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# Rat Repellent in Rice Fields Using Sound Sensors and Solar-Powered BEN 5M-MFR Autonic Sensors

**Mochamad Alfin Bachtiar Alfad[1], Indah Sulistiyowati[2]**
[1,2]Muhammadiyah University of Sidoarjo, Indonesia

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**ABSTRACT**

***Objective:*** *Rice is a staple food in Indonesia, but pests such as rats and birds often cause significant crop failures. This research developed a technological solution using solar power to deter these pests and optimize yields.* ***Method:*** *The study utilized a research and development approach, testing components such as solar panels, a timer, an FC-04 sound sensor, and an autonic BEN5M-MFR sensor.* ***Results:*** *The results indicate that the sensor can detect pests within a 7m range, triggering ultrasonic waves regulated by the timer to effectively repel rats and birds. The solar panel maintained a consistent 13V throughout the day, and the battery powered the system for 7 hours, demonstrating the viability of the solar-powered design to meet operational requirements.* ***Novelty:*** *This innovation contributes to enhancing food security by mitigating the impact of pests on rice cultivation through the integration of renewable energy technology.*

## INTRODUCTION

Located right on the equator, Indonesia has a strategic advantage in the form of a tropical climate with abundant sunshine to illuminate its vast landmass. This advantage makes Indonesian society an agrarian society, utilizing the agricultural sector as its main livelihood. One of the main commodities in Indonesia is rice for rice production, which is the staple food for the majority of the population [1]. According to data from the Central Bureau of Statistics in 2023, local rice production reached 30.90 million tons. This figure is down 645.09 thousand tons or 2.05% compared to rice production in 2022, which reached 31.54 million tons [2]. There are many factors that cause this decline, such as the continuously increasing population, conversion of agricultural land, poor fertilizer quality, or panel failure due to toxins and pest attacks. Pest attacks caused by herbivorous animals like rice field rats can lead to economic losses because they can reduce the effectiveness, quality, and quantity of the affected crops [3], [4].

In taking preventive measures to control the increasing rodent population, there are many mechanisms that can be employed. One mechanism that can be used is to exploit the weakness of field mice to ultrasonic waves with frequencies in the range of 5-60 KHz, which can disrupt the mice's body systems, eliminating the need for farmers to use chemical elements [5], [6]. This research aims to create an ultrasonic frequency generator tool that will be designed using an AUTONIC BEN5M-MFR sensor control. When the sensor detects movement, the tool will immediately send a signal to the ultrasonic waves, producing a sound that will disturb mice for several minutes, depending on the time setting, with a frequency range of 40 – 60KHz [7]. This final project intends to create a mouse pest repellent tool in rice fields using a sound sensor and a solar-powered AUTONIC BEN 5m-mfr sensor. This device is equipped with an autonic distance sensor and a sound sensor as inputs for ultrasonic waves. The autonic distance sensor will activate if it detects movement in front and send a signal to the relay, which will then turn on the timer, causing the ultrasonic device to sound and automatically turn off according to the timer setting. The sound sensor will be connected in parallel with the distance sensor, but the sound sensor will only activate if it detects sound in the vicinity and will operate the ultrasonic device in the same way as the autonic distance sensor, automatically turning it off. The power supply will come from solar panels that will charge the battery. The inverter here functions to convert DC current into AC.

Several previous studies on this topic have been conducted, including research by Herlambang (2020), where the researcher created a mouse pest repellent device utilizing the capabilities of a PIR sensor to detect mouse objects at a maximum distance of 4 meters, which is then controlled by an Arduino Uno microcontroller. When the sensor detects mouse movement, a sound produced by a buzzer will be emitted and the servo motor will move [8].

The second study used as a reference in the creation of this final project is Mochamad Farras Fauzan (2023), where the researcher developed a solar power plant to supply power to the Arduino Uno microcontroller and PIR sensor, which was then supplemented with an output in the form of scarecrows that would vibrate when the PIR sensor detected rat pests [9], [10].

