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Iot-Based Cattle Pen Security System Prototype with Wemos

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Abstract

Cattle theft in cow barns frequently occurs in Central Java, Indonesia, highlighting the need for a monitoring system to prevent such thefts. The system developed uses Wemos integrated with a PIR sensor, employing Internet of Things (IoT) methods to detect human movement within the cow barn. A magnetic sensor will be installed on the barn door to provide remote monitoring. The monitoring system activates a buzzer and sends theft data to the cow barn owner from different locations. Testing of this monitoring system was successful, as evidenced by the PIR and magnetic sensors detecting breaches by triggering the buzzer. However, test results indicated that sending data to smartphones requires an internet connection within the barn. Compared to a CCTV system, this setup can deter theft by emitting a loud sound from the buzzer, but it lacks video and photo recording capabilities since it does not include a camera. Based on the design and testing results, it can be concluded that this cattle theft monitoring system has effectively detected suspicious movements in the barn.

Keywords*: IoT, Wemos, Cattle Pen*

Abstrak

Pencurian ternak pada kandang sapi sering terjadi di daerah jawa tengah indonesia, sehingga perlu sebuah sistem pemantauan yang dapat mencegah pencurian ternak. sistem yang dikembangkan menggunakan Wemos dengan dukungan sensor PIR yang terintegrasi dengan metode IoT (*Internet of Things*) untuk mendeteksi pergerakan manusia di dalam kandang sapi. Sensor magnet akan ditanam pada pintu kendang dari jarak jauh. Sistem monitoring akan berbunyi buzzer dan mengirim data pencurian kepada pemilik kandang sapi dari lokasi yang berbeda. Uji coba sistem monitoring ini berjalan sempurna yang dibuktikan dengan sensor PIR dan Magnetic yang mampu mendeteksi pelanggaran dengan membunyikan suara buzzer. Namun berdasarkan hasil uji coba, pengiriman data ke smartphone membutuhkan jaringan internet di dalam kandang. Sedangkan dibandingkan dengan CCTV sistem ini bisa mencegah pencurian dengan memberikan suara nyaring dari Buzzer akan tetapi tidak mampu merekam video dan foto karena tidak memiliki kamera. Berdasarkan hasil rancangan dan uji coba dapat disimpulkan bahwa sistem monitoring pencurian ternak ini telah berhasil mendeteksi pergerakan yang mencurigakan di kandang.

Kata kunci: IoT, Wemos, Kandang Sapi

Introduction

Numerous cattle farms, both privately owned and operated by the community, may be found in Indonesia. Because there are so many breeders in Indonesia, there is an issue with livestock theft. This is concerning for breeders because livestock is expensive there, therefore any theft will result in losses. Accessed on May 7, 2024, the Solo Pos

Jogja news page reported that livestock theft had taken place in Margosari Village, Kapanewon Pengasih, Kulonprogo Regency. The farmer lost five goats in one night as a result of this incident. Other breeders can learn from this experience to stop livestock theft. To overcome this theft, several companies use CCTV, but this tool is not a means of preventing theft but only as evidence of theft, this is still detrimental to farmers. This has been compared with the creation of a system with PIR by Surantha and Kletsel [1][2]. This is also in line with research conducted in do Afif but add IoT technology [3]. The same is true of Andreas' research, where he installed an Internet of Things-based PIR on the house's door to detect thievery. The data is then transmitted to a smartphone via IoT technology, activating a danger alarm [4].

The use of IoT technology will provide data information in real time so that monitoring can be carried out at any time. This has already been researched by several researcher in creating a system at a low price [5] 6]. The same thing is done by Shang to monitor the condition of livestock [7], IoT technology can be done so that from the data obtained, the cage security system can be carried out [8]. In the design that will be made, this system will use an Wemos with a PIR sensor to detect thieves who enter the pen when they enter, sometimes not through the stall door, while the door uses a magnetic sensor which will be triggered when the cow pen is forced open [9][10]. If all the conditions are met, the data will be sent to the farmer's smartphone using IoT [11] technology in real time, and it will trigger a buzzer sound so that the theft will be immediately heard by local residents. So with this system, it is hoped that theft can be prevented because there is a buzzer sound [12].

