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SMART RICE BOX - THE PROTOTYPE OF ORGANIC RICE STORAGE ANTI-RICE WEEVIL FOR FOOD SECURITY DURING PANDEMIC

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ABSTRACT

The need for organic rice among the people continues to increase in line with the declining level of public health due to the COVID-19 pandemic. Consuming organic rice is one way to maintain body immunity, but organic rice is susceptible to attack by Sitophilus Oryzae L, a type of rice weevil which is the main pest in postharvest commodities. Proper storage of rice is one way to address food security during a pandemic. In this study, a prototype of an anti-rice weevil (Sytophilus Oryzae L) organic rice storage was made using a Raspberry Pi controller and several additional sensors such as a camera sensor and temperature and humidity sensors. UV Hydroponic Lamp and LED Grow Light are used to reduce the growth rate of rice bugs during storage. The results showed that the whole system was running well and the rice bugs on rice were drastically reduced within 36 hours and 18 minutes of storage.

***Keywords**: organic rice, prototype, raspberry pi, Sytophilus Oryzae L, UV light.*

I. INTRODUCTION

RICE is a staple food for most Indonesian people. In the rice commodity, we know organic rice and non-organic rice. In Indonesia, the growth of organic rice farming has increased significantly over the last few years. In 2019, according to data from the Ministry of Agriculture, Indonesia has exported approximately 252 tons of organic rice to various countries such as Japan, Hong Kong, Germany, the United States, France, Malaysia and Singapore. The increase in organic rice production has been reported in various media as proof that the quality of organic rice in Indonesia is able to compete with the quality of organic rice in other countries, as evidenced by the high export value of organic rice which also increases every year [1].

The COVID-19 pandemic that is currently affecting the world has impacted many aspects of people's lives. From a health standpoint, it is important to remember that good food intake and nutrition are efforts to boost the body's immunity in order to prevent the transmission and spread of the COVID-19 virus. One way to maintain endurance is to consume organic rice. However, according to Mastuti in 2020, organic rice is extremely vulnerable to attack by a rice weevil known as Sitophilus Oryzae L. This is a significant pest in post-harvest commodities, particularly in important human food categories such as grain/rice, shelled corn, wheat, cassava, and others [2].

During the pandemic, food availability, stability and access will certainly be disrupted. Based on data from the World Food Organization (FAO), the potential for a food crisis during a pandemic will threaten the world, including Indonesia [3]. Based on these facts, to maintain the stability of the availability of organic rice, proper storage of rice is one way to overcome food security during the pandemic.

Several studies were carried out by [4]–[7] i.e., a smart rice box that can monitor and dispense rice

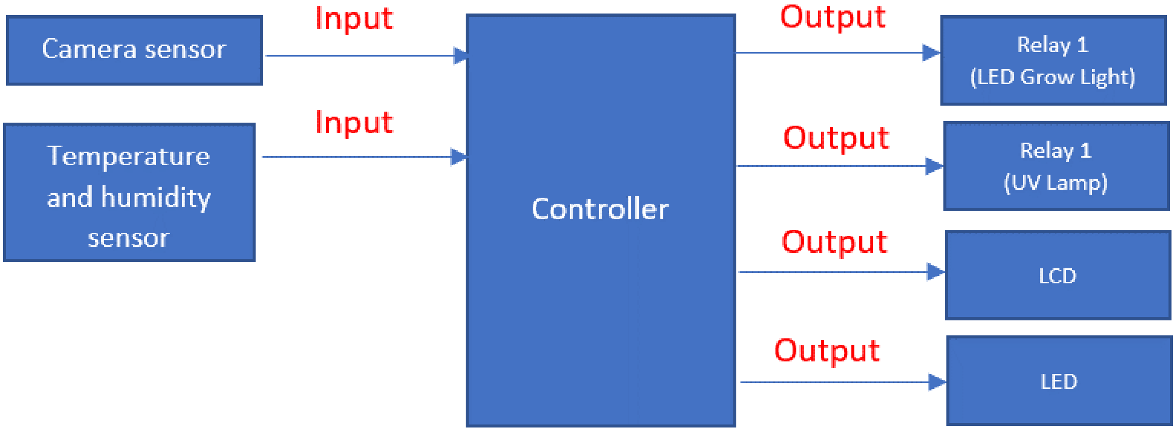


Figure 1. Hardware Design

automatically [4], can eject rice automatically with a predetermined measure and can monitor whether or not rice is in the rice storage box [6], can carry out a rice measuring system based on serving portion requirements [5], can predict rice consumption using the linear regression method [7].

