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# The Use of Wireless Sensor Networks for the Monitoring and Tracking of Cattle's Health

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## ABSTRACT:

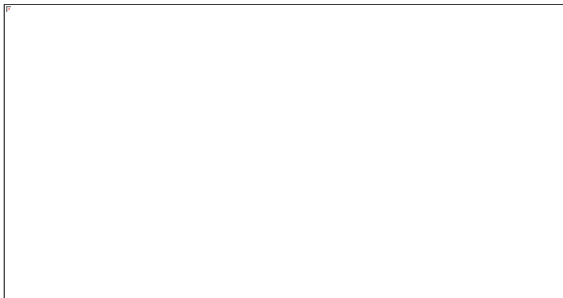
In order to avoid diseases, increase output, and improve animal welfare, contemporary livestock management relies heavily on cattle health monitoring. Keeping tabs on the health of cattle the old-fashioned way is tedious, error-prone, and requires a lot of manual effort. In response to these issues, we provide an Internet of Things (IoT) system for monitoring and tracking the health of cattle that incorporates DHT11 humidity and temperature sensors, pulse sensors, GPS tracking, and a buzzer alarm system. In order to provide real-time health insights, the DHT11 sensor constantly analyzes the cattle's core temperature and relative humidity. To aid in the early diagnosis of stress, fever, and other abnormalities in health, a state-of-the-art pulse sensor detects the heart rate. The GPS gadget monitors the cattle's whereabouts in real time, which helps keep them secure and cuts down on instances of livestock theft. In addition, a buzzer warning system is built in to let farmers or vets know if there are any unusual health readings, so they can intervene quickly. The system's architecture is built on an Arduino-based microcontroller, which collects data from sensors and communicates with a cloud service to provide notifications. With the data acquired, farmers can track their cattle's whereabouts and health from anywhere using a smartphone app. The Internet of Things (IoT) and wireless sensor networks work together to provide real-time tracking, which cuts down on the need for human health checks and boosts productivity. To update cow farming, this technology offers a scalable and cost-effective option. The suggested method maximizes farm output, improves cow wellbeing, and helps with livestock management by allowing early illness identification, real-time monitoring, and automatic warning systems. A more proactive and efficient livestock farming industry may be possible with the addition of AI-based illness prediction, analytics powered by machine learning, and automated drug delivery in the future.

## EMBEDDED SYSTEMS

A computer system that is purpose-built to carry out a single or limited set of tasks, often under the restrictions of real-time computing, is known as an embedded system. As with other physical and mechanical components, it is often integrated into a whole device. A personal computer or other general-purpose computer, on the other hand, may be programmed to do a wide variety of functions. These days, many of the everyday items we use rely on embedded systems to function. Design engineers may improve the embedded system to decrease product size and cost while boosting reliability and performance since it is devoted to certain functions. Because of their mass production, certain embedded systems are able to take advantage of cost savings. From small, handheld gadgets like digital watches and MP3 players to massive, permanently installed systems like those managing nuclear power plants, traffic lights, and industrial controls are all examples of physically embedded systems. From simple systems using a single microcontroller chip to complex systems housing several modules, peripherals, and networks in a massive chassis or enclosure, complexity may range greatly. The phrase "embedded system" lacks a precise definition because the majority of systems have programmability in some form. While they share some components with embedded systems, such operating systems and microprocessors, handheld computers are not technically embedded systems as they enable the loading of multiple programs and the connection of peripherals. Computer hardware and software, either fixed in capability or programmable, particularly intended for a certain sort of application device—this is what's called an embedded system. Embedded systems may be found in a wide variety of objects, including but not limited to: vehicles, medical devices, cameras, home appliances, aircraft, vending machines, toys, and, of course, cellular phones and personal digital assistants. A programming interface is given to programmable embedded devices, and programming for embedded systems is a niche field in and of itself. Embedded Java and Windows XP Embedded are

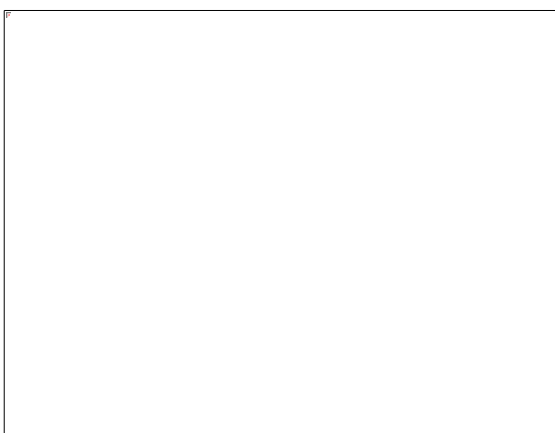
two examples of embedded-specific operating systems and language platforms. On the other hand, certain budget consumer goods include integrated application and operating system components, employ very cheap microprocessors, and have limited storage space. Instead of being loaded into RAM (random access memory), as applications on personal computers are, in this situation the program is written permanently into the system's memory.

