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Development of a Solar Powered Bird Repellant System for Increasing Rice Production in Nigeria

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ABSTRACT :*In 2022, the Nigerian Government implemented a ban on rice imports, aiming to bolster local rice farming and alleviate pressure on foreign exchange reserves. This initiative aimed to encourage farmers to prioritize domestic rice cultivation to cater to the dietary needs of the Nigerian populace, given rice's ubiquitous status as a staple food.*
However, an initial hurdle arose as birds began infiltrating rice fields during the early morning hours, wreaking havoc on the precious crops. Conventional bird deterrent methods, such as scarecrows and hawk kites, proved ineffective against these avian intruders.
Birds, being an integral part of the ecosystem, pose a significant threat to agricultural productivity by causing damage to economically significant crops. Traditional bird scaring techniques, relying on scarecrows, hawk kites, and manual labor, have become increasingly inadequate over time.
To protect farmlands and crucial crops from avian predation, a user-friendly and reliable solution was proposed: a solar-powered electronic Ultrasonic bird repellent. This innovative design harnesses solar energy during the day and is supplemented by battery power at night, controlled by an Arduino circuit. It offers a dependable and safe method for dispersing and controlling birds in agricultural settings, potentially enhancing rice production yields if adopted in Nigeria or other applicable regions.
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KEYWORDS *Solar,bird, repellant,sound, solar, wind.*

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I. INTRODUCTION

Farmers use different approach when it comes to pest control especially when it comes to more active pest like Birds and animals like rodent[1] etc. Farmers employ diverse approaches to pest control, particularly when dealing with active pests like birds and rodents. This study explores current strategies used by farmers for bird pest control and evaluates their effectiveness. It also details the construction of our prototype and the technology employed. Several techniques are available to safeguard crops from bird damage, and the focus of this study is on assessing the efficacy of each technique, which varies depending on the bird species involved. The most effective bird control methods often combine multiple techniques or employ them in a strategic rotation.

Traditionally in Africa, cost-effective methods are prioritized. Preventive methods aim to deter birds from fields and can be categorized as lethal and non-lethal techniques. Lethal techniques, managed by national or regional crop protection units, aim to reduce bird populations through methods like manual pest destruction, avicides (chemicals dangerous to particular bird species), and tools such as explosives or flamethrowers. Non-lethal techniques include agronomic practices such as vegetation and weed management, strategic planning of crop seasons, and selecting bird-resistant crop varieties. Additionally, traditional religious practices like shamanism and fetishes are still widely employed, especially in Africa[2].

When birds do invade rice fields, protective measures focus on minimizing crop damage. These include using bird repellents, installing nets or wires to shield fields or nurseries, and covering individual crop heads with grass or cloth bags as safeguards.

Traditionally, on small privately owned farms in Africa, manual bird scaring, flags, and scarecrows can effectively protect crops when bird numbers are low. However, these methods prove inadequate when facing

large-scale pest infestations in government-run agricultural projects due to their inefficiency, inconvenience, and high costs.

Farmers face significant risks, prompting the need for safeguarding strategies such as insurance schemes (e.g., PINORD)[3] against major bird infestations. In several African countries, large-scale chemical control methods are still commonly used to suppress bird populations to non-pest levels, although their effectiveness varies geographically and based on the control mechanism used. It is important to note that these chemical strategies carry environmental risks and must be managed carefully[4]., while various techniques exist for bird pest control in agriculture, their effectiveness depends on factors like bird species[5], geographical location, and the scale of agricultural production. Integrating multiple methods and adapting strategies to local conditions are crucial for successful pest management and sustainable agriculture[6].

II.METHODOLOGY

An Arduino controlled circuit is used It also contains our mode of our design and technology used. Numerous techniques exist to shield crops from bird damage. This study primarily focuses on evaluating the effectiveness of these techniques, which varies depending on the species of birds involved, particularly in Africa., traditionally, low cost methods are mainly considered[7].

