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Review Article

A Review on Wearable Devices for Animal Health Monitoring

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Abstract: Internet of Things has changed everyone's life. It often changes the way people interact with their environment and objects. IoT devices use wearable devices that are used to monitor the activities of animals. The Internet of Things for Animal Health (IoTAH) uses biosensors and software to monitor and manage animal health information. This work concerns the development of a mobile application coupled with a hardware device (called CAHM) attached to an animal's collar. Companion Animal Health Monitoring App. Equipped with a smart collar, the system feature's location tracking, heart rate, body temperature measurement, disease detection and isolation, detection of reproductive cycles, as well as monitoring physiological wellbeing of the animal. With further advancements in technology, data analysis algorithms and IoT systems, using these technologies we can improve our understanding of animal health, improve prevention and support healthy, happy animals.

Keywords: Internet of Things (IoT), Wearable devices, IoTAH (Internet of Things for Animal Health), Biosensors, Companion Animal Health Monitoring (CAHM), Smart Collar.

1. INTRODUCTION

Artificial intelligence is one example of a current agricultural technology that is gaining recognition in the animal welfare sector. Their presence enables farmers and scientists to monitor cattle behavior and health. Although some technologies and tools are currently only suitable for humans, the technology and biosensor have great potential in the livestock industry. Wearable biosensors are being used as monitoring devices for animal health management and monitoring. That's why Precision animal technologies are designed to help farmers manage animal productivity and health. Furthermore, these sensors and devices are used to monitor the health and activities of livestock, particularly cattle, without causing any harm. The types of wearable devices include e-tags, cow collars and electronic earrings. These wearable gadgets are linked to individual livestock and frequently include data processing systems that can detect diseases early, averting epidemic breakouts among animals. However, various factors influence the accuracy of the results obtained from the animal, as each type of sensor has unique needs for enhancing its usefulness. Because this is true for almost all wearable technology, a need to classify them arises [1].

Wireless systems involve the use of the Internet of Things (IoT), a revolutionary purpose driven data architecture that enables businesses and organizations to provide flexible and secure exchange of "goods." The IoT is a phenomenon that uses the Internet as a communication tool to connect everyday devices such as phones, computers and other devices. IoT facilitates the development of applications that use devices by providing smart solutions for applications and middle systems using the architectural process for devices (Ramao Tiago Tiburski, 2015). Wireless sensors, also known as wireless sensor nodes or sensor nodes, have a huge impact on people's daily lives. RFID and WSN are two complementary technologies; Therefore, the combination of these technologies increases their complete operation to obtain the position of faraway individuals [3].

1.1 IoT in Wearable Devices

IoT-enabled vacuum sensor technology is an emerging area in healthcare. As the healthcare business grows, we require door-to-door diagnosis, simple monitoring, and data management. The ultimate goal is to incorporate IoT technology into emergency rooms, connected buildings, smart hospitals, electronic medical records, and other applications. The data we collect from

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smart gadgets and smart hospitals allows us to monitor patients' symptoms in real-time. This can help us develop breakthroughs in treatments, pharmaceuticals, medicines, and vaccinations. The main purpose is to transfer information to cloud computing, cloud computing, etc. To ensure that it is safe and accessible to appropriate employees. For information transfer to be fast and uninterrupted, different wireless technologies and communication protocols must be taken into account. This information can also be used for analysis using statistical data. WSN is a network of sensors connected wirelessly using different communication methods. This review compares a brief overview of deep learning algorithms and WSNs used to identify and develop IoT in healthcare. An EHR is a digitized record of a patient's medical information. Figure 1 depicts smart hospitals, human body sensors, ingestible sensors, electronic health records, emergency services, remote monitoring, and so on. It consists of components that can be linked to the cloud platform via various communication methods. Wearable sensors and other healthcare demands require the creation and management of wireless sensor networks. Combining all of these components allows us to develop smart therapy [4].

2. LITERATURE SURVEY

The table of distinguishing factors for each study emphasizes the importance of the data and findings in cattle health monitoring. Essentially, this is an assessment of what has already been done and how these studies may influence the future development of intelligent wearable devices and biosensors. A classification was created to categorize cutting-edge wearable devices based on sensor type, health parameter, and body type data collection and attachment [1].