The latest research by Muhamad Hilmy Afif (2023) involved implementing a siren with a frequency of 1Khz to 2.5Khz to scare away bird pests. The microcontroller used is the Arduino Uno, combined with a PIR sensor. The device is powered by a solar power plant, making it independent of the government's electricity grid [11], [12].

Current research provides an update on the innovation of using the BEN5M-MFR sensor to detect sound and distance [13]. Furthermore, the use of the PLC CP1E from a microcontroller, which is generally like Arduino, makes this tool superior to previous research [14].

## RESEARCH METHOD

The research utilizes a research and development method by testing the effectiveness of the tool thru various experiments, improvements, and finalization of the tool in order to overcome the problems faced and achieve the final goal where the product functions according to the research objectives [15]. The stages in the research and development method are problem identification (1); literature review (2); design (3); testing (4); improvement (5); and implementation (6).

**A. Block diagram**

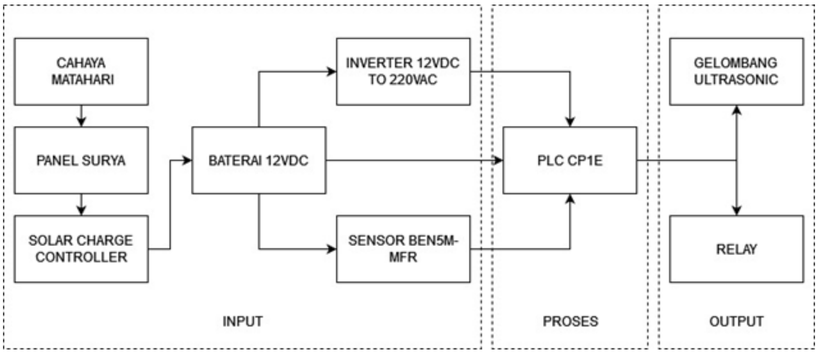


**Figure 1.** Block Diagram.

The system block diagram starts with the voltage source center, which is the 12V battery automatically charged by the solar panel SCC. It then goes to the step-up transformer for 24VDC power output to the BEN5M-MFR distance sensor, where the sensor will detect movement passing in front of it. If there is movement, it will automatically turn on the timer, and the timer will emit ultrasonic waves. The inverter in this circuit functions to change the voltage from a 12 VDC battery to 220 VAC, then from the inverter to the sound sensor as an automatic switch to turn on the timer. When the sensor detects sound, it automatically turns on the timer, and the timer will emit ultrasonic waves.

**B. Flowchart**

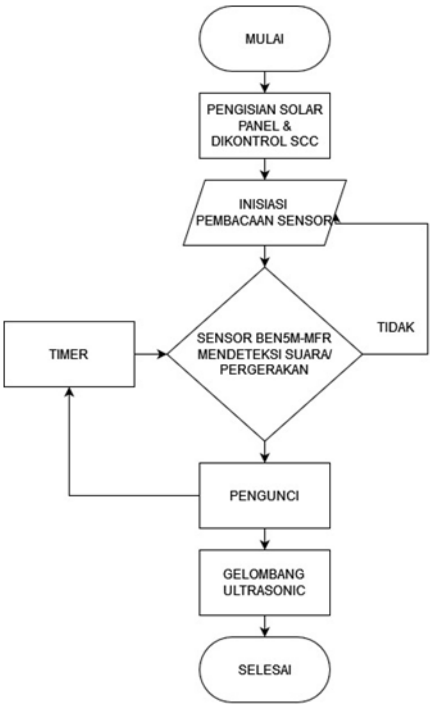


**Figure 2.** Flowchart.

The flowchart begins with the solar panels connected to the SCC and charging the batteries. After receiving power from the battery, the distance sensor will detect movement, while the sound sensor will detect nearby sounds that will activate the ultrasonic waves. Once the distance/sound sensor detects movement/sound, the ultrasonic waves will emit sound until the timer reaches its target, at which point the ultrasonic waves will automatically turn off.