The Designed model

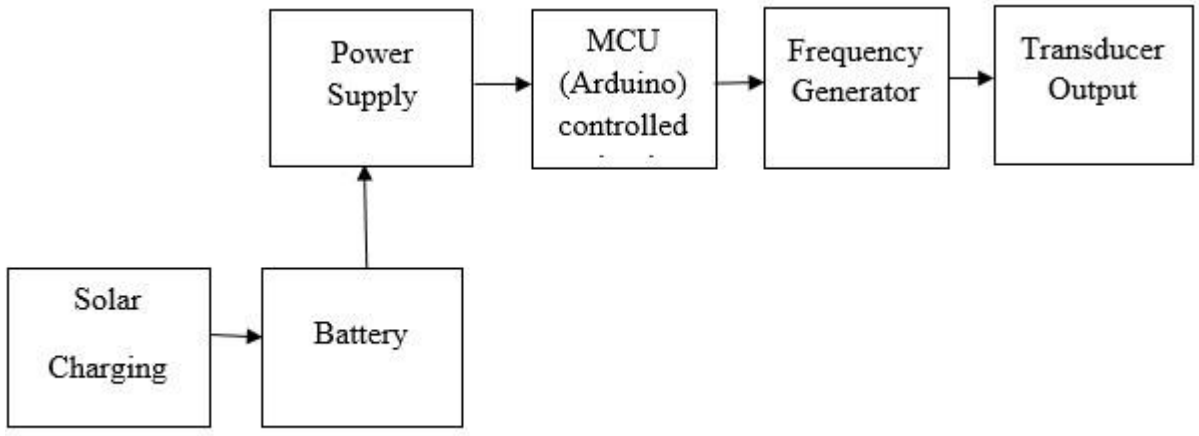

Figure 1: Block diagram of the bird repellant

Operation of the system

The system is completely automated, with an ultrasonic motion sensor configured and uploaded to the microcontroller turning it on and off for a predetermined time interval. The dynamic and sonic bird repellant is made up of two different components that work together to make the bird repellant efficient in scaring or deter birds from the fields while preventing them from becoming accustomed to the scaring methods employed. The motion gesturing system and the sound production system are both active at the same time. The following is a detailed description of each subsystem's operation:

Power source supply

An 18volt, 15watt solar panel collects energy from the sun and uses it to charge a 12V DC battery. Electrolytic capacitors filter the 12V DC voltage, which is then regulated by a voltage regulator to produce a pulsing 5V DC. The microcontroller receives a fixed 5V DC supply from the zener diode. And the buzzer-speaker also receives 5-12volts from the zener diode.

MicrMicrocontroller

A microcontroller (MCU), housed on a single integrated circuit (IC) chip, functions as a miniature computer. It integrates one or more CPUs, memory, and programmable input/output peripherals. Typically, it includes program memory like ferroelectric RAM, NOR flash, or OTP ROM, alongside a small amount of RAM. Unlike

microprocessors found in PCs or general-purpose applications using separate chips, microcontrollers are specifically tailored for embedded applications.

, Even when Intel introduced the first microcontroller, the 4004, there was already a burgeoning demand for such devices[8]. The contemporaneous TMS1082 from Texas Instruments, originally designed for calculators, by the end of 1971 was being promoted for applications in cash registers, watches, and measuring instruments. The TMS 1000, introduced in 1974, integrated RAM, ROM, and I/O on-chip, marking one of the earliest microcontrollers, despite being labeled as a microcomputer. The Intel 8048, notably integrated into PC keyboards, and its successor, the Intel 8051, along with Motorola's 68HCxx series, were among the first microcontrollers to achieve widespread adoption. Today, microcontroller production numbers reach billions annually, with these devices integrated into a vast array of appliances. [9].