Literature Review

a. Internet of Things (IoT)

The Internet of Things (IoT) is a network of physical devices, vehicles, equipment and other physical objects embedded with sensors, software and network connectivity. These devices can collect and share data without human intervention, allowing them to communicate with each other and with other Internet devices. The main goal of the IoT is to create self-reporting devices that can communicate with each other and users in real time, improving efficiency and bringing important information to the surface faster than a human-dependent system. IoT has a wide range of applications in various industries, including [13].

Smart home: IoT devices can control and monitor home appliances, lighting and security systems, improving the overall life experience.

Healthcare: IoT devices can remotely monitor patients, monitor medical devices, manage inventory and monitor medication adherence, improving patient outcomes and healthcare management.

Industrial automation: IoT devices can monitor machine performance, identify equipment failures and optimize production processes, improving efficiency and reducing downtime.

Traffic: IoT devices can be used in autonomous vehicles, allowing them to share real-time information and respond to traffic signals.

Urban planning: IoT devices can be used to monitor and manage urban infrastructure, such as traffic flow, waste management and energy consumption, optimizing urban operations.

Retail: IoT devices can track customer behavior, track inventory levels and optimize store layouts, improving customer experience and business.

Agriculture: IoT devices can monitor soil conditions, weather conditions and crop growth, optimize yields and reduce waste.

b. Passive infrared (PIR)

Passive infrared (PIR) refers to the detection of infrared radiation emitted by objects in the environment. This radiation is an electromagnetic type that is invisible to the human eye but that electronic equipment made specifically for that purpose can detect. Any item that is above absolute zero releases thermal energy in the form of infrared radiation, which varies depending on the object's surface properties and temperature. Electronic devices called passive infrared sensors, or PIR sensors for short, measure this infrared radiation in order to detect changes in the surrounding environment, such as the movement of people or animals[14].

c. Magnetic Sensors

Magnetic sensors are used in various Arduino-based security systems to detect changes in magnetic fields that may indicate the presence or movement of objects. These sensors are particularly useful in applications that require a simple and non-invasive detection method, such as home security systems or alarm systems.

d. How Magnetic Sensors Work

Magnetic sensors, such as the KY-024 Linear Magnetic Hall Effect Sensor Module used in the Arduino project discussed in the article, detect changes in magnetic fields produced by magnets. These sensors can be configured to detect both strong and weak fields. The strength of the observed magnetic field affects the sensor's output, which the Arduino board can interpret as an analog or digital signal [15].

e. Applications of Magnetic Sensors in Security Systems

Security systems typically use magnetic sensors to detect when windows, doors, or other locations with a magnetic field open or close. For instance, a magnetic sensor can be installed inside a window or door in a home security system to track when it is opened or closed. The homeowner can then receive a notification or set off an alarm using this information.

f. Advantages of magnetic sensors in security systems

There are various benefits of using magnetic sensors in security systems. They are a cost-effective option for home security systems because they are simple to install and comparatively affordable. Additionally, magnetic sensors are non-invasive, which means that they don't need to come into direct contact with the thing being seen. This is beneficial when the thing being observed is delicate to vibration or touch.

Method

Prototyping is a design method that creates an initial model or sample of a product, system or service to test and refine its concept, functionality or process before final development. This method is widely used in various industries, including software, system development, and electronic design, to evaluate ideas, gather feedback, and ensure that the final product meets users' needs and expectations [12].

The steps in the prototyping method include:

1. Defining the goals: Clearly define the goals and requirements of the prototype, including which aspects of the product or system need to be tested or improved. In this research, the formulation of the problem was obtained from interviews with cattle breeders in the Kendal area and through literature studies from previous research so that the problem of cattle theft could be concluded.
2. Development: Create a prototype that, depending on the stage of development and its complexity, can be a simple or detailed representation of a product or system. Currently in development, this project uses the Arduino IDE program to instruct Wemos on how to use Firebase storage media, which the smartphone will eventually access, to power the PIR sensor and magnetic sensor.