There are some drawbacks to using IoT technology in animal health monitoring, such as concerns over the privacy and security of the collected data. Additionally, the cost of implementing an IoT-based system can be a significant barrier for some farmers or animal owners. Overall, the application of IoT technology in animal health monitoring has the potential to transform how we care for and manage animals. With the ability to gather and analyze real-time data on animal health indicators, we can better understand and handle health issues in animals, resulting in greater animal welfare and more efficient management techniques [3].

Dairy cows are often identifiable by their visible ear tags. Because of the cost, tags with embedded RFID devices have been available for electronic scanning; however, most tags employ low-frequency (LF) RFID, which requires the scanner to be within a few inches of the tag. The researcher created and built a wireless network prototype using long-range ultra-high frequency (UHF) RFID tags as well as low-cost wireless and computational components. The wireless network provides scalable data collection without costly infrastructure, while the long-range RFID enables unmanned scanning of numerous tags [6].

IoT-enabled wearables are intelligent devices that can be worn as external accessories, incorporated in clothing and textiles, implanted in the body, or even bonded to or tattooed onto the skin. These gadgets can connect to the Internet and collect, send, and receive data that can be utilized to make informed decisions. These wearables are becoming an increasingly significant component of IoT technology, with their development progressing from simple accessories to more specialized and useful uses. Smart wearables can communicate with a variety of other devices, including smartphones, for computing and communication [7].

3. WORKING PROCESS

Wearable devices for animal health monitoring using IoT (Internet of Things) typically follow a similar working process. Here's an overview of the steps involved:

1) Sensor Integration: The wearable device is equipped with various sensors capable of monitoring different parameters relevant to animal health. These sensors may include accelerometers, heart rate monitors, temperature sensors, GPS, and so on. The sensors are carefully incorporated into the wearable gadget to enable precise data collecting.

2) Data Collection: The sensors in the wearable device continuously collect data from the animal's body. For example, the accelerometer measures the animal's movement patterns, the heart rate monitor measures the heart rate, and the temperature sensor measures body temperature. The collected data is then processed by the device for further analysis [3].

Figure 1: Working process

3) Data Processing and Analysis: The collected data is processed and analyzed within the wearable device or transmitted to a connected gateway device for processing. Advanced algorithms and machine learning techniques may be employed to extract valuable insights from the raw data. The analysis may involve identifying patterns, anomalies, or deviations from normal behavior to assess the animal's health condition.

4) Wireless Communication: Once the data is processed, the wearable device communicates wirelessly with a connected network or a gateway device. This communication can be achieved using technologies such as Bluetooth, Wi-Fi, or cellular networks. The device transmits the collected and processed data to a centralized server or cloud platform for storage and further analysis.

5) Cloud Storage and Analysis: The data received from multiple wearable devices is stored in a cloud-based platform. This allows for long-term data storage, easy accessibility, and scalability. The cloud platform may also provide additional computational power for advanced analytics, combining data from multiple animals, and generating actionable insights [4].

6) Real-time Monitoring and Alerts: The cloud platform or a dedicated application enables real-time monitoring of the animal's health parameters. If any abnormalities or critical health conditions are detected based on the analyzed data, the system can trigger alerts and notifications to the animal owners or veterinarians, allowing for timely intervention.

7) Data Visualization and Reporting: The collected data can be visualized through user-friendly interfaces, such as web dashboards or mobile applications. These interfaces provide animal owners, veterinarians, or researchers with a clear overview of the animal's health trends, historical data, and specific health parameters. Reports and summaries may also be generated to track progress or share information with relevant stakeholders [8].

By following this working process, wearable devices for animal health monitoring using IoT enable continuous monitoring of animal health, facilitate early detection of health issues, and support timely intervention, leading to improved animal welfare and care.

Figure 2: Working of wearable device

4. METHODOLOGY USED

LoRa Technology:

LoRa (Long Range) is a low-power, wide-area networking (LPWAN) technology that is specifically designed for long-range communication in IoT (Internet of Things) applications. It enables long-range wireless communication with low-power consumption, making it deal for connecting batter-operated devices and enabling them to transmit data over long distance [3].

