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Smart Collar for Cattle Tracking and Health Monitoring Using IoT on ESP32

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Abstract: In Indonesia, there is still no real-time system for monitoring the health of cattle. Instead, a microchip RFID ear tag is used, which is implanted in the cow, but there is still no connection to the Internet of Things to help cattle producers with monitoring. The existing monitoring still relies on human labour, which is undoubtedly inefficient, particularly if you have to keep track on the health of many cows on a big farm. Cattle's movement, heart rate, and body temperature may all be read via a collar gadget. By gathering information from temperature sensors, heart rate sensors, and an inertial measurement unit installed on a dairy cow's neck, information is sent via the internet. To provide normal, less normal, and abnormal health categorization outputs, the gathered data is saved and categorised using machine learning. Also, depending on the axis sensor, generate a graphic output.
Keywords: Smart Collar, IoT, Health Monitoring, Cattle, Communication, Machine Learning, Signal processing.

I. INTRODUCTION

The Internet of Things (IoT) is being used to agriculture and the farm in Thailand as a research and implementation stage. The Internet of Things (IoT) technology may be used to create a device for tracking and managing agricultural output, lowering issues, and ultimately improving the goods' quality. The primary goal of this project is to examine and put into practise the cow collar for monitoring cow activities. This phase involves hardware implementation, and the next phase uses an advanced algorithm to forecast cow behaviour and health in the future. A big volume of milk is produced by a cow with excellent behaviour, and it also helps to keep the cow healthy. The health of the cow and the significance of the care method determine the quality of milk products.

The cow's disease may be predicted by detection behaviour before it worsens. For instance, a cow will often move its tail and scrape its body against a tree when it is connected to its neurological or digestive systems. Cow moving slowly deviates from the typical condition associated with having a fever. In this study, we concentrate on detecting cow neck motions, including walking, running, sleeping, standing, and sobbing. As part of the study design process, we visited a large farm in Saraburi Providence to gather user requirements, evaluate the actual environment, and learn about the demands of the system from the farmer and rancher. Modern microcontroller technology has extremely compact integrated circuit I/O ports, analogue inputs, and built-in huge memory sufficient for creating data collectors. The ESP8266, Arduino, or Node-MCU families were chosen for the cow collar. It is simple to include wifi functionality in the cow collar using ESP8266's built-in Wi-Fi. These days, a smartphone may function as a Wi-Fi hotspot for 8 to 12 connected devices, which is plenty for a small farm.

Knowing the cow's health is the major goal of collar belt design so that the farmers can readily determine the quality of the cow's milk output as well as its health.

- Small farmers produce about 80% of the dairy consumed in developing nations. The employment of technology on this platform is still necessary even if these kinds of small farmers and family farmers are remote from technology and engage in traditional farming.
- Dairy producers face several challenges in the current commercial environment, including herd management, fixed production capacity, and costly farm labour.

In both animal husbandry and animal breeding, keeping track of cow behaviour has been a constant concern. In the past, a variety of techniques have been used to keep tabs on the behaviour and grazing habits of cattle. We put out a strategy for exploiting multimedia networks to track livestock in real time. Cattle grazing patterns and behaviour in the grazing field are observed for the research. Using a networked system, a global positioning system monitoring collar for cattle tracks each animal's movements while it is grazing in order to make the aforementioned observation.

II. RECENT WORKS

Before cows were visibly lame, Henry Williams et al. found that their milk production dropped by an average of 0.7 kg/d for around seven weeks. Moreover, for four weeks following recuperation, the milk production of lame cows remained decreased. To reduce welfare effects and productivity loss, it is crucial to detect production illness as soon as feasible **[2]**.

Williams et al. have previously evaluated a system that uses pressure plates to monitor weight distribution in order to diagnose lame cows. While they came to the conclusion that these devices required additional work to improve their sensitivity, they believe that since weight shifting by the cow may be evident via gait analysis, these instruments will likely be useful in lowering the personnel costs associated with mobility scoring. It could be more fruitful to use behavioural changes to identify subclinical illness before gait impairments manifest **[3]**.