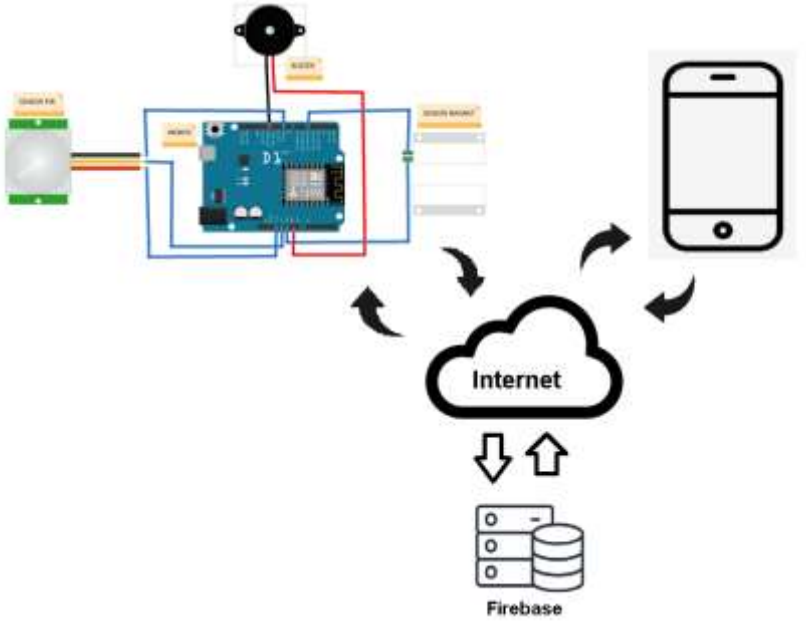

Figure1. Schematic Flow of the Cow Pen Security System

3. Refine: Refine the prototype based on feedback from users, stakeholders, or other relevant parties to address identified issues or concerns. At this stage the research carried out prototype trials on breeders in the Kendal area who had at least 10 cows, by demonstrating the prototype in front of the breeders in the form of a miniature cow pen with a system appropriate to the location.
4. Demo: Present the prototype to users or stakeholders to gather feedback and validate the design. At this point, the prototype is shown, and the interested parties are given a number of questionnaires about the system under development so they may provide helpful feedback to address any shortcomings..
5. Test: Conduct usability tests, performance tests, or other tests to evaluate the functionality, usability, and overall performance of the prototype. In this research, testing was carried out on the PIR sensor to see whether it could detect human

presence, the magnetic sensor when the door was opened when the system was on and sending PIR and Magnetic sensor data to the Firebase database and displaying the data to the application on the smartphone. This test was carried out in the presence of the stakeholder.

6. Implementation: After refining and testing the prototype, deploy the final version of the product or system with the lessons learned from the prototyping process.

Result and Discussion

In this system the user must first connect the Android smartphone to the WiFi that has been determined according to the coding program, in this case the author uses a portable tethering smartphone as a connection. After successfully connecting, users can immediately operate this system application. The user first opens the cowshed application.

Figure 2. Home Display on the Smartphone Application

In the home display in Figure 1 the "*Gerbang Kandang*" is the location where we place the magnetic sensor where when the cow pen door is closed the display on the smartphone will be "*Tertutup*", while we place the PIR sensor in the corner in front of the door so that when there are no humans inside cage then it will display "*Tidak ada Gerakan*" on the smartphapplication.

Figure 3. PIR Sensor Detects Motion but Door is Closed

The PIR sensor in Figure 3 detects movement within the cage even while the door is still closed. As a result, the buzzer sounds and data is sent to the smartphone, as shown in Figure 4.

Figure 4. Smartphone Display When the PIR Sensor Detects Movement but the Door is Still Closed

In figure 4 it can be seen that "*Gerbang Kandang: Tertutup*" which means that the magnetic sensor is still connected and the cage is not open, "Sensor PIR: Ada Gerakan" this means that the PIR sensor detects the presence of humans in the cage, this PIR sensor will trigger the sound of the buzzer sounds and is expected to scare away thieves.