A prototype of an anti-rice weevil (Sitophilus Oryaze L) smart rice box was created in this study. The first step in developing an anti-rice weevil smart rice box was to detect the rice weevil itself. Several related studies have been conducted [8]–[10] , including a piezoelectric rice weevil detector [8] a sound wave rice weevil detector [9] and a nuclear magnetic resonance rice weevil detector [10].

In contrast to previous research, in this study the rice weevil detection method applied computer vision technology with the thresholding method in the HSV color space as the main detection principle. Until now, this method is still the best detection method based on color differences. Several previous studies regarding this method have been carried out. The thresholding method in the HSV color space can distinguish objects to be detected from background objects [11]–[16].

In this study, UV irradiation and color variations of the Hydrophonic LED Grow Light were used to reduce the growth rate of rice weevils in storage. Similar studies have also been conducted [17]–[21]. These previous studies include the effect of irradiating UV light can reduce the growth rate of rice weevil Sytophilus oryzae [17], flour insects [18] , Tyrophagus putrescentiae [19], , Oryzaephilus surinamensis, Tribolium castaneum, mites, Acarus siro and Tirofagus putrescentiae [20], and other types of insects from Alphitobius diaperinus and their heredity [21].

This study aims to make a prototype of an anti-rice weevil Sitophilus Oryzae L organic rice storage container by applying appropriate technology that can detect the presence of rice weevils in the storage area while simultaneously reducing the growth rate of rice weevils so that organic rice can remain durable and safely stored in storage containers. long time. Finally, food security can be created during a pandemic.

II. RESEARCH METHOD

The method used in this study includes the creation of hardware and software, which are then combined to form a single prototype of the smart rice box.

A. *Hardware Design*

Figure 1 shows the hardware design for a smart rice box prototype. Based on Figure 1, a controller, namely a Raspberry Pi is used to control two sensors, namely a camera sensor which functions to detect the presence or absence of rice weevils in the storage area along with temperature and humidity sensors which function to check the temperature and humidity conditions in the storage area. The two sensors are interconnected because rice weevils will easily land and reproduce if the storage conditions are humid. Thus, the temperature and humidity conditions in the storage area must be considered carefully.

The next device controlled by the controller is the relay. In this study, two relays were used to activate Hydroponic LED Grow Light and UV Lamp respectively. These two hardware components function as

