Design and Construction of a Solar Powered Automatic Pest Control System

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Abstract— Agriculture has proven to be the most sustainable and reliable source of livelihood for the human race. This is due to the eco-friendly processes involved in crop and animal production and their regenerative nature. Rodent and bird pests constitute major source of losses in farming; existing pest control methods pose environmental and health challenges to humans and the entire ecosystem, hence the need to develop a more efficient, human and eco-friendly system for the control of pests. This work focuses on the design of a solar powered automatic pest control system that will employ the three basic signals of motion, sound and light as deployed by humans to scare rodent and bird pests from the farm.

Keywords— solar powered; automatic; pest control; time based

I. INTRODUCTION

A griculture has proven to be the most sustainable and reliable source of livelihood for the human race. This is due to the eco-friendly processes involved in crop and animal production when properly carried out.

However, like all human endeavors, crop production is faced with numerous challenges prominent among which is animal pest [1]. These pests of various species attack crops from planting to maturity stages. Losses associated with pest have been estimated to lie between 5 and 40 % as in [1]. Man in his quest for survival has continuously evolved strategies to minimize the damaging effects of these categories of animals on crop production.

These methods span from Physical, Chemical, Cultural Practices, and Biological Control to Ecological methods [2]. Generally these methods suffer some level of drawbacks that affect their efficiency hence the need to employ a more reliable and efficient method of pest control.

This involves the simulation of the three basic signals used by humans to scare rodents and birds from the farm. These signals include motion, sound and light. A solar powered automatic pest control system designed to generate to and fro motion, sound and light signals at determined intervals will be used to simulate the presence of human in the farm to scare rodents and birds from the farm.

A. Physical Control

Physical control of pests involves all the techniques geared towards limiting access of pests to the crop by inducing behavioral changes or death of the pest through a mechanical, electrical/electronic means [3]. The method to be employed in this design will use electrical energy converted from solar radiation to drive mechanical, acoustic and photo devices to limit rodent and bird pest from accessing the crops. Existing physical control methods include thermal shocks, and electromagnetic radiations [4]. Physical control methods impact minimal environmental damage.

B. Biological Control

Biological control of pests involves the reduction of pest population by the use of their natural enemies and as such involves human effort [5]. This limitation of human involvement is to be minimized by the deployment of an automatic system known as a solar powered automatic pest control system.

C. Chemical Control

Chemical control of pests could be described as the use of chemicals known as pesticides to control the damaging activities of pests by either attracting and destroying or repelling them [6]. There is need to change mode of action (MOA) to avoid resistance by target pests in the application of pesticides [7]. This is a precaution that must be taken while using pesticides to ensure sustained efficiency. Application of pesticides has established health and safety concerns. Adequate measures must be taken while using pesticides as a pest control option as misuse will result hazards to humans and environment [8]. The effect of pesticides on ground water and endangered ecosystem species is of great concerns. This makes it a necessity to protect the ecosystem from the adverse effect of pesticides hence the need for eco-friendly pest control schemes [9].

D. Cultural Control

Cultural pest control methods are methods that rely on the inherent characteristics of cropping systems to control pests, some of these systems include crop rotation, intercropping and strategized timing of operations like weeding and climatic effects to control pests [10].

E. Ecological Control

Over dependence on single control method of pest control like pesticides has been associated with environmental degradation, food contamination, chemical residue and even resistance to targeted pests [11]. The use of ecological method involves the sustainable application of all known pests control methods such as physical, cultural, chemical and biological methods in a way to exploit their inherent strength in pest management. The deployment of an electrically automated system in pest control is a good advancement.

II. OBJECTIVES

Having reviewed the state of pest control methods available, this design is set to develop a solar powered automatic pest control system that will need minimal human interference to ensure effective control of rodent and bird pests. The realization of this design is through the following segments.

- A. Design of the motion subsystem
- B. Design of the sound subsystem
- C. Design of the lighting subsystems

III. MATERIALS AND METHODS

The following electrical and mechanical components form the parts of the design.

- Dc electric motors
- Dc horns
- Bulbs
- Light dependent resistor
- Solar panel
- Battery
- Connecting wire
- Mechanical support

A. Method

The above components were connected using the circuit diagram in figure I below.