### CHARACTERISTIC OF EMBEDDED SYSTEM



### APPLICATIONS OF EMBEDDED SYSTEMS

Here, in the Embedded World, we are living. The smooth operation of the various embedded goods that surround you is crucial to your day-to-day existence. In your living room, you have a TV, radio, and CD player; in your kitchen, you have a washing machine or microwave oven; and at your office, you have card readers, access controllers, and palm devices that let you do a lot. In addition to all of this, your automobile has a plethora of built-in controls that handle functions between the bumpers, most of which you probably don't give a second thought to.



### MICROCONTROLLER VERSUS MICROPROCESSOR

When comparing microprocessors and microcontrollers, what are the key differences? Any general-purpose microprocessor, such as an 8086, 80286, 80386, 80486, or a Pentium from Intel, or a 680X0 from Motorola, etc., is considered a microprocessor. In addition to lacking on-chip I/O ports, these microprocessors also lack random-access memory (RAM). Because of this, they are often called general-purpose microprocessors. Designing a working system around a general-purpose CPU like the 68040 or Pentium requires the addition of extra components like as RAM, ROM, I/O ports, and timers. Though these systems are more costly and cumbersome due to the inclusion of external RAM, ROM, and I/O ports, they provide the benefit of being versatile in that the designer may choose the quantity of RAM, ROM, and I/O ports required for the work at hand. Microcontrollers are an exception to this rule. On a single chip, you'll find a microprocessor, random access memory (RAM), read/write (ROM), input/output (I/O) ports, and a timer in a microcontroller. So, since the CPU, random access memory (RAM), read/write memory (ROM), input/output (I/O) ports, and timer are all integrated into a single chip, the designer is unable to include any more memory, I/O ports, or timer into the product. Because of its set quantity of on-chip ROM, RAM, and number of I/O ports, microcontrollers are perfect for many applications where space and cost are important considerations. It is not necessary to have a 486 or even an 8086 CPU for many applications; for instance, a TV remote control. Typically, these programs will need some kind of input/output function in order to read signals and toggle bits.

### INTRODUCTION

Despite the importance of cattle ranching, it might be difficult to keep track of the well-being of a big herd. In order to track the health and activity of specific objects, the system employs wireless sensor points that can be attached to them. Machine learning algorithms examine the data transmitted to a central server in order to identify health issues. Veterinarians and farmers can detect health issues in animals in the early stages with the use of real-time monitoring. Achieving better efficiency and reducing manual control are both aided by the system. The overarching goal of the system is to optimize agricultural techniques, guarantee the quality and safety of dairy products, and enhance the health and wellbeing of animals. The goal is to:

- Keep an eye on animals in real time so we can catch any health issues early on.
- Make big farms more efficient and cut down on labor-intensive manual control.
- Make sure that meat and dairy products are safe and of high quality by keeping an

eye on animal health and reducing the risk of disease transmission.

## LITERATURE SURVEY

Building a system of wireless sensors specifically for use in feedlot animal health monitoring This research presents a novel and practical method for monitoring the health of cattle using wireless sensor networks and directional antennas. Ear tags based on IEEE 802.15.4 must be fastened to the animals for the system to work. They must then record their eating habits and transfer the data to the aquarium router. For a tag interpretation success rate over 90%, the bare minimum wake-up time required by simulations is 2500 ms. The system also has a routing technique that thinks about the energy usage vs. network lifespan trade-off.

Rather than focusing on duty cycle-based routing, future studies should investigate the trade-offs between wake-up radio, solar energy, LPWA technology, drone help, and router numbers. Cattle Health Monitoring Through the Use of Intelligent Wearable Devices and Biosensors: A Taxonomy [2] The use of smart wearables and biosensors is quickly becoming the standard for livestock management, and smart farm technology is quickly becoming the norm for monitoring livestock health. You may get real-time monitoring and quick responses with these little, non-invasive gadgets. But at the moment, these technologies are not formally classified. Developing a taxonomy of the most cutting-edge smart wearables and biosensors used for cattle health monitoring is the primary objective of this work. Type of sensor, power source, health parameter monitored, and body part connected are all factors in this categorization. Using wireless sensor networks to gather biometric data from cow farms remotely.

