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IoT-based implementation of rickshaws for real-time monitoring and measuring the weight of cattle feed

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ABSTRACT

In the era of modern agriculture that is increasingly dependent on technology, livestock management has become crucial to increasing efficiency and productivity. An important aspect in livestock management is providing appropriate feed to fattening cattle. Manual monitoring of feed weight is often complex and prone to errors, which can have a significant impact on operational efficiency and result in losses. Accuracy in monitoring feed weight is the key to maintaining optimal health and growth of cattle. Internet of Things (IoT) technology is emerging as an innovative solution to overcome these challenges. The use of Angkong load cells, a tool connected to IoT, allows automatic monitoring of feed weight with a high level of precision. The test results show an error rate close to zero, with a Mean Absolute Percentage Error (MAPE) of around 0.158%, making the Angkong load cell a reliable tool. With this capability, farmers can monitor cow feed weight in real-time with minimal error rates. This not only increases the operational efficiency of the farm but also optimizes the health and growth of livestock more efficiently, having a positive impact on overall farm productivity. The aim of this research is to monitor the amount of feed given to cows with an adequate level of accuracy. Rickshaw load cells can be well suited for this use due to their ability to handle relatively large weights with fairly good accuracy, but do not necessarily have the level of precision required in laboratory measurements or the pharmaceutical industry.

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1. INTRODUCTION

Technological developments nowadays are very rapid [1]. Technology developments in the information bussiness sector have a major impact [2]. Many emerging technologies help understand human behavior in this technological world [3]. Modern agriculture is increasingly dependent on technology to increase efficiency and productivity [4]. An important aspect in livestock management is providing adequate feed to livestock, including cows [5]. Providing accurate and appropriate feed is crucial to maintaining the health and optimal growth of fattening cattle [6], [7]. However, manual monitoring of feed weight is often complicated and prone to errors, which can disrupt farm operation efficiency and result in significant losses [8], [9].

If cows experience a lack of feed, the cow's body weight will decrease, leading to a decrease in meat production and poor health conditions [10], [11]. In this situation, cows can experience excessive stress and become susceptible to disease [12]. In addition, feed efficiency becomes low, so maintenance costs increase. On the other hand, if cows are fed, they tend to gain excessive weight, resulting in meat that is too fatty and unhealthy meat [13].

In an effort to overcome this challenge, the implementation of Internet of Things (IoT) technology has emerged as a solution. Using connected sensors and devices, farmers can monitor cow feed weight in real time with high accuracy. The use of IoT-based rickshaws (a tool used to weigh feed) allows automatic monitoring of feed weight, which can provide more accurate data and help farmers weigh feed. he progress of IoT which includes anywhere, anytime, and anyone to connect with these objects with the hope that is to expand the network and get ahead of the IoT [14].

2. METHOD

The prototype method is an approach applied to face challenges in feeding management for fattening cattle by using Internet of Things (IoT) technology. The following are the stages of the prototype method that can be applied in this research. Can be seen in Figure 1.

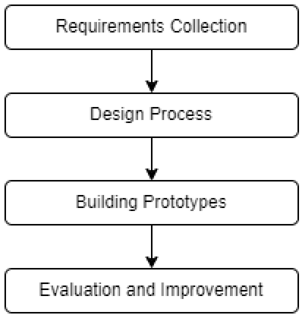

Figure 1. Prototype method

Requirements Collection

First of all, it is necessary to carry out in-depth requirements collection to understand the problems faced in feeding fattening cattle. This need includes an understanding of aspects such as accurate feed weight, reduction of feeding errors, operational efficiency, and impact on cow health.

Design Process

Once the requirements are collected, the next step is to design an IoT-based solution. This design process will include selecting the appropriate sensors to monitor the feed weight, selecting tools (such as rickshaws) that can be integrated with the IoT technology, and designing the software needed to collect and transmit data in real time.

. Building a Prototype

The prototype of an IoT system designed involves installing sensors in the feed equipment (rickshaws), setting up the hardware, and developing software to send data to a server or monitoring platform. This prototype will be used to test the initial concepts and functionality. It can be seen in Figure 2 below.