### C. Wiring Diagram

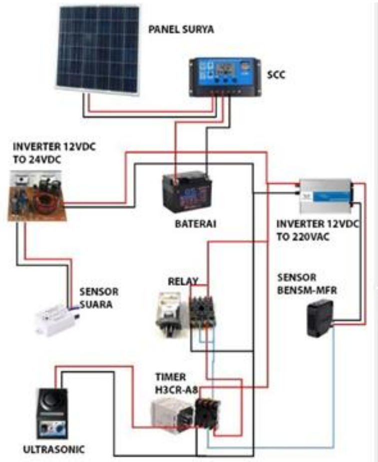


**Figure 3.** Wiring Diagram.

Solar panels absorb or store sunlight energy, which is then converted into electricity as a power supply source. The SCC then controls battery charging from the energy generated by the solar panels, and the battery stores the energy generated by the solar panels to supply power to the load after being converted from DC to AC thru the inverter. The inverter is useful for converting DC voltage to AC and the 12VDC to 24VDC inverter is used to supply the distance sensor. The battery charged by the SCC will go to the 12VDC to 24VDC inverter and the 12VDC to 220VDC inverter. The 24VDC inverter is connected to the distance sensor power and the NO contact of the distance sensor is given 220VAC voltage. When the sensor detects movement, the NO contact will change to NC and the 220VAC voltage will go to the timer. While the timer is working, it will be locked by a 220VAC relay and the ultrasonic waves will sound until the timer setting time is over. The 220VAC inverter will be connected to the sound sensor, which also has an NO contact connected to 220VAC voltage. When the sensor detects sound, it will work and the NO contact will change to NC and turn on the timer, just like the distance sensor, because the distance and sound sensor circuits are connected in parallel.

## RESULTS AND DISCUSSION

### A. Solar panel charging test

Solar panel testing is conducted to determine the charging capacity of the solar panel, which is regulated by the solar charge controller (SCC) and then stored in the battery.

**Figure 4.** Process of Testing Solar Panel Charging When Displayed on SCC.

The solar panel testing in this study was conducted under two different conditions, namely sunny and cloudy, to determine the difference in voltage charging between the two. The results of this testing can then be seen in the table below.

**Table 1.** Solar Panel Charging Test.

| Test | Output Voltage (Sunny Weather) | Output Voltage (Cloudy Weather) |
|---|---|---|
| 1 | 13.65 volt | 12.00 volt |
| 2 | 13.72 volt | 12.01 volt |
| 3 | 13.80 volt | 12.02 volt |
| 4 | 14.86 volt | 12.04 volt |
| 5 | 14.00 volt | 12.05 volt |
| Average | 13.806 volt | 12.024 volt |
| SD | 0.12 volt | 0.02 volt |

As can be seen in the table above, there is a fairly consistent difference: when the sun is bright, the average voltage produced is 13VDC, while when it is cloudy, the voltage produced only reaches 12VDC.

**B. Battery Endurance Testing**

Battery endurance testing was conducted by performing calculations and analysis, followed by direct testing using a single 12V/7Ah capacity battery. The battery voltage here reads 13.76 Volts, so what is meant by a 12 Volt battery is the battery's capacity when the voltage is low.

Given:

Battery Voltage = 13.76 Volts.

Battery Capacity = 2 x 7 Ah.

Therefore,

Battery Power = 13.76 x 7 x 2 = 192.64 Wh (Watts per Hour)

Control Circuit Power = 12.4 Volts x 2 A = 24.8 Watts

Battery Endurance = 192.64 Watts / 24.8 Watts = 7 Hours.

So, based on the calculation results, the battery can supply the control circuit for a duration of 7 hours with a solar panel capacity of 30WP. However, in field use, the battery is only used up to a maximum of 50% of its capacity to extend its lifespan.

