

Development and Implementation of Arduino-based Birds Repellent for Farmers

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Abstract: *The problem faced by rice farmers in terms of bird scaring is quite worrisome and demands urgent intervention especially at this critical period in the history of our dear country when the price of rice is increasing almost on daily basis as a result of land border closure against the importation of rice coupled with covid-19 pandemic and inability of indigenous farmers to meet up with local consumption demands. According to the local reports in Nigeria, quelea birds invasions of many major rice farms in Jigawa, Kebbi, Kano, Kaduna, Ogun and Ekiti account for over 15% loss in rice production yearly. This has been one of the major discouraging factors affecting rice production in Nigeria. Unchecked birds invasion of farm badly affects the quantity and quality of farm produce. The use of women and children in tedious and laborious work of bird scaring should be discouraged because it negatively affect productivity as precious time is devoted on birds scaring process thereby affecting other food production activities. This work is therefore centred on the development of a microcontroller-based bird repellent capable of automatically sensing the presence of birds on the farm and consequently produces sudden and loud sound that scares them. Eight strategically arranged PIR motion-detection sensors were used. These sensors detect the presence of birds on the farm and outputs 5 V signal at their output terminals connected to the arduino board. The arduino is programmed to activate industrial sirens located at different positions on the farm. The sirens in turn produce sound loud enough to scare the birds away. The developed bird repellent is also modified to produce loud sound for three seconds every half-hour neglecting the PIR sensors in order to keep birds away even if a sensor malfunctions. The device can cover more 0.4 hectares of farmland when the positions of the sensors and the sirens are professionally decided. The device is powered by rechargeable battery which can be removed and replaced by another battery as soon as it runs down. The set-up is completely economical because it is easy to install and maintain by any literate farmer. It can be installed on rice, sorghum, millet, and other plantations. It can also be mounted beside wind mills and antenna to scare birds.*

Keywords: Birds, farmers, sensor, repellent, arduino, sound, rechargeable battery

1. Introduction

One of the major challenges faced by farmers (especially rice farmers) in Nigeria is the inability to effectively control pest birds which negatively influence food production. In fact birds account for about annual loss of 15% in rice production world-wide [4], [11]. Birds feed on the cereal crops during early stage of fruit bearing thereby render the grain empty. In northern and south-western Nigeria, foraging birds come in flocks and attack rice plantation by sucking the milk of ripening rice on the farm [1], [4]. Damage to crops by birds does not occur at random. It occurs majorly at a particular time in the life span of crops. Familiarisation with the time and nature of the damage helps to reduce it or lower the cost of controlling it by concentrating control methods in particular areas and at time of the season when the damage is most severe [2]. Orchardists for instance concentrate on pest control majorly during the fruit bearing seasons of their crops. To combat the damage done by pest birds, growers often use a variety of pest control measures including pesticides, trapping and fencing using nets [7]. These and other approaches have been tried to scare birds away, to kill them or to try to make the places they visit less attractive to them. Unfortunately none of the available methods offers a complete solution to the problem [1]. Netting which happens to be one of the most effective methods is very expensive especially when the area to be covered is very large. In other ways, people spend up to twelve hours scaring birds on the farm during the fruit bearing period. This affects other areas of food production because all working hours of the day is being spent chasing the birds. In the same vein, children are saddled with tedious and boring responsibility of chasing

birds from the rice farm and drying beds. Therefore, to control the menace of birds both at the airports and farms, the use of electronic repellent which is a relatively new invention needs to be embraced by all and sundry [3]. The development of an electronic device that will detect the presence of the birds and produce sound loud enough to automatically scare the birds is necessary.

1.1 The Roles of Women and Children in Birds Scaring

Majority of farmers in Nigeria consider the use of women and children as alternative cheaper means of controlling pest birds due to the fact that a good number of them are ignorant of other means of scaring birds. The employment of women and children in scaring birds in rice farms basically involves stationing them in the farm to effect the driving away of the pests from the rice using such means as shouting, singing, drumming, throwing missiles etc to produce sound loud enough to scare the birds away. Children also use catapults to drive the birds. In spite of the importance of rice to the economy of Nigeria coupled with the national border closure, manual labour is still employed in driving away birds. Going by the continued increase in the per capita consumption of rice in Nigeria, fixated reliance on women and children and in fact on human beings to prevent the birds from doing harm to their rice in the field will to that extent perpetually prevent the people from realizing their potentials for increasing rice production [1]. This eventually results to huge loss for rice farmers. Employing the child-bearing women as bird scarers in rice farms is an extra burden on the traditionally demanding role of parenthood. For the elderly women it is work beyond retirement. For the school-age children, they miss classes, have less time

available for homework and self-study. In extreme cases the children drop out of school. Children who are engaged in farming have lower school attendance [6]. They enter the labour force prematurely [2].