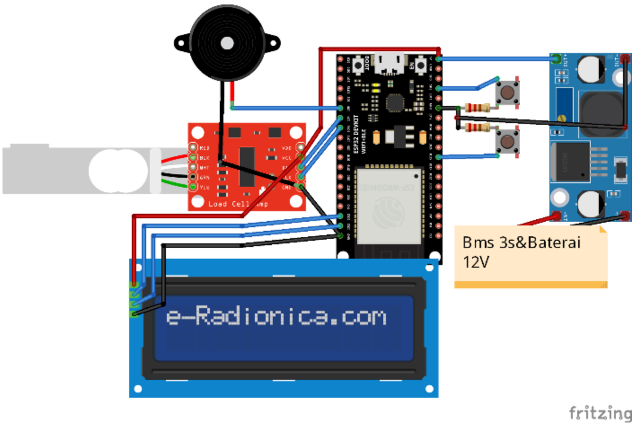

Figure 2. Prototype circuit

The battery acts as the main power source that will supply electricity for managing the retrieval of data from the load cell and sending it to storage or display, either via a website or an integrated LCD screen on the rickshaw. The load cell, as a crucial component in the system, functions to accurately weigh the feed weight. Weight data obtained from load cells is important information in cattle feed management and can provide a clearer picture of livestock feed intake. This system also has a very useful feature, namely the "upload" button, which allows users to save feed weight data directly. These data can later be used for monitoring, analysis, and better decision making in livestock management.

In addition to that, there is also a monitoring feature that allows users to access real-time feed weight data, either via a website that can be accessed remotely or via an LCD screen installed on the rickshaw. This provides easy and open access to data, which can help farmers make quick and appropriate decisions in cattle feed management. With the integration of this technology, feed management for fattening cattle becomes more efficient and accurate, with easy and controlled data access. The following is a flow chart of the IoT-based implementation of rickshaws to monitor and measuring the weight of cattle feed in real time. You can see this in Figure 3.

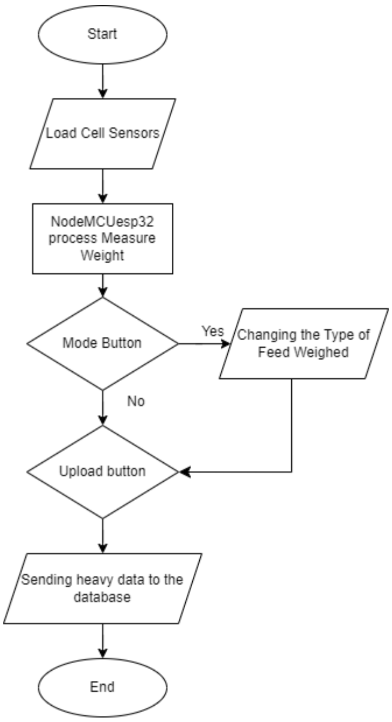

Figure 3. How tools work

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3. RESULTS AND DISCUSSIONS

The load cell sensor test by measuring the relative error level between the measurement results of the Angkong Load Cell and the digital scale load cell. To carry out accuracy comparisons, the author uses the MAPE (Mean Absolute Percentage Error) method, which provides estimates to determine the extent to which the measurement results from the Angkong Load Cell deviate from the Digital Scale Load Cell measurement results. This can be seen in the MAPE formula image.

$$MAPE = \frac{1}{n} \sum_{1=1}^{n} \left| \frac{A_i - F_i}{A_i} \right| x\, 100\% \quad (1)$$

Information:

- n is the sample size
- Ai is the actual data value
- Fi are the forecast data.

The research carried out has an observation sequence number (No) that is used to identify each measurement. The second column contains the weight of the rickshaw in KG, while the third column contains the weight measured with a digital scale, also in KG. The comparison between the weight of the rickshaw and the weight of the digital scale can be seen in the fourth column, namely MAPE. MAPE is a metric that is used to evaluate the degree of the difference between two measurements, with lower values indicating a smaller degree of error. In the fourth and fifth observations, MAPE was zero, indicating that there was no difference between the weight of the rickshaw and the digital scale. It can be seen in Table 1.