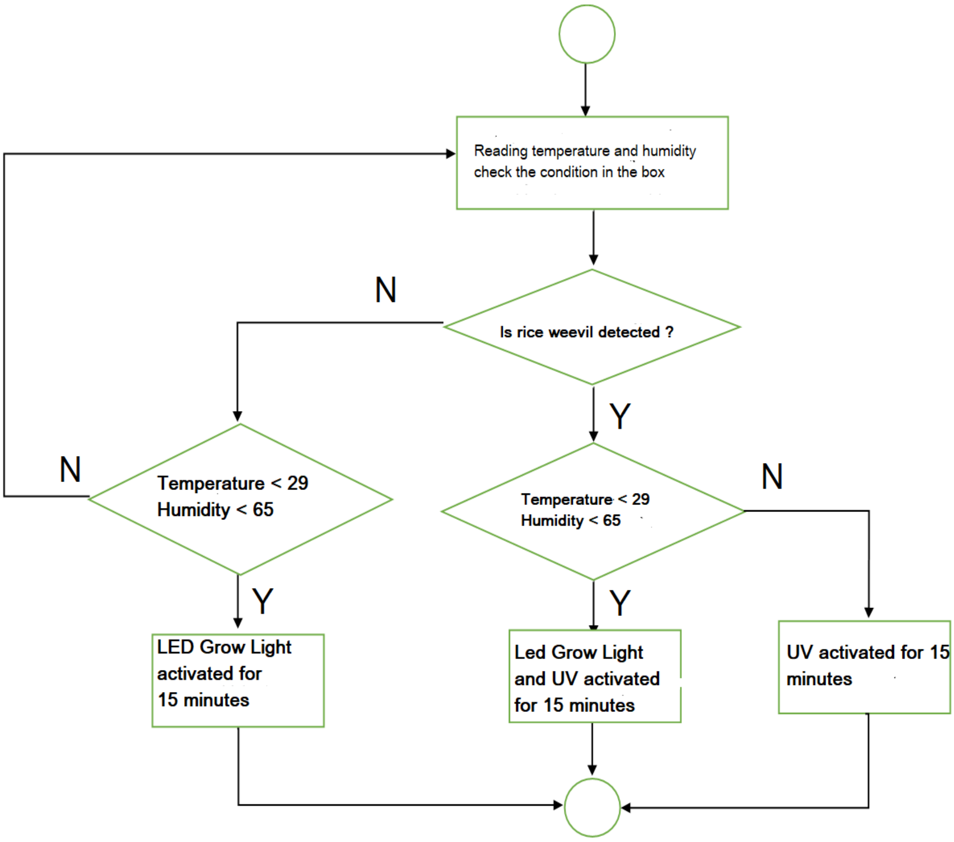


Figure 2. Software Design

actuators that follow up on checking the camera sensor and temperature and humidity sensors. To facilitate the detection of rice weevils in the storage area, an LED is used to display temperature and humidity conditions as well as other conditions such as the detection of rice weevils using an LCD screen.

It is widely known that sunlight contains ultraviolet (UV) radiation. Based on the wavelength, sunlight is divided into 3: Ultraviolet Rays A (UVA), Ultraviolet Rays B (UVB), and Ultraviolet Rays C (UVC). In this study, 2 lamps were used, namely Hydroponic Grow Light LED lamps and UV lamps which were used as a substitute for sunlight in the rice storage area. This light is used because in the traditional way, generally if the rice stored in the storage area is attacked by rice weevils, the most effective way is to dry the rice directly in the sun for some time. With the development of technology, the researchers felt that this method could be replaced in a more practical way without disassembling the rice in the storage area, namely by looking for hardware to replace the original sunlight which is currently widely circulated in the market.

Hydroponic LED Grow Light is a lamp that is used as a substitute for sunlight. This type of lamp varies depending on the color of the lamp. In this study, a total of 80 Hydroponic LED Grow Lights were used with the full color spectrum. This lamp provides a super bright effect in storage with a wide variety of colors and high wavelengths, the red spectrum ranges from 665 – 726 nm and the blue spectrum ranges from 445 nm – 486 nm.

UV lamps are commonly used in aquariums or for disinfection by irradiation. In this study, a UVC lamp containing ultraviolet C was used. When rice weevils are detected and the temperature in the storage area is below standard, this lamp will raise the temperature in the storage area while causing the rice weevils and other insects in the storage area to come out / die slowly (sterilized).

B. Software Design

The software integrated into the prototype hardware is designed as shown in Figure 2. Based on Figure 2, the initial conditions of the system will read the temperature and humidity conditions (temperature and humidity sensors) in the storage area along with the condition of the rice in it (camera sensor) whether there are rice weevils or not . If rice weevils are detected, temperature and humidity conditions will be checked gradually. If the temperature < 29 and humidity < 65, the system will activate the Hydroponic LED Grow Light and UV Lamp for 15 minutes.