According to Anderson et al., tracking beef cows required a one-second time interval, and thresholds of mean movement rates derived over one-minute intervals were used to differentiate between grazing, resting, and walking. For behavioural categorization to be accurate, a number of characteristics need to be taken into account. The element that gauges how precise a tracking device is at a distance is the first deciding factor. According to, the role that behavioural diversity across breeds of the same species, as well as between other animal species, might have in the development of unique behavioural states. The third consideration is the potential impact of GPS field measurement time intervals on categorization accuracy **[4]**. Whereas state-space models clearly represent data in the time and spatial order in which they have been captured, machine learning approaches, while being flexible and simple to use, neglect the temporal and geographical process that underpins the data. Nonetheless, it was possible to include more causes of mistake. Nonetheless, implementation requires more work and greater processing power. The purpose of the project, as stated before, is to use multimedia networks to monitor cattle in real-time **[6]**.

Agents are variables that help create a detrimental impact on cow behaviour. The physical agent is the primary focus of this investigation, with the chemical agent coming in second. The temperature is the most frequent physical factor that has an impact on cattle. For instance, any significant variation in temperature would have a negative impact on cow behaviour **[7]**. The fundamental concept of SDF was first proposed by researchers about 20 years ago, and now, smart dairy farms are commercially available. Researches and contributions by various researchers vary. In order to enable data analysis in SDF, much ontology has been merged. The authors have chosen and put into practise a sensor-enabled, smart dairy farming project. Cows' much behaviour has been observed. According to the findings, feed efficiency ontology is the feeding method that eventually results in improved milk production. Smart Herd management, which analyses animal behaviour and keeps track of animal health, has proved successful in boosting milk output. Micro service-oriented design has been introduced in this study to support distributed computing **[8]**.

This study also tackles certain obstacles to IoT-based dairy farming implementation, such as the lack of Internet access in most farms' distant locations. The authors have suggested a fog-based architecture to solve this problem, which lowers transaction costs by 84%. The main difficulty facing dairy producers is animal health and welfare. The coupling and integration of newly developed sensor-based technology with the activity-based system is highlighted in the review. Farmers may observe cow behaviour and the breeding process with the help of this cutting-edge technology **[9]**.

To increase milk production, industry and academics are working to enhance dairy animal health. For the purpose of boosting cow reproduction, many cutting-edge technologies have also been incorporated in this investigation. With the use of sensor equipment, the authors of the study outlined many crucial areas for managing fertility. This paper outlines the present and foreseeable factors for improved reproduction. The authors add that it is still important to take genetic selection into account when managing reproduction and breeding procedures (early detection of pregnancy). Dairy farming and smart agriculture are ideal IoT applications **[10]**.

An IoT-based semantic model for agricultural applications was suggested by the authors. The most challenging duty in fertility control, according to the authors, is heat measurement. A tool for improved fertility control has been suggested. A tool that may help to control fertility and reproduction techniques is +e automated heat detection. To fulfil the rising market demand, researchers' main goal is to maximise productivity rather than expand herd size. The authors used a real-time big data warehouse on dairy farms for their study **[11]**. By taking into account the aforementioned technical publications, we discovered that cows are sociable animals **[3]** and that their impaired alertness is caused by being isolated from their herd.

The eye can view roughly 310 degrees in the direction of their pals, which is why cow behaviour is interested by nature. When the cow wakes up and is startled, it could behave badly and hurt people. Like to humans, cows experience pain, but they display their suffering in a few different ways. The food chain's role in the development of the cow and its ability to reveal another animal's suffering and ailment. One cow's many daily activities suggested poor health. Activities include actions like walking, sleeping, making sounds, and swaying while standing still. The walking face conveys the stomach ache. Sleeping and making a few movements may induce leg discomfort, which is why you need to sleep if you're becoming ill. Medium to high pain and sickness are seen in the till sway and sound expressiveness. Veterinary professionals and herdsmen must conduct observation in order to diagnose behaviour that differs from that in a normal state.

III. METHODOLOGY

Various sensors such as Accelerometer, Temperature sensor, Heart Rate sensor is interfaced with Esp32. Henceforth, providing a stable connection with Wi-Fi and helps in constantly uploading the data to the cloud.

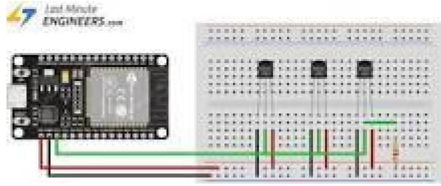

Fig.1. Circuit diagram of the Temperature sensor interfaced with Esp32.