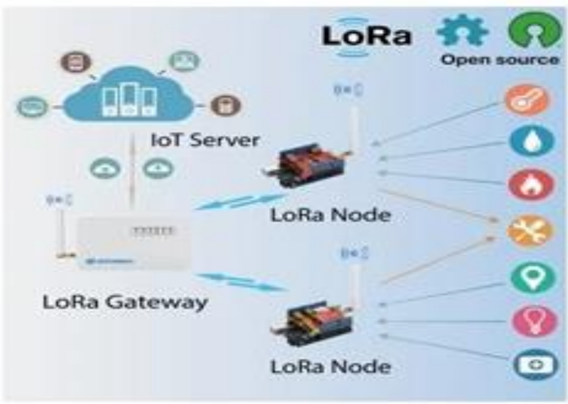

Figure 3: LoRa Technology

Arduino Technology:

Arduino technology offers a versatile and customized platform for developing wearable devices for animal health monitoring in the IoT context. It enables seamless sensor integration, data processing, wireless communication, power optimization, and rapid prototyping, empowering developers to create innovative and effective solutions for monitoring and improving animal well-being.

Figure 4: Arduino Board

Companion Animal Health Monitoring (CAHM):

Companion Animal Health Monitoring (CAHM) refers to the practice of using various technologies, including wearable devices, to monitor the health and well-being of companion animals. It involves the application of sensors, trackers, and other monitoring devices to gather data on various parameters, such as activity levels, heart rate, temperature, sleep patterns, and behavior.

Wearable devices for CHAM often incorporate Internet of Things (IoT) technology, enabling the seamless transmission of data to smartphones or cloud-based platforms for analysis and interpretation.

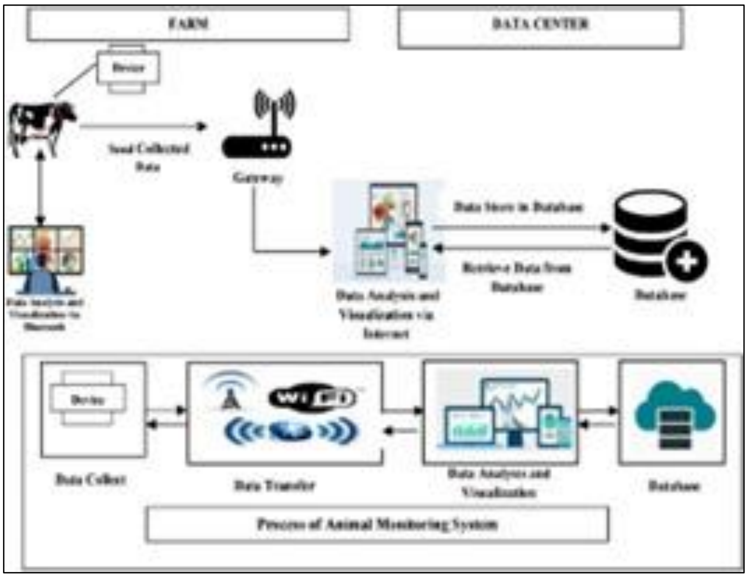

Figure 5: Overview of Monitoring

Biosensors:

The integration of biosensors in IoT wearable devices enables real-time monitoring, wireless data transmission, data analysis, and personalized healthcare. This combination empowers individuals to take proactive steps towards their health and well-being while facilitating remote monitoring and collaboration with healthcare professionals. As technology continues to advance, biosensors in IoT wearables are expected to play an increasingly significant role in preventive healthcare and remote patient monitoring.

These parameters may include heart rate, blood pressure, body temperature, glucose levels, oxygen saturation, electrocardiogram (ECG) signals, and more. Biosensors transform biological impulses into electrical signals, which the wearable device can then interpret and evaluate.

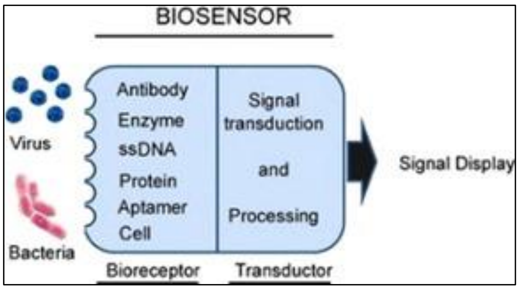

Figure 6: Biosensors

GPS Collor:

A GPS Collor is a wearable gadget made for animals that is primarily used to track their location and movement. It consists of a collar or harness with a built-in Global Positioning System (GPS) receiver, which allows for real-time tracking and monitoring of the animal's location.