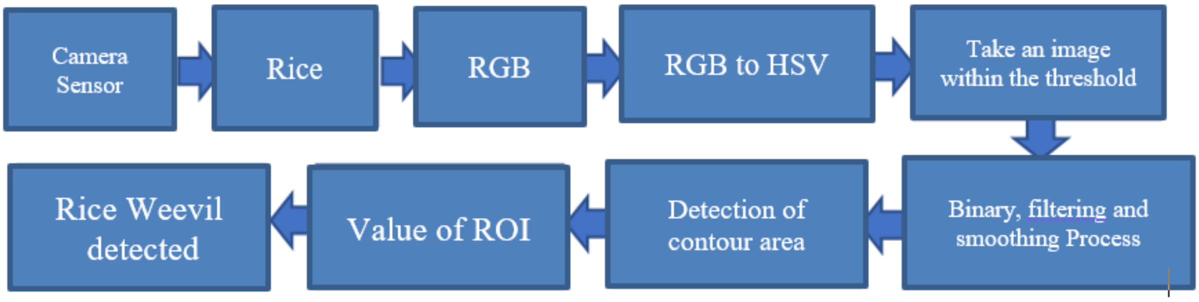
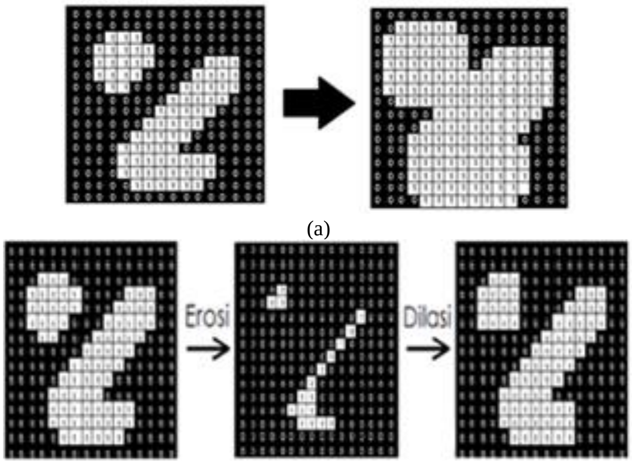


Figure 3. The Flow of Rice Weevil Detection



(a)

(b)

Figure 4. Morphological Filter (a)Dilation (b)Opening

If rice weevils are not detected and the temperature conditions are below the reference, only the LED Grow Light Hydroponic will be activated, but if the rice weevils are detected and the temperature conditions are above the reference conditions, only the UV lamp will be activated. After all conditions are met, the system will repeat to check from the beginning, and so on during the storage process in the prototype of smart rice box.

This study uses the Python programming language with the Open CV Library and several digital image processing methods. Flow detection in the smart rice box system is illustrated in Figure 3. Based on Figure 3, the image data from the camera sensor in the form of an RGB image is converted into an HSV image. Then, the value of the HSV image that is within the threshold is taken. This threshold limit is determined before making the whole program. This threshold is needed to distinguish between rice weevil images and rice images. The threshold value in question is the color value that is clearly different between the rice hulls and other rice around it. Values that fall within this threshold will be retrieved and then processed using binarization, filtering, and smoothing methods.

Binarization functions to change the value of an image to black (0) or white (1). In this case the rice weevil image will be changed to white while the rice image will be changed to black. In order for the binary image to be sharper, the filtering method is used, which is a process of filtering certain frequencies from a set of signals that will be passed. This study uses a morphological filter operation called dilation and opening. Morphological filter is an image processing method based on the shape of image segments which aims to improve segmentation results [22][23].

Dilation is a method for extending the object boundaries of a binary image by adding layers around the object. The dilation method is shown in Figure 4a and the opening process is shown in Figure 4b. As can be seen in Figure 4a, background points (0) which are adjacent to object points (1) are changed to object points (1). Meanwhile, Opening is a type of morphological filter operation that uses a combination of two methods, called the erosion method followed by the dilation method. The erosion method is the reverse of the dilation method. The opening process begins with image scraping, then dilation is carried out on the scraped image. Typically, the opening is used to remove small objects.

