on the IoT cloud infrastructure would enable a more in-depth analysis and decision making process from detailed insights. Wireless communica- tion technologies, such as LoRa WAN or 5G, might also be implemented to enhance the range and reliability of data transmission, particularly across remote or large farm areas. Using GPS-enabled wearable devices or smart collars could also help with monitoring by providing geo-tagged health data and tracking cattle movement. Furthermore, creating automated feedback loops, where environmental controls automatically kick in based on sensor readings, can help ensure that the cattle remain in ideal conditions. Integrating and customizing health protocols using sensor data, in collaboration with veterinary professionals, can be better to treat patients. Such developments would not just further enhance accuracy and efficiency of health monitoring, but also promote animal welfare and farm productivity, leading to smarter and more responsive practices in the agriculture sector.

8 CONCLUSIONS

Overall, the cattle health monitoring system incorporating an Arduino Uno and IoT connectivity has the potential to revolutionize farm management, especially in large-scale dairy farms. Combine the capabilities of DHT11, pulse sensor, and accelerometer, the system enables continuous tracking of vital health indicators like body temperature, heart rate, and rumination. Collecting this data over time helps with identifying aggregated results for any possible health issues, thus allowing for a quick response without frequent physical checks.

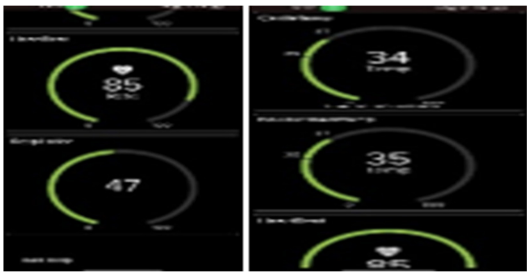

Figure 8: Output.

This gives the alerts to the farmer in the form of a notification as well as in the form of a buzzer, which helps him act fast enough to any abnormal situation. By taking preventative actions, not only are the cattle healthier but the farm is profitable with lower long-term health costs. The project facilitates more effective management practices by automating and streamlining the health monitoring process, which leads to better animal care resulting in enhanced operational efficiency in dairy farming. The figure 8 shows Output.

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