Fig. I. Circuit diagram of automatic pest control system

B. Design Specifications

Table I. Design specifications

S/No	Component	Description	Specifications		
			Parameter	Formula/Evaluation	Value/unit
	Dc Motor	Wiper motor with	Rated voltage	V	12volts
1		rotary to oscillatory motion	Rated current	Ι	2A
		conversion	Speed	Ν	30rpm
			Power	P = IV = 2x12	24watts

			Parameter	Formula/Evaluation	Value/unit
			Rated voltage	V	12volts
			Rated current	I	2A
			Power	P = IV = 2x12	24watts
2 Horn		Troilor trois hour	Intensity in Decibel β		100dB
		I raher truck form	Minimal intensity	Io	10^{-12} w/m ²
			Intensity[12]	$\beta = 10 \log(I/I_0)$ $I/I_0 = 10^{\frac{\beta}{10}}$ $I = 10^{\frac{100}{10}} \times 10^{-12}$	10 ⁻² w/m ²
			Parameter	Formula/Evaluation	Value/unit
3	Bulbs	De bulbs	Rated voltage	V	12volts
5	Buios	De builds	Rated current	I	0.5A
			Power	P = IV = 0.5x12	6watts
			Parameter	Formula/Evaluation	Value/unit
			Rated voltage	V	12volts
4	Resistor	Light Dependent Resistor	Maximum resistance	R	500Ω
			Maximum Power	$P = \frac{V^2}{R} = \frac{12^2}{500}$	0.288watts
			Parameter	Formula/Evaluation	Value/unit
5	Solar panel	Mono crystalline	Rated voltage	V	12volts
			Rated current	Ι	29A
			Power	Р	350watts
			Parameter	Formula/Evaluation	Value/unit
			Rated voltage	V	12volts
6	Battery	Deep cycle nonspillable	Rated capacity		300AH
			Charging current	Ι	25A
			Charging Duration	Т	12Hours
			Parameter	Formula/Evaluation	Value/unit
7	Charge controller	PWM	Rated voltage	V	12/24volts
			Rated current	Ι	30A
			Parameter	Formula/Evaluation	Value/unit
8	Relays and Timers	Dc Relays and timers	Rated voltage	V	12volts
			Rated	Ι	10A
			Time Range	Т	0-60mins
			Parameter	Formula/Evaluation	Value/unit
9	Wire	Stranded cables	Cross sectional area	А	6mm ²
			Rated Voltage	V	600volts
10	Circuit Breakers			230v/30A	

Table II.	Input/outp	ut Power S	Specification

Input			Output(Load)				
				Component	Rated Power(watts)	Quantity	Total Power(watts)
	Component	Rated Power(watts)	If	Motor	24	2	48
	Solar panel	350	Ī	Horn	24	2	48
	Battery	300	Ī	bulb	6	10	60
					Total Power		156



Fig. II. Solar powered automatic pest control system



Fig. II. Control circuitry of solar powered automatic pest control system IV. RESULTS AND DISCUSSION

A. Results

The table below shows results obtained from post construction tests on the solar powered automatic pest control system.

Table III. Results

S/No	Component	Voltage(v)	Current(A)	Power(watts)
1 Solar panel		13.8	28.5	393.3
	Battery	12.8	25.6	327.68
	Dc motor	12	2.1	25.2
	Horn	12.2	2.12	25.864
	Bulb	12	0.51	6.12

B. Discussion

The system was implemented according to the design.

- i. The system uses solar panels to trap solar energy from the sun and converts such energy to electricity and stores the energy in a chemical cell (battery) through the help of a charge control system.
- ii. It supplies the stored electric energy to connected output devices that include dc motor, horn and LED lamps through the control of connected timer relays which determine the duration and interval of operation of each output device.
- iii. The light dependent resistor only allows the LED lamps to come ON in the night when its resistance tends to maximum.
- iv. These three output devices namely dc motor, horn and light simulate the three basic signals of motion, sound and light used by man to scare rodent and bird pests away from the farm.
- v. The system continues to perform this human presence simulation in the farm and as such scares bird and rodent pests away for as long as the sun continues to shine on daily basis till the life span of the battery or solar panel is exhausted.

C. Operational Precautions

The following precaution should be taken for safe and effective use of the solar powered automatic pest control system.

i. Always wear hearing protective devices like ear plugs or muffs while working within 25meter range from the system to avoid hearing damage due to prolonged exposure to high intensity sound [12].

- ii. Ensure the battery is housed to maintain temperature changes within acceptable limit for the battery.
- iii. Ensure location of the system within 25meter radius of targeted area.
- iv. Avoid the direct exposure of the control unit to adverse weather conditions like rain, excessive heat and humidity.
- v. Use thread and light weight materials like polythene bags to transfer motion from the moving arms of the motor system to various parts of the farm.
- vi. Protect the motor from water humidity.

V. CONCLUSION

The results obtained from tests carried out shows that the solar powered automatic pest control system designed and constructed in this research has the capacity to simulate human presence in the farm by producing the three signals of sound, motion and light used by humans to scare bird and rodent pests from the farm automatically and as such has the capacity of minimizing losses due to rodent and bird pests with minimal environmental and health hazards.

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