**Table 2.** Battery Endurance Testing.

| Test | Battery | Battery Endurance | Measured |
|---|---|---|---|
| 1 | 100% | 7 hours | 13.76 V |
| 2 | 75% | 5 hours | 12.5 V |
| 3 | 50% | 3 hours | 11.58 V |
| 4 | 25% | 0 hours | 11.0 V |

The amount of time the device can be used when the battery is full (100%) is up to 6 hours with a rated voltage of 13.76V and ultrasonic waves can be emitted well. When the battery power is 75%, the battery lasts for 4 hours. However, when the battery capacity reaches below 50%, the use of the entire device must be stopped to preserve the battery and extend its lifespan, as using it at a voltage below 11.0 volts will cause overvoltage.

**C. Testing the BEN5M-MFR distance sensor**

Testing the BEN5M-MFR distance sensor was conducted to evaluate the sensor's capabilities and detect objects within a specific distance range.

**Table 3.** BEN5M-MFR Distance Sensor Testing.

| No. | Distance | Distance Sensor BEN5M-MFR | Ultrasonic Wave |
|---|---|---|---|
| 1. | 1 meter | ON | Sounds |
| 2. | 3 meters | ON | Sounds |
| 3. | 5 meters | ON | Sounds |
| 4. | 7 meters | ON | Sounds |
| 5. | 8 meters | OFF | No |

The BEN5M-MFR distance sensor testing shows that the effective range of the sensor is from 1 meter to 7 meters. When the mouse pest object is within that effective range, ultrasonic waves can be emitted to repel the pest.

**D. Overall Testing**

Overall testing of this pest repellent device was conducted to test the device's overall capabilities to ensure it met the device's previously determined objectives and algorithms.

**Figure 5.** Overall Tool View.

The image above shows the tool created in the study, where the solar panels are installed as a single unit with a lightweight steel frame, and below it is a control panel containing the SCC, inverter, and battery.

**Table 4.** Overall Testing.

| No. | Distance | Distance Sensor BEN5M-MFR | Sound Sensor | Ultrasonic Wave | Rat Reaction |
|---|---|---|---|---|---|
| 1. | 1 meter | ON | - | Sounds | Runs |
| 2. | 3 meters | ON | - | Sounds | Runs |
| 3. | 5 meters | ON | - | Sounds | Runs |
| 4. | 7 meters | ON | - | Sounds | Runs |
| 5. | 8 meters | OFF | - | No | No |

The test results show that when the BEN5M-MFR distance sensor successfully detects rat pests and activates ultrasonic waves, the rats run away from the rice fields.

## CONCLUSION

**Fundamental Finding :** The solar panel and battery charging system shows optimal charging, enabling the battery to last for 7 hours, allowing the device to activate the BEN5M-MFR distance sensor for as long as possible so that ultrasonic waves can effectively repel mice and birds from rice fields, preventing crop failure for farmers. **Implication :** The solar panel and battery charging system shows optimal charging, enabling the battery to last for 7 hours, allowing the device to activate the BEN5M-MFR distance sensor for as long as possible so that ultrasonic waves can effectively repel mice and birds from rice fields, preventing crop failure for farmers. This result indicates that solar-powered pest control systems can be a practical and sustainable solution for agricultural pest management in rice fields. **Limitation :** The installed sound sensor did not show significant results, so an alternative sensor that is more effective when paired with the BEN5M-MFR autonic sensor is needed. **Future Research :** The installed sound sensor did not show significant results, so an alternative sensor that is more effective when paired with the BEN5M-MFR autonic sensor is needed. Future studies should explore the integration of more responsive sensing technologies to improve pest detection accuracy and system effectiveness under diverse field conditions.

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**Mochamad Alfin Bachtiar Alfad**
Muhammadiyah University of Sidoarjo, Indonesia

***Indah Sulistiyowati (Corresponding Author)**
Muhammadiyah University of Sidoarjo, Indonesia
Email: indah_sulistiyowati@umsida.ac.id