Table 1. Comparison of the weight of cattle feed on the charge and the digital scales

No	Angkong(KG)	Digital Scales (KG)	Mape
1	2,05	2,06	0,49
2	10,00	10,02	0,20
3	20,85	20,83	0,10
4	30,72	30,72	0,00
5	45,90	45,90	0,00
	Average		0,158%

Based on the measurement data obtained, it can be concluded that the Angkong load cell provides very accurate and consistent measurement results when compared with the Digital Scale Load Cell. MAPE (mean absolute percentage error) which is close to zero or even exactly zero in each measurement indicates that the measurement results from the Angkong load cell are almost identical to the measurement results from the Digital Scale Load Cell. The average MAPE of around 0.158% indicates a very small error rate, confirming that the Angkong load cell can be relied upon as an excellent alternative in weight measurement.

The MAPE measurement table that has been presented shows that the Angkong load cell has a very low error rate in measuring weight when compared to the Digital Scale Load Cell. However, there are aspects that need to be considered in the context of using Angkong load cells, especially for applications that require a very high level of accuracy in weight measurement. The accuracy stated in the calculation accuracy of 0.00 grams shows that for very small weights, the Angkong load cell may not be able to provide accurate results. This becomes especially important in industries or laboratories that require high precision, such as chemical or pharmaceutical laboratories, where very small amounts of substances must be measured with high accuracy.

In situations where greater precision is required, the use of a Rickshaw load cell needs to be considered carefully. The use of more precise measuring instruments, such as analytical balances or special devices with increased precision, may be more appropriate. Therefore, selecting the right tool really depends on the application requirements and the required precision. If the Angkong load cell does not meet the required accuracy in a particular context, then more accurate and appropriate alternatives need to be explored to ensure that the weight measurement results are truly reliable and meet the required standards.

Additionally, it is important to understand that in some cases, such as the use of Rickshaw load cells to weigh cattle feed, very high accuracy is not a top priority. In an application like this, the main goal is to monitor the amount of feed given to cows with a sufficient level of accuracy. Rickshaw load cells can be well suited for this use due to their ability to handle relatively large weights with fairly good accuracy, but do not necessarily have the level of precision required in laboratory measurements or the pharmaceutical industry.

The use of Angkong load cells in livestock feeding applications can also provide additional benefits, namely affordability and good resistance to rough environments. This makes this tool an economical and durable choice for measuring the feed of cows or other livestock.

The selection of measurement equipment should always be based on the specific needs of the application. If high accuracy is required, then selecting equipment that has higher precision is important. However, for applications that do not require a high level of accuracy, such as measuring cattle feed, using a Rickshaw load cell can be a very practical and economical choice.

Web Appearance Testing

In the testing phase, we succeeded in developing and testing a web display that allows real-time monitoring of the feed weight sent by Angkong via the internet network. The test results show that this web interface functions well and has a number of very valuable features. First, the web display can display real-time feed weight data, so farmers or operators can monitor it accurately without having to be at the physical location of the Angkong.

Figure 5. Web views

On this Web page, users can easily monitor the weight of feed given to cows directly and in real-time. This web display displays the weight of feed measured by the Angkong Load Cell with sufficient accuracy for livestock feeding purposes. Cow feed weight data is updated automatically in real time, so users can see changes in weight when feed is added or removed. This information is displayed in large, clear numbers so it is easy to read.

In addition to that, this web display may also be equipped with additional elements, such as graphs of the development of cow feed weight over certain time periods. This can provide a deeper understanding of cattle feeding patterns and help make better decisions regarding animal feed management. This web display, which displays the weight of cattle feed in real time, provides a practical and efficient solution for monitoring and managing livestock feed with sufficient accuracy for the application's needs.

4. CONCLUSION

Feed management in fattening cattle farming is an important aspect that influences the health and productivity of livestock. Errors in monitoring feed weight can cause a variety of problems, including weight loss, low meat production, and high rearing costs. However, the implementation of Internet of Things (IoT) technology using Angkong load cells opens up opportunities for more accurate and efficient monitoring.

The test results show that the Angkong load cell provides very accurate and consistent measurement results. With an error rate that is close to zero, a MAPE of around 0.158%, the Angkong load cell can be relied on as a tool that can provide accurate and reliable feed weight data. This allows farmers to monitor cattle feed weight in real-time with minimal error rates, which, in turn, can improve livestock operational efficiency and optimize livestock health and growth.

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