## EXISTING SYSTEM

Manual inspection and routine veterinarian exams are the backbone of traditional cow health monitoring, but they aren't always reliable and may lead to missed diseases. In order to detect any health problems, farmers usually look for outward signs like decreased movement, lack of appetite, or unusual behavior. However, by the time these symptoms become apparent, the illness can have already advanced. Cattle are often physically handled when farmers take their temperatures and heart rates using stethoscopes and thermometers, a process that may be taxing on the animals and the farmer both. Further complicating matters is the fact that current methods do not allow for the tracking of stray or

missing animals in real-time. Without automated alarm systems, farmers would be unaware of their health's decline in the event of an emergency, delaying assistance and causing financial losses. Also, health monitoring is more reactive than preventative since most farms don't use IoT-based solutions. Traditional methods of livestock management are not automated, which leads to greater death rates, less output, and higher veterinary expenses.

## PROPOSED MODEL

To provide real-time health monitoring and position tracking, the proposed Internet of Things (IoT) system for cattle incorporates DHT11 sensors, pulse sensors, GPS, and a buzzer. The DHT11 sensor detects early signs of disease by continually measuring the humidity and body temperature of the cow. Conditions including fever, dehydration, and stress may be detected with the use of the pulse sensor, which tracks fluctuations in heart rate.

In order to avoid theft and make it easy to find missing livestock, the GPS module is installed to monitor their real-time whereabouts. In the event that any unusual vital signs are detected, the buzzer system will promptly notify the farmers or veterinarians. This lessens the likelihood of illness escalation and guarantees quicker reaction times. A cloud-based platform processes all the data collected by the sensors and sends it to a mobile app that farmers can use to get real-time updates. By connecting to the internet of things, data may be collected automatically, which improves productivity and decreases the need for human health checks. Farms of all sizes may benefit from this system's affordability, scalability, and ease of implementation.

## BLOCK DIAGRAM

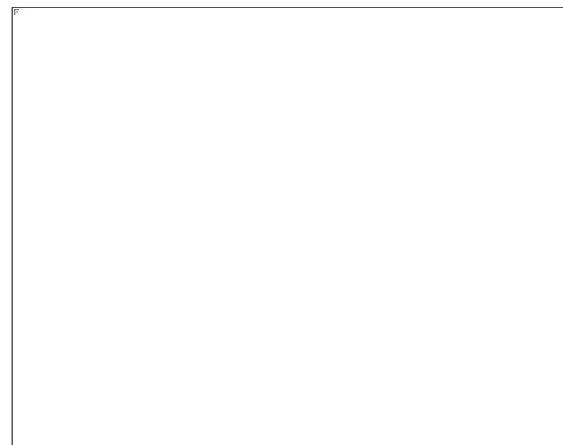


Figure 1: Block Diagram

**Microcontroller:**

A tiny controller, or microcontroller, as the name implies. Often used as a processing or controlling unit, they are similar to single-chip computers. For instance, microcontrollers that do decoding and other regulating operations are likely integrated into the control you are using. They find further use in vehicles, home appliances, microwaves, toys, and any other area requiring automation.

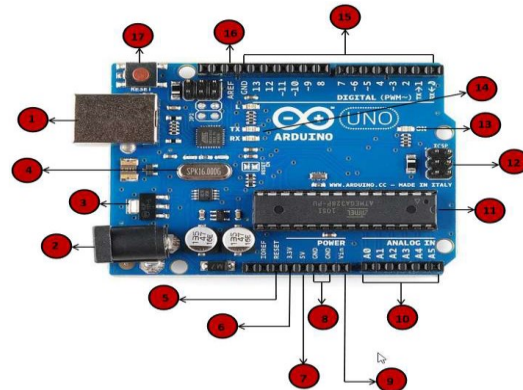
**Arduino Uno Microcontroller:**

One such microcontroller board is the Arduino Uno, which uses the Atmega328 (datasheet). It has a 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (6 of which may be used as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

A key difference between the Uno and all previous boards is the absence of the FTDI USB-to-serial driver chip. Rather of that, it has an Atmega8U2 that has been configured to convert USB to serial. To celebrate the impending release of Arduino 1.0, the name "Uno"—which means "One" in Italian—has been chosen. The Uno and Arduino version 1.0 will serve as the foundational versions for future Arduino releases. For a comparison with prior generations, see the index of Arduino boards. The Uno is the newest in a series of USB Arduino boards and the standard model for the Arduino platform.

