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# Object Detection-Based Security Monitoring System in The Framework of Architectural and Structural Design Optimization

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**ABSTRACT:** Rats are one of the main pests that cause significant damage to grain during storage in warehouses. Rat activities such as gnawing on sacks, contaminating grain, and damaging storage structures can drastically reduce the quality and quantity of grain. Conventional security systems, such as passive CCTV, are unable to provide automatic notifications or real-time threat identification. This study aims to design and develop a warehouse security system based on *Object Detection* using the YOLO algorithm to automatically detect the presence of rats. This system is integrated with environmental sensors to monitor the temperature, grain humidity, room humidity, and light intensity in real-time to support optimal storage conditions. The implementation of YOLO in the system is expected to provide a high level of accuracy in detecting rats, so that warnings can be given quickly to warehouse operators. Thus, this system has the potential to minimize the risk of grain damage, increase the effectiveness of warehouse surveillance, and support more modern and efficient security management.

**KEYWORDS:** Grain Warehouse, Security, *Object Detection*, YOLO, *Real-time*.

## 1. INTRODUCTION

Grain storage warehouses play a very important role in maintaining the quality and quantity of crops before they are further processed into rice. However, in practice, this storage process faces various challenges that can cause a significant decline in grain quality. One of the main problems that often occurs is pest infestation, especially rats, which can gnaw on grain sacks, contaminate the harvest, and cause physical damage to the storage structure. The presence of rats in warehouses is a serious threat because they can reduce grain quality by 25–40% if not handled properly and quickly.

In addition, uncontrolled warehouse conditions— such as temperature fluctuations, increased humidity, and minimal lighting—can also trigger the growth of mold, destructive microorganisms, and accelerate chemical reactions that reduce grain quality. According to post-harvest research, an increase in grain moisture content of only 1% or an increase in ambient temperature of 5°C can drastically accelerate grain deterioration, with the ideal safe moisture content limit being below 15%. Unmonitored environmental problems and sporadic rat infestations have caused many warehouses to experience crop losses and significant economic losses.

Amid these challenges, developments in information technology, particularly in the fields *of the Internet of Things* (IoT) and *Computer Vision*, offer great opportunities to improve warehouse security and monitoring systems. However, most security systems currently in use are still passive, such as conventional CCTV, which only records without the ability to automatically detect threats. This means that the process of identifying the presence of rats depends on human operators, making it prone to delays in taking action.

This research not only offers practical solutions for warehouse managers but also makes an important contribution to the development of computer-based security technology for the agricultural sector. With this approach, the designed system is expected to reduce the risk of grain damage, improve storage efficiency, and minimize economic losses due to rat attacks and unmonitored warehouse conditions.

Object Detection, particularly the YOLO (*You Only Look Once*) algorithm, has become one of the most widely used technologies in various fields such as industry, health, and agriculture due to its ability to detect objects quickly and accurately. In the context of grain storage warehouses, this technology has great potential for real-time detection of rodent presencesuch as industry, health, and agriculture due to its ability to detect objects quickly and accurately. In the context

of grain storage warehouses, this technology has great potential to detect the presence of rats in real-time so that operators can take mitigation measures quickly before the damage spreads.

This research not only offers practical solutions for warehouse managers but also makes an important contribution to the development of computer-based security technology for the agricultural sector. With this approach, the designed system is expected to reduce the risk of grain damage, improve storage efficiency, and minimize economic losses due to rat infestations and unmonitored warehouse conditions.

## 2. MATERIALS AND METHODS

This study uses a literature-based research and system experimentation approach to develop and evaluate *an Object Detection-Based* Grain Storage Warehouse Security System with a primary focus on rodent detection. This approach was chosen to gain an in-depth understanding of rodent characteristics, movement patterns in warehouse environments, and the effectiveness of visual detection technology in the context of food warehouse security.

### 2.1 System Development Methods

The methods used in developing this system include:

1. System Design: Creating a system design, including the design of the main workflow using a flowchart.
2. System Creation: System implementation will use the Python programming language and the YOLO algorithm. The creation of the *Object Detection* model will involve searching for the best *dataset* using Google Colab.
3. System Testing**:**

- Functional Testing (Python): To ensure that every aspect and function of the system runs as designed.
- Acceptance Testing Acceptance (UAT/YOLO): Conducted by end users (warehouse operators, warehouse owners) to verify that the system meets their needs and functions properly. This method uses a user satisfaction questionnaire.

The designed system will be accessed via *a browser* by warehouse operators (chairman, deputy, warehouse owner).

## 3. DISCUSSION

### 3.1 Effectiveness of Mouse Detection Systems in Grain Warehouse Security

The presence of mice in grain warehouses is one of the main causes of declining crop quality and quantity. Mice can damage grain sacks, eat seeds, and leave droppings that cause biological and microbiological contamination. Traditionally, warehouse surveillance is usually done manually or through passive CCTV, which is unable to provide automatic warnings when mice are detected. Therefore, a security system that is capable of operating in real-time and has the ability to independently identify threats is needed. Object Detection technology such as YOLO provides an innovative solution with its ability to quickly and accurately detect small moving objects such as rats. The integration of this system with environmental sensors also strengthens the function of preventing grain damage due to pests and unstable environmental conditions.