1.2 The Bird Scaring Methods

Birds scaring is one of the inevitable cultural practices in rice production in Nigeria. Birds scaring is a set of activities carried out on the farm to facilitate the driving away of pest birds from rice and fruit farms during specific period of the year. Severe pest birds invasion of rice farms during the milk stage of rice production and fruit crops at a particular period of the year demands deployment of highly effective birds scaring mechanisms to drive the birds away from the rice farms. During this stage, grain-eating birds invade the rice fields and suck the milky grains leaving traces of empty or poorly filled grains, broken stems and cut panicles. The sugary semi-liquid substance is being sucked by the birds leaving behind an empty husk. At later stages when the grains are ripening, birds also cause grains to shatter [1]. Bird invasion of rice farms causes whitehead and very low yields. The damages done by birds is very devastating and irreversible. Adequate measure is therefore needed to put in place to prevent birds from destroying our farms. Different birds scaring devices are used and more so, human bird scares are employed from 6am to 7pm two weeks after planting and from heading to harvesting. Birds scaring can also be done manually by the use of scares and spoilt video tapes which make noise whenever the wind blows. Meanwhile, birds control measures can be categorized into preventive and protective. The preventive methods aim at discouraging birds from coming to the field, while protective methods focus on protecting the rice crop when birds do visit the field. Preventive methods can be subdivided into lethal and non-lethal techniques [11]. The non-lethal method includes auditory birds deterrent, chemical repellants and visual techniques. Lethal means on the other hand encompasses various methods of destroying birds, their eggs or nests. This method includes shooting, destruction of eggs and nests.

1.2.1 Non-lethal Methods

Auditory bird deterrent technique involves the use of different forms of traditional noise making devices to produce acoustic stimuli. Noise produced by more sophisticated techniques such as carbide cannons at a rate of two per hectare with positions and directions of fire changed every other day; activating bio-acoustic, acoustic, ultrasonics and high intensity sound; shouting, drumming and hitting noise producing items like wooden clappers and periodic use of shotgun (pyrotechnics) to augment explosive scarers [9]. Furthermore, recorded distress calls and alarm calls of birds are often used to scare away birds. Artificially synthesized versions are also used as they are amplified and broadcast through a loudspeaker. Acoustic stimuli scare birds with sudden loud noise.

Application of chemical repellants such as Thiram, is effected to repel ducks and bush fowls which damage seeds at sowing time; ziram at recommended dosage can be effective at controlling birds; at the maturity the following chemicals are applied for repelling grain eating birds:

mesurel (methicarb) 3kg/100l/ha, Thiram 3kg/100/ha, Aluminium ammonium sulphate 10kg/100/ha. Chemical taste repellents such as methyl-anthranilate, anthraquinone and methiocarb are being used in birds control [4]. Chemical method of pest control has been found to be very effective but quite expensive to maintain. Also, some of these chemicals are highly poisonous and harsh both to humans and pests alike as a result of their ability to pollute the air [8].

Visual stimuli include plastic bags set out in fields to flutter in the wind. In addition to driving away birds already in the field, the plastic bags deter birds on the wing from coming and landing on the rice farms. Other visual stimuli include human effigies, scare crows balloons with eye spots painted on them, netting and of course caging.

1.2.2 Lethal Methods

These methods of birds control are allowed for certain species of birds and at a particular area where birds constitute nuisance to the environment or farmers. Meanwhile licenses are issued in many countries before such measure of controlling birds can be employed. Killing of birds by shooting, destruction of their nests and eggs are considered as cruel means of controlling pest birds.

2. Materials and Methods

The materials used include arduino board, PIR motion sensor, light emitting diodes, capacitors, resistors, 7805 regulator, industrial siren and relay module. Other accessories are connecting wires, veroboard and casing materials. Some of the key components of the device are discussed below.

2.1 Passive infra-Red (PIR) Motion Sensor

This motion sensor consists of a Fresnel lens, an infrared detector, and supporting detection circuitry. The lens on the sensor focuses any infrared radiation present around it toward the infrared detector. Birds generate infrared heat, and this heat is detected by the motion sensor. The sensor outputs a 5V signal for a period of one minute as soon as it detects the presence of a bird. It offers a tentative range of detection of about 6–7m and is highly sensitive [5]. The diagram showing the constituent components of the sensor is illustrated in figure 2.1. Eight sensors are connected together to cover relatively large area of land.

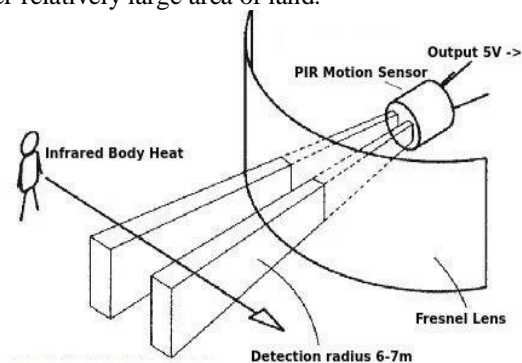


Figure2.1: The PIR Sensor

2.2 Arduino Board

Arduino is an open source programmable circuit board. It is a computer without interactive interface. This board contains a microcontroller which can be programmed to sense and control objects in the physical world. It responds to sensors and inputs, and in turn interacts with a large array of outputs such as LEDs, motors, relays and display units [10]. A typical picture of arduino board is shown in figure 2.2.