Figure 7: GPS Collar for Animals

Figure 8: GPS Collar

5. ARCHITECTURE DIAGRAM:

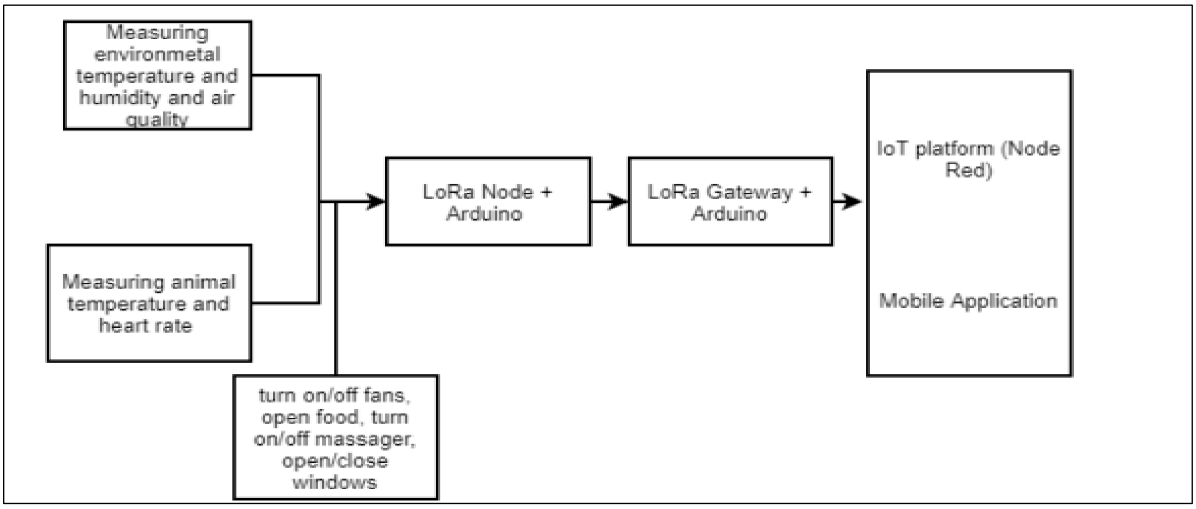

Figure 9: Overall block diagram of implemented system.

In this research, the duties have been divided into three parts. The first phase entails getting readings from the many sensors that are connected to the animal (in this case, a hamster) as well as the environment, The second step entails regulating the many parameters that were being watched, and the third step involves transmitting the data acquired to a gateway, which will then display the data on an IoT platform for viewing on a GUI as well as a mobile application. The project has different tasks that involve getting readings from the sensors. Four different types of sensors have been used, the first one is the DHT11 which has been used to measure the level of temperature of the animal as well as the temperature within the environment. The second sensor is the MQ-135 sensor that measures the level of carbon dioxide gas that is present within the surroundings and the third sensor is the Pulse Sensor. This sensor monitors the number of beats produced per minute within the animal's heart. Once all the data from all the sensors has been obtained, it is processed and this causes the control mechanisms to be initiated. These mechanisms involve turning on fans and regulating the speed when the level of temperature in the environment is outside the normal range assigned. Another process involves the activation of a massager unit, which is triggered when the animal's heart rate is irregular. When the MQ-135 sensor detects a high level of $CO2$, the servo motor rotates and opens a window to aerate the room. In terms of body temperature, when it lowers below 35°C and increases above 38°C, it indicates sickness within the animal, which drives the production of water.

6. CONCLUSION

Wearable devices for animal health monitoring offer tremendous potential for enhancing veterinary care, improving animal well-being, and advancing our understanding of animal health. These devices, incorporating technologies such as sensors, GPS, and connectivity, provide real-time data on vital signs, activity levels, and behavior, enabling proactive and personalized healthcare for animals. By leveraging the Internet of Things (IoT), wearable devices can seamlessly transmit data to veterinarians, pet owners, or centralized platforms for analysis and interpretation. This facilitates early detection of health issues, remote monitoring, and timely interventions, leading to improved treatment outcomes and reduced healthcare costs.

However, all available sensors must be integrated to establish an efficient online monitoring system, allowing animal health to be tracked in real-time and without delay. Looking ahead, other wearable technologies for animals, such as nano biosensors and improved molecular biology diagnostic tools for the identification of numerous infectious diseases in cattle, are expected to be widely adopted.

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