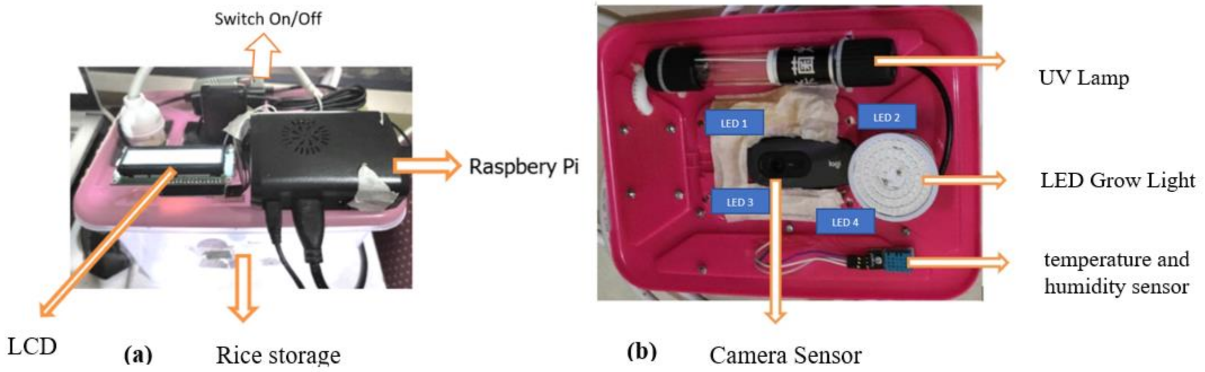


Figure 5. Overall prototype (a) external view (b) inside view

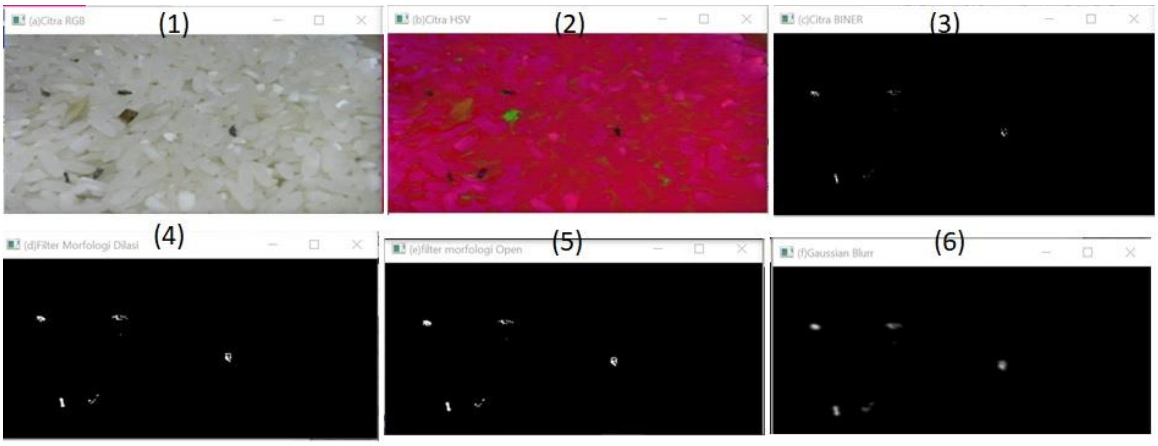


Figure 6. Images of Rice Weevil Detection Process

The next method used is image smoothing. This method is used to create subtle effects on images as well as to emphasize the desired area/ROI (Region of Interest) value. This image alignment process uses the Gaussian Blur method. Gaussian Blur is a very effective method for removing Gaussian noise from images [24]–[26].

The last method used to avoid detection errors between rice weevils and paddy, due to the similarity of threshold values and reduced light intensity factors in the detection space, is the second detection method called the contour area method. The detection of this contour area is in the form of the type of contour and the width of the contour area to produce an ROI that matches the size of the Sitophilus Oryzae L rice weevil.

III. RESULT AND DISCUSSION

The results of this study include hardware, software, and overall system test results from the smart rice box prototype which are explained in each of the following sub-chapters.

A. Hardware

Figures 5a and 5b show the hardware prototype of the smart rice box. Figure 5a shows the smart rice box from the outside, showing the controller, LCD display, and on/off switch. Figure 5b shows the inside of the smart rice box, which includes a camera sensor, temperature and humidity sensors, 4 LEDs, UV lights, and a permanent Hydroponic LED Grow Light.