**ARDUINO UNO BOARD:**

One board that uses the Atmega328 microprocessor is the Arduino Uno. A 16 MHz ceramic resonator, 6 analog inputs, 14 digital I/O pins (including 6 PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.



**Figure 2:** Arduino uno board

In contrast to all of its predecessors, the Uno does not have the FTDI USB-to-serial driver chip. As an alternative, it makes use of USB-to-serial converters coded into the Atmega16U2 (Atmega8U2 up to version R2).

**HARDWARE COMPONENTS**

**POWER SUPPLY UNIT**

The power supply for this system is shown below.



**Figure 3:** power supply

**Diodes:**

Only one path of electrical current may pass through a diode. Current may flow in either direction, as shown by the arrow in the circuit symbol. Originally termed valves, diodes are essentially an electrically enhanced version of the mechanical component.

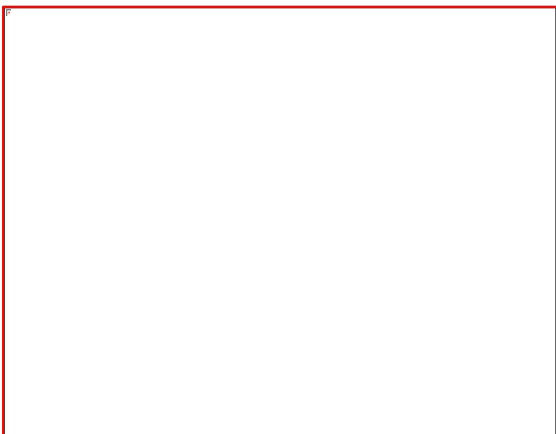


**Figure 4: Diode Symbol**

One kind of electrical component that restricts current flow is the diode. A voltage loss of around 0.7V will be the sole influence on the signal when the diode is "forward-biased" in this way. No current will flow through a diode that is "reverse-biased" when the current is applied in the other direction.

**Rectifier**

A rectifier's job is to change the phase of an alternating current (AC) waveform so that it appears as a direct current (DC) waveform. Both "half-wave" and "full-wave" rectifiers are used for rectification. Diodes are used in both devices to convert AC current into DC current. The Half-Wave Rectifiable The graphic shows that the half-wave rectifier is the simplest rectifier type since it only employs one diode.



**Figure 5: Half Wave Rectifier**

**LIQUID CRYSTAL DISPLAY**

An array of color or monochrome pixels arranged in front of a light source or reflector makes up a liquid crystal display (LCD), a thin, flat display device. Two polarizing filters, with their polarity axes perpendicular to one other, and a column of liquid crystal molecules hanging between two transparent electrodes make up each pixel.

Light would not be able to travel through them if the liquid crystals weren't interposed. To make light flow through two filters, the liquid crystal changes the polarization of the light entering the first filter.

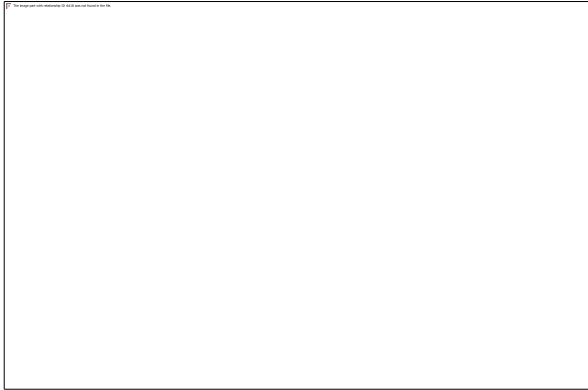
A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. 16X1, 16x2, and 20x2 LCDs are among the most popular types of displays that are often linked to the controllers. Which works out to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line. The use of "smart LCD" displays allows for the visual output of information by many microcontroller devices. Affordable, user-friendly, and capable of producing a readout utilizing the display's 5X7 dots plus cursor, LCD displays built on the LCD NT-C1611 module are a great choice. They use mathematical symbols and the usual ASCII set of characters. The display needs a +5V power and 10 I/O lines (RS, RW, D7, D6, D5, D4, D3, D2, D1, D0) for an 8-bit data bus. The only additional lines needed for a 4-bit data bus are the supply lines and six more (RS, RW, D7, D6, D5, D4). The data lines are tri-state and do not affect the microcontroller's function when the LCD display is disabled.