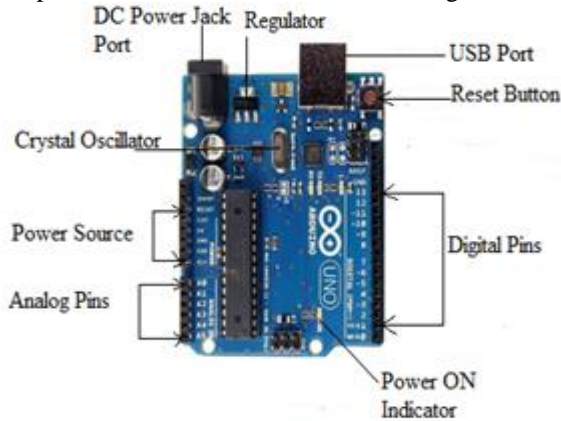


Figure 2.2: Arduino Board

2.3 Relay Module

The relay module is shown in figure 2.3. This circuit connects (disconnects) the speaker to (from) the battery based on the information it receives from the microcontroller. When there is bird within the area covered by the sensors, the pins to which the inputs of the relay module are connected made 'high' and therefore connects the battery. It disengages the battery when there is no bird within the area covered and therefore prevent the battery from running down quickly.



Figure 2.3: The Relay Module

3. Construction of the Repellent

The block diagram of the repellent is shown in figure 4. The device comprises of three main sections. These are the sensing, controlling and sound producing units. The sensing unit is made up of eight PIR sensors which are connected as shown in figure 5. The output of each of the sensors are connected to pins 4, 5, 6, 7, 8, 10,11 and 13 on the arduino board. Each of the sensors is powered the rechargeable battery via 7805 voltage regulator. The controlling unit comprises of arduino board and the relay module. Pins A3 and A5 are connected to LN1 and LN2 of the relay. The pair of the sirens are connected to the relay module as shown in

figure 5. The sensors and sirens are mounted on poles whose heights can be adjusted depending on the level of the vegetation. The picture of the siren is shown in plate 1. The whole set up is powered by rechargeable 12 V battery. Meanwhile the 12 V battery cannot be directly used to power the arduino board and the PIR sensors. Therefore a 5V regulator was used to provide the voltage needed to power them as shown in figure 5.

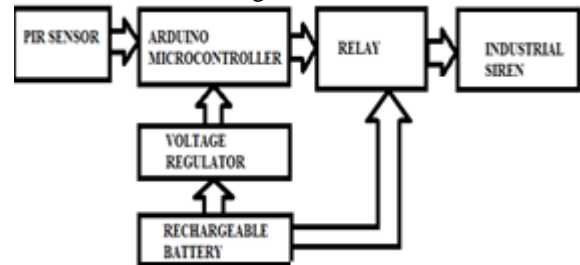


Figure 3.1: The block diagram of the bird repellent.

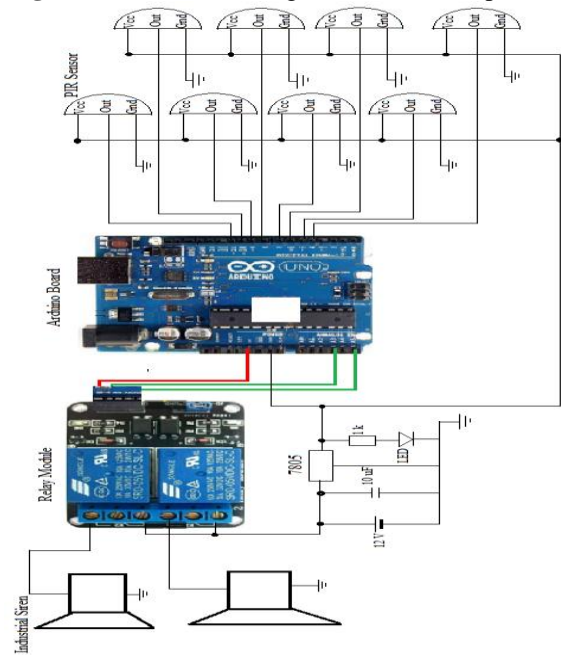


Figure 3.2: The Circuit Diagram of the Repellent



Plate 1: Picture showing the Installed Siren on Pole

4. Working Principle

The sensors detect the presence of birds. Birds generate infrared heat, and this heat is detected by the motion