Figure 5. The condition of the Door Cage is Open and the PIR Sensor Detects Movement

In figure 5 is the condition where the door is open and the magnetic sensor detects the door is open and the PIR sensor detects human movement in the cage, in this condition the buzzer will sound loudly indicating that there is a thief.

Figure 6. Smartphone Display When the Cage Door is Open and the PIR Sensor Detects Movement

The condition in Figure 5 will change the display on the smartphone which can be seen in Figure 6 where the status is "*Gerbang Kandang: Terbuka*" which means that in the cow pen the magnetic sensor will send data to Firebase and will be displayed on the smartphone giving notification that the cow pen door open, while the status "Sensor PIR: "*Ada Gerakan"* means that the PIR sensor in the pen detects a human being in the cow pen, this condition will trigger a buzzer sound and notify the owner of the cow pen that there is a thief in the pen.

Table 1. Test data on the PIR sensor, Magnetic Sensor, Buzzer, and sending data to Firebase and appearing on the Smartphone in the form of PIR and Magnetic Sensor data

Tes to	Hardware				Smartphone	
	PIR Sensor	Magnetic Sensor	Buzzer	Internet	Gate	Sensor PIR
1	Detects	Closed	Sound	Connected	Closed	there is movement
2	Not Detect	Closed	Doesn't sound	Connected	Closed	no movement
3	Detects	Open	Sound	Connected	Open	there is movement
4	Detects	Open	Sound	Connected	Open	there is movement
5	Not Detect	Closed	Doesn't sound	Not Connected	No data	No data
6	Detect	Open	Sound	Not Connected	No data	No data
7	Detect	Open	Sound	Connected	Open	movement
8	Detects	Closed	Sound	Connected	Closed	there is movement
9	Not Detect	Closed	Doesn't sound	Connected	Closed	no movement
10	Not Detect	Closed	Doesn't sound	Connected	Closed	no movement

In table 1, it is known that when PIR data, magnetic sensors, but there is no internet, the data is not sent to the smartphone so that the display on the smartphone will be no data, but the buzzer in the cage will still sound because the buzzer sound is not influenced by the presence of the internet, when the pir sensor detects and the magnetic sensor on the door is open the buzzer will sound when there is internet data will be sent to the smartphone and will give the condition that the cage is open and there is movement in the cage.

There will undoubtedly be movement when the door opens because the magnetic sensor will sense that the door is open and the PIR always detects movement. However, this does not imply that the PIR will detect movement. The door will open since there's a chance that a thief could enter through the opening rather than through the door. The other path resembles a cage's roof.

Table 2. Comparison of CCTV with A Cattle Pen Security System

No	Form	CCTV	Cattle Pen Security System
1	When there is a theft, what can be done?	Just recording the incident	Provides notifications in the form of sound and on the smartphone
2	Can the system prevent cattle	Can't, because it	This could be

	theft?	only records	because the noisy sound of the buzzer will scare thieves and wake up livestock owners
3	Can the system record theft incidents?	CCTV can record events that take place	It doesn't have the ability to record images and photos

Table 2 shows that CCTV can only capture events without alerting the owner of the cow pen to potential theft. This is not the same as the cowshed system, which alerts users through sound when the cage door is unlocked or a robber enters the cage. mobile application. Nevertheless, images or videos that would show theft proof cannot be captured by the cowshed security system.

Conclusion

The research findings indicate that the internet is critical to the operation of an Internet of Things (IoT) system because without it, data cannot be sent to a smartphone device. The security system installed in the cowshed can deter theft because it can send out alerts, such as a loud buzzer sound when the barn door is opened. Table 1 of the cow pen security system experiment shows what happens when the pear senses activity in the cow pen. The cowshed security system can be employed, as shown in Figures 2, 3, 4, 5, and 6. It can identify movement within the cowshed and open doors, and it can send data to a smartphone using Internet of Things technology. When a robber is identified, a buzzer sound is generated.

The inability to record occurrences is one of the drawbacks of this cowshed security system when compared to CCTV, aside from the fact that data information is not delivered to the smartphone when there is no internet in the cowshed. Perhaps the recording flaws can be fixed by utilizing the ESP32 Cam instead of the Wemos Microcontroller.

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