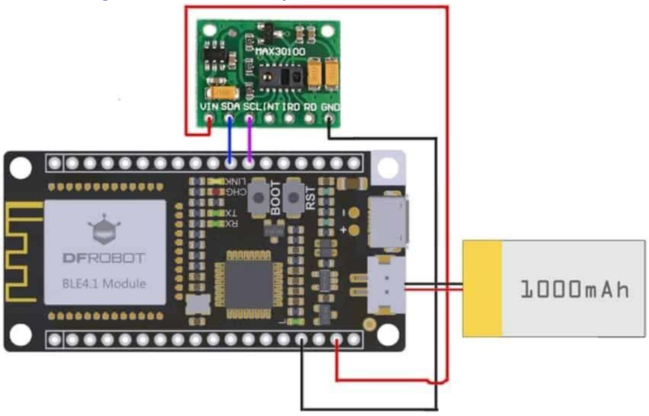

Fig.2. Circuit diagram of the Heart Rate sensor interfaced with Esp32.

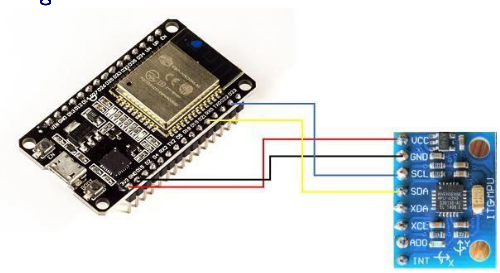

Fig.3. Circuit diagram of the Accelerometer interfaced with Esp32.

Several protocols, including SPI and I2C, have been utilised to connect the sensor, as can be seen in Fig. 1, 2, and 3. By doing this, we are able to effectively interface with the sensors and collect data to be processed later.

IV. RESULTS AND DISCUSSIONS

Fig. 4 shows the hardware integrated model for the suggested system. It is made up of all the aforementioned sensors connected together and enclosed in a watertight shell for durability and defense against diverse environmental conditions.

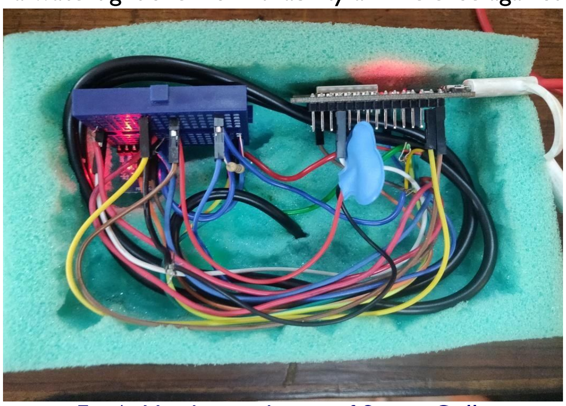

Fig.4. Hardware design of Smart Collar

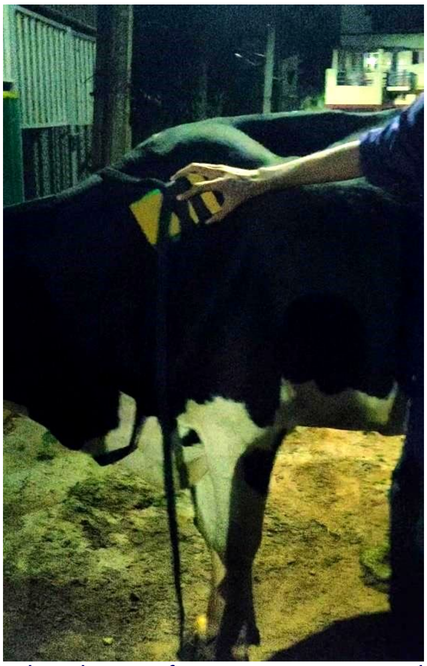

Fig.5. Smart Collar tied to the cow for monitoring various health parameters.