**A. Impact of Mouse Detection on Grain Damage Reduction**

The implementation of YOLO-based mouse detection has proven to have a significant impact on grain storage stability. With YOLO's algorithmic ability to detect small and fast-moving objects, the system can identify the presence of mice even in low- light conditions, which often occur at traditional warehouses . ResultsTesting shows that the system can provide automatic alerts within seconds of detecting mice, enabling operators to take preventive actions quickly. This contrasts with conventional systems that rely on manual monitoring, often resulting in delayed responses. The effectiveness of this early detection has greatly contributed to reducing the risk of grain damage by tens of kilograms per storage period, especially in large-scale warehouses that store hundreds of sacks of grain.

**B. System Performance in Various Warehouse Environmental Conditions**

Warehouse environments are dynamic, with fluctuating temperatures, changing humidity levels, and uneven lighting. These factors affect the system's visual ability to detect mice and influence the likelihood of pests appearing. Tests show that the YOLO model is able to maintain stable detection accuracy even when light intensity changes. In low- light conditions, the use of infrared cameras also helps maintain image quality so that mice can still be clearly identified. In addition to visual aspects, the integration of environmental sensors provides additional information to support decision making. For example, high humidity and warm temperatures increase the potential for mouse activity, so the system can display predictive alerts based on sensor patterns. This information is important to help operators understand when the risk of mouse presence increases so that preventive measures can be taken more quickly.

**C. Operator Response Analysis and User Acceptance Testing (UAT)**

*The User Acceptance Test (UAT)* results show that warehouse operators responded positively to the implementation of the YOLO-based security system. Users found the system's ability to provide automatic notifications and clearly display the location of mice on the dashboard helpful. In addition, the integration of sensor data into a single display makes it easier for operators to monitor warehouse conditions without having to perform time- consuming manual checks.

However, some operators suggested improvements to network stability and camera quality, especially in warehouses located in rural areas with limited internet access. This indicates that further implementation of the system needs to take into account the supporting infrastructure to ensure the smooth running of the real-time monitoring process. Overall, the level of user satisfaction shows that the system has great potential for widespread application in grain storage warehouses, especially in areas that are prone to rat infestations.

### 3.2 Warehouse Environmental Challenges and the Risk of Rat Infestation in Grain Storage

The environment of grain storage warehouses is dynamic and complex, posing various risks to crop quality. One of the biggest risks is rodent infestation, which can cause significant losses through destruction and contamination. As explained in post-harvest studies, the presence of rodents in warehouses is influenced by environmental factors such as temperature, humidity, light intensity, and storage layout. The instability of these environmental conditions poses challenges in maintaining optimal grain quality. In addition, conventional security systems do not provide automatic detection, so rodent activity often goes unnoticed until damage has already occurred. Therefore, rodent control and detection efforts require a more sophisticated approach, including the application of YOLO-based *Object Detection* technology, which is capable of recognizing small objects in real-time under various lighting and warehouse conditions.

#### A. Environmental Risk Factors That Trigger Rat Activity

In general, there are several key environmental factors that contribute to increased rat activity in grain warehouses. The first factor is the physical condition of the warehouse environment, including high temperature and humidity. Rats are very fond of humid and warm environments, so warehouses that do not have adequate ventilation have the potential to become ideal breeding grounds.

The second factor is the availability of food and physical access. Randomly stacked grain sacks, food waste, and gaps in the walls or floors of warehouses are potential entry points that rats can exploit. Without an automated visual monitoring system, rat activity in these areas often goes unnoticed.

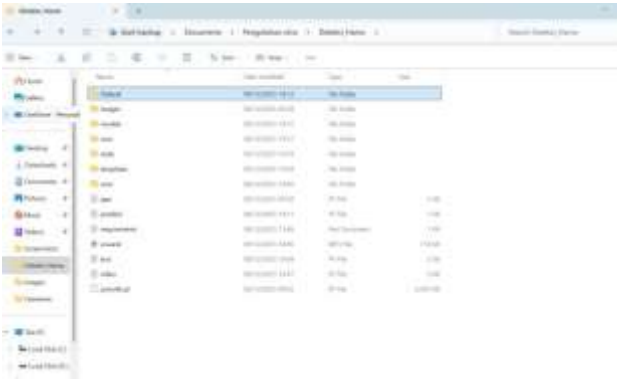
#### B. The Impact of Environmental Risks and Rat Activity on Warehouse Security

Unaddressed environmental risks and rat activity have a significant impact on grain quality and warehouse operational efficiency. First, physical damage to grain sacks is the most common impact, where rats gnaw on sacks causing grain to spill, lose weight, and become contaminated. This damage can occur quickly without detection if the warehouse relies solely on manual inspection. In addition to physical damage, contamination from rat droppings causes far more serious health and quality problems. Contaminated grain is no longer fit for consumption and can increase the risk of disease due to bacteria and pathogens.