**Figure 6: 2x16 LCD Display**

**BUZZER**

In a magnetic transducer, the circuitry includes an iron core, a yoke plate, a wound coil, a permanent magnet, and a vibrating diaphragm that can be moved. The magnet's field gently draws the diaphragm up nearer the core's surface. A positive alternating current (AC) signal causes the diaphragm to move up and down, which in turn vibrates the air. This is achieved by the current passing through the excitation coil, which forms a fluctuating magnetic field. A resonator, which is composed of a cavity and one or more sound holes, may amplify vibrations in order to generate a loud sound.



## ESP8266 Wi-Fi Module

This project revolves on this. Because the project relies on WIFI control of appliances, the module is a crucial part of it. One remarkable feature of this tiny board is the integrated MCU (Micro Controller Unit), which allows for the control of I/O digital pins via a simple programming language that is almost pseudo-code like. Another benefit is that the ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Espressif Systems is situated in Shanghai and makes this gadget. In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-party company AIThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. His tiny size and cheap pricing (1.7–3.5\$) enticed a lot of hackers and geeks to look into it and utilize it for all sorts of projects. Because of its enormous success, Espressif now offers a wide variety of models with varying size and technological specs. Its replacement includes ESP32.

## RELAYS:

Industrial controls, automotive systems, and home appliances all make extensive use of electrically controlled switches called relays. By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

Inductor

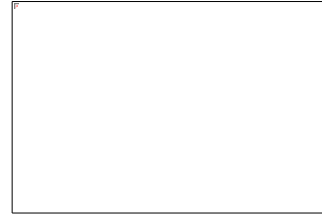


Fig 7 : Circuit symbol of a relay

## DRIVING A RELAY:

Two of the SPDT relay's five pins are used by the magnetic coil, one serves as the common terminal, and the other two are typically closed and normally connected. The coil is activated when a current passes across it. At the beginning, when the coil is deenergized, the usually closed pin and common terminal will be connected. A new connection will be formed between the common terminal and usually open pin when the coil is activated, breaking this connection. Therefore, the relay will be activated whenever the microcontroller sends an input signal to it. You may drive the loads connected between the common terminal and typically open pin while the relay is on. Consequently, the high-current loads are driven by the relay, which receives 5V from the microcontroller. This means the relay may be used as a means of isolation. The microcontroller and digital systems do not have enough current to operate the relay. In contrast to the 10 milliamps required to activate the relay's coil, the microcontroller's pin can only provide 1 or 2 milliamps. This is why the microcontroller and the relay are separated by a driver, like ULN2003, or a power transistor. By connecting ULN2003 to the relay and microcontroller, it is possible to activate many relays simultaneously.

## SOFTWARES

The Arduino platform is an open-source, user-friendly hardware and software environment for prototyping. It is comprised of a programmable circuit board (also called a microcontroller) and an Integrated Development Environment (IDE) called Arduino that is pre-made for writing and uploading code to the physical board. The main characteristics are:

- Many sensors can send signals in digital or analog formats to Arduino boards, which may then be used to activate motors, control LEDs, establish connections to the cloud, and much more.
- The Arduino IDE (also called "uploading software") allows you to command your board's operations by communicating with the

microcontroller on the board.

- A separate device, known as a programmer, is not required to load fresh code into an Arduino board, in contrast to most prior programmable circuit boards. The usage of a USB connection is all that is required.
- The Arduino IDE employs a streamlined version of C++, which facilitates programming learning. Last but not least, Arduino offers a standardized form factor that simplifies the microcontroller's tasks.

Now that we know what the Arduino UNO board is and how it works, we can go on to setting up the Arduino IDE. As soon as we figure this out, we can upload our software to the Arduino board.

## RESULTS



Model



Node worn by cow

## CONCLUSION

A clever and effective way to keep tabs on livestock health in real time is with the help of the Internet of Things (IoT) cattle tracking and health system. Early illness identification, automatic warnings, and exact position tracking are made possible by this system's integration of DHT11 temperature and humidity sensors, pulse sensors, GPS tracking, and buzzer alarms, which greatly improves cow management. Continuous monitoring, reduced human effort, and improved animal welfare are all benefits of this system compared to more conventional approaches. The health risks can be minimized thanks to the buzzer alert system, which allows for immediate intervention. Cattle theft and loss may be prevented with the use of the GPS function, which allows for

real-time tracking. Improving precision livestock farming might be possible in the future with advancements like automated drug dispensers, cloud-based health record management, and AI-based predictive analytics for illness detection. As a whole, this scalable and reasonably priced system is a huge step forward in smart farming technology, which will help farmers maximize output while improving cattle health.

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