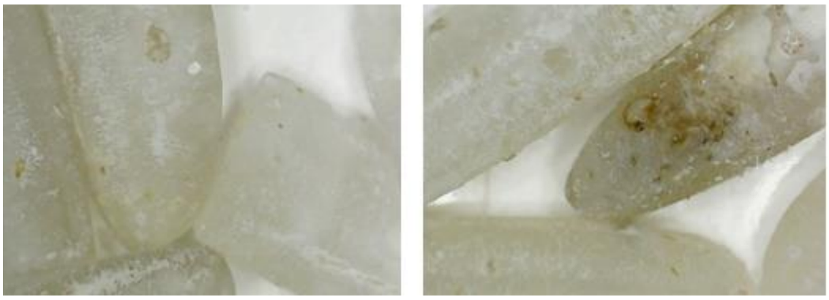
B. Software

The results of the camera sensor detection process are shown in Figure 6. Figure 6 shows the processes in digital image processing as described in the previous chapter. Image (1) is an RGB image from the camera sensor in real-time, (2) is an HSV image converted from an RGB image, (3) is an HSV image used as a binary image, (4) is a binary image filtered with a Dilation filter Morphology, (5) is the resulting image from the Opening Morphology filter, and (6) is the resulting image from the Gaussian Blur.

TABLE 1
RESULTS OF ENTIRE SYSTEM TESTING ON ORGANIC RICE SAMPLES

Condition	Smart Rice Box (Received treatment)	Regular Box (Untreated)
Rice	A bit fresh	Not fresh
Rice Weevil	Burn and die	Breed
Other Insect	Is lost	Breed
Rice Smell	Normal	Musty
Rice Color	Slightly yellowed	Yellow
Rice Texture	Not flour	Flour

Figure 7. Final Results of Rice Weevil Detection



(a) (b)
Figure 8. (a) Rice in Smart Rice Box (b) Rice in Regular Box

(a) (b)
Figure 9. (a) Rice Weevils in Smart Rice Box (b) Rice Weevils in Ordinary Box

The results of the camera sensor detection after processes (1)-(6) are shown in Figure 7. As shown in Figure 7, there are several rice weevils on the rice and also small stones whose color is almost similar to rice beetles. However, the program does not detect stones as rice weevils. The detection results are perfect and can really distinguish between rice and rice weevils.

C. Discussion

The whole system was tested using organic rice test material that contained rice weevils and other insects, but the quality was still quite good. This organic rice is divided into two parts, each weighing 302.5 grams. The first section contains rice that has been tested using a Smart Rice Box (receiving treatment) for 36 hours 18 minutes, while the second section contains rice that has not been stored in a Smart Rice Box (without treatment) or an ordinary box. Table 1 shows the results of this test.

Based on Table 1 it is known that the condition of the rice and rice weevils in each section experienced a significant difference. From the rice side it looks like in Figure 8a for rice in a Smart Rice Box and Figure 8b for rice in a regular box. It is clear that the rice in the Smart Rice Box still looks a little fresh even though there are several holes bitten by the rice weevil, but not as much as the rice stored in a regular box, where this rice tends to be very damaged. The condition of this rice can be seen after approximately 2 months after testing with the Smart Rice Box.

The condition of the rice weevils in the Smart Rice Box and in the regular box can be seen in Figure 9 below. In Figure 9a it can be seen that the rice weevils stored in the Smart Rice Box for 36 hours and 18 minutes burned and died. Meanwhile, in Figure 9b are rice weevils in a regular box that are still fresh and lively. Then, other insects that were originally found on organic rice disappeared after being tested with a smart rice box. In terms of the smell of the rice, it also looks different, the rice tested in a smart rice box does not smell, the color is slightly yellow and the texture is not starchy, while the rice stored in a regular box smells a bit musty, has a yellow color and flour texture. Overall, the rice bugs found in the previous rice reduced drastically after testing with a smart rice box.

IV. CONCLUSION

The Smart Rice Box prototype in this study can be used properly and the whole system can work well in terms of hardware and software. Detection of rice weevil with threshold value determination method works well and can distinguish rice, small stones, and rice weevils. After testing for 36 hours and 18 minutes, the Sitophilus Oryzae L. rice weevil decreased drastically, other insects on the rice also disappeared and did not return, the rice did not suffer further damage and was checked again after 2 months of testing. The Smart Rice Box prototype is expected to be developed on a large scale and can contribute to food security during a pandemic.

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