The second impact concerns operational efficiency and warehouse management costs. When rodent activity increases, operators need to carry out manual control measures such as setting traps, conducting regular inspections, or using pesticides. This approach is not only time-consuming but also increases operational costs. In fact, some traditional control methods can pose additional risks such as chemical contamination of grain. In addition, damage caused by rodents can result in the loss of part of the harvest, which on a large scale can cause significant economic losses.

## 4. INPUT AND OUTPUT IMAGES

### A. Figure 1 (Dataset file)

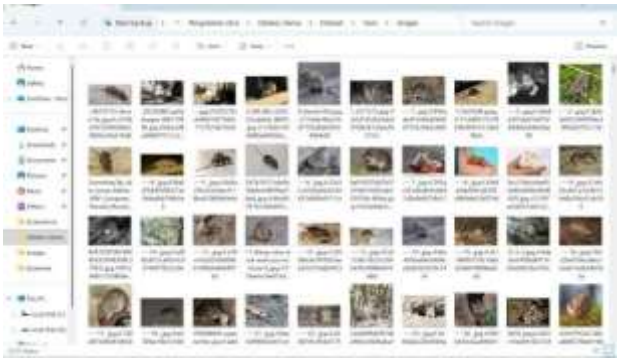


(In this image, I am in my project folder, which contains the initial dataset with images)

### B. Figure 2 (Training dataset display)

(Image 2 shows me on Google Chrome while testing my dataset)

**C. Figure 3 (Image of the training dataset results)**



(Figure 3 shows the results of testing the image dataset I used in my project, which consists of approximately 2,000 images)

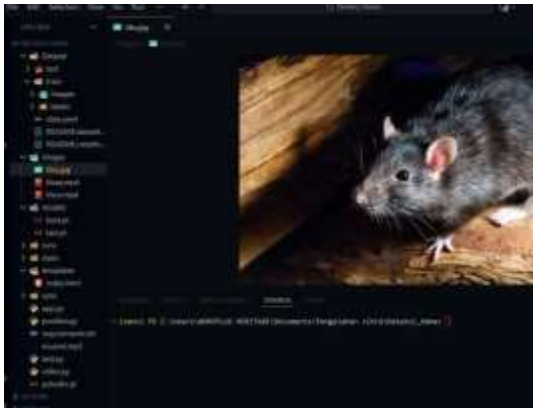
**D. Figure 4: Connecting image display**

(Figure 4 is the data.yaml file for displaying my photo-video calls)

**E. Figure 5 (Video input location)**

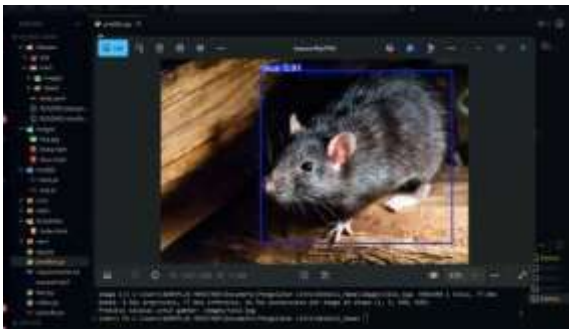
(Image 5 is display of the video storage location that I will test)

**F. Figure 6 (Image Input)**



(Figure 6 is the mouse image input that I will detect)

**G. Figure 7 (Image Output)**



(Figure 7 is the output result of the image I input in Figure 6, successfully detected)

**H. Figure 8 (Video Input)**

(Figure 8 is the video that I will test for detection)

**I. Figure 9 (Video Output)**

(Figure 9 is the detected video output)

**J. Figure 10 (Web Detection Output)**


(Figure 10 is the web output result and camera detection that a mouse has been detected, it has been detected and will sound an alarm)

## 5. CONCLUSION

This research produced a prototype of a Grain Storage Warehouse Security System based on *Object Detection*, with a primary focus on real-time rat detection as a form of improving warehouse security systems that have largely relied on conventional methods. Based on the analysis, design, and discussion that has been carried out, this research proves that the application of YOLO-based Computer Vision technology, when integrated with IoT, can be a modern and effective solution in maintaining grain warehouse security, and has the potential to be further developed as an integrated security system that can be implemented on an industrial scale in agriculture. Several conclusions are as follows:

1. The warehouse security system designed is capable of detecting the presence of rats in real- time using the YOLO algorithm, which has been proven to have a good level of accuracy in recognizing small objects in warehouse environments with varying lighting conditions. This allows operators to take preventive action more quickly before damage to the grain spreads.
2. The system has been proven to provide automatic early warnings, both through visual detection and sensor data, thereby increasing the effectiveness of surveillance compared to manual methods manual or passive CCTV methods. These early warnings play an important role in reducing potential grain damage and maintaining long- term storage quality.
3. The User Acceptance Test (UAT) results show that the system is well received by warehouse operators, as it helps make the daily monitoring process more efficient and provides more complete and easily accessible information through a web-based interface.
4. This research proves that the application of YOLO-based Computer Vision technology, when integrated with IoT, can be a modern and effective solution in maintaining grain warehouse security, and has the potential to be further developed as an integrated security system integrated that can be implemented on an industrial scale in the agricultural sector.

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