Microcontrollers are essential components in automated products and devices, ranging from automobile engine control systems and implantable medical devices to remote controls, office machines, appliances, power tools, toys, and various embedded systems. By integrating microprocessors, memory, and input/output devices on a single chip, microcontrollers significantly reduce size and cost compared to designs using separate components. This integration makes it cost-effective to digitally control a wide range of devices and processes. [10]

Ultrasonic motion sensor

An ultrasonic sensor is an electronic device that utilizes ultrasonic sound waves to measure the distance to a target item and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than audible sound waves, which are within the range of human hearing. The primary components of ultrasonic sensors include a transmitter, which generates sound using piezoelectric crystals, and a receiver, which detects the sound after it has traveled to and bounced back from the target.The sound-producing system has the key components of the sonic bird repeller that was conceived and built. The four cardinals facing ultrasonic motion sensors are mounted at the four cardinal points in the device box in order to sense movement all around the box location to cover the surrounding area of the box, while the sound system consists of a buzzer-speaker that sends out a particular frequency sound at a frequency range 15-25 KHz.

System construction procedures

The 12V battery is attached to the microcontroller connected to the four ultrasonic motion sensors that are located facing the four cardinal points from the box container, powered by a18V 15W solar panel. One of the buzzer's legs is also connected to the collector of an NPN transistor, which has a grounded emitter and is base is attached to a resistor connected to a microcontroller.

Motion unit

The motion unit working principle is that a ultrasonic motion sensor functions as an input to the microcontroller, which delivers a digital high (1/ON) or digital low (0/OFF) signal to the microcontroller depending on the differential change observed by it to turn on the buzzer-speaker on or off when a bird is detected. A high digital signal from the ultrasonic sensor is delivered to the microcontroller, triggering the buzzer-speaker as motion is detected. If no bird is observed in its vicinity, the sonic sensor sends a low digital signal, which signifies the unit continues in the same state of no motion.

Sound producing unit

A piezo buzzer-speaker is set at a particular frequency within range of 15-25KHz at (12~220V, < 20mA), and four Ultrasonic sensors make up this unit.

The Ultrasonic sensor act as input to the microcontroller, it is used as an input to the microcontroller in this unit. When the Ultrasonic on the bird repeller device detects motion within its detecting range, it transmits a digital high signal (1/ON) to the microcontroller, which turns on the buzzer-speaker, and makes a designed frequency sounds for a predetermined time as written in the software to irritate and scare away the birds.

III. COMPONENTSELECTION

Table 1: Component used in implementing model

1.	ITEMS	QUANTITY

2.	MICROCONTROLLERAT MEGA 328	4
3.	ULTRASONIC SENSOR	4
4.	CD4047 OSCILLATOR	4
5.	TRANSISTOR 2N3904	4
6.	VARIABLE RESISTOR 10K	10
7.	BATTERY 12-VOLTS DC 100AH	2
8.	SOLAR PANEL DC 24V,250W	2
9.	TWEETER SPEAKER FREQ 4KW	4
10.	CERAMIC CAPACITOR 104µF	4
11.	Charge Controller	2
12.	ON/OFF SWITCH	2

Figure 2: Ultrasonic Bird repellant case and solar panel

Figure 3: Internal circuitry of the designed repellant

IV. TESTINGANDRESULT

The performance test of this research was tested on a rice farm settlementwhere the bird repeller device is tested for its effectiveness in scaring away birds. The device got switched on in the rice field and is monitored

for a while with the duration of 60mins and was observed that no birds could stay at the site within the device covered area as the twitter speaker buzzes at any sensed bird approach.

The ultrasonic bird repeller effectively generates abrupt sound alerts that deter birds from lingering in the field. Equipped with sensors capable of detecting bird movement from all four cardinal directions within a 300cm radius, the device promptly triggers the twitter speaker set at a frequency of 20 kHz, causing discomfort to the birds and prompting them to flee.

V. CONCLUSION

The aim of this research is to limit or eradicate the infestation of bird pest on agricultural crops on a farm land. Thus, farmers can procure their produce from the field in both quantity, reflecting the ratio of crops planted to the harvest amount, and quality, denoting robust crop yields.

This research concept is primarily tailored for agricultural use, making it suitable for deployment in farm fields. However, it can also find application in geographical areas where birds naturally inhabit, effectively clearing them from desired locations. While it can be utilized in residential settings, it's primarily an outdoor device.

The switch button enables users to turn the device on or off, providing control over its activation based on when it's needed or not needed.

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