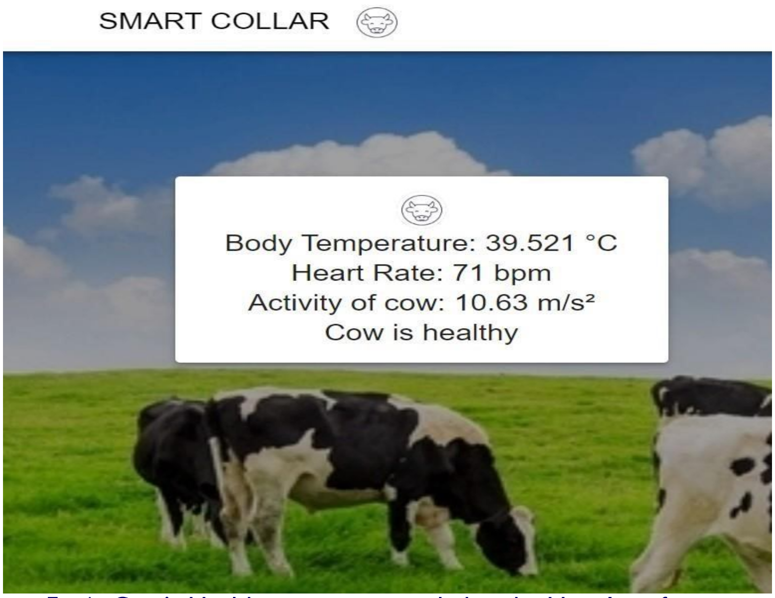

Fig.6. Cow's Health parameters availed at the User Interface

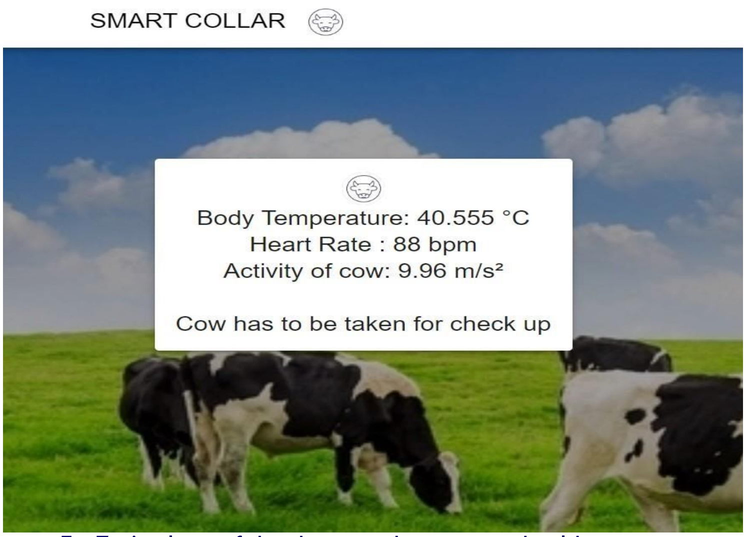

Fig.7. Analysis of the data, predicting an unhealthy cow.

The smart collar's design for monitoring the health of cows is shown in Fig. 4 and Fig. 5 shows the cow's stylish collar being fastened to its neck. The ESP32 WiFi module receives the data from the temperature sensor, accelerometer, and heart rate sensor first. Through the internet, the real-time database, firebase, stores the data that the ESP32 has received. The website then makes this data available for study so that users may decide if the cow is healthy or not. The same data is also sent to the Ada fruit IO platform, where it is used to analyze the average temperature and accelerometer readings over time using a graph. So, using the internet, producers may quickly ascertain if the cow is healthy or not. The results from a healthy cow with a normal heart rate and all of its normal temperature are shown in Fig. 6. Moreover, Fig. 7 depicts a picture of a sick cow that should be exhibited during the examination.

V. CONCLUSIONS

Dairy farming is a lucrative industry in today's globe that may be promoted to enhance a nation's economic standing. The emphasis of this study is on various automated processes including milking and feeding. These two methods are the most important and effective ones that might shape the future of a modern dairy farm. More efficient feeding and drinking practices may improve cow nutrition, which may eventually result in higher milk output. A framework that might assist a farmer in boosting milk output has also been suggested. The system that is being offered is an overall architecture for better implementing the most recent methods for enhancing feeding and milking processes. IoT-based farming may be more effective with a system that has a comprehensive architecture, superior technological adaption, and adaptable design. While it could initially demand a lot of investment, later on, the better technical infrastructure might create a balance between the amount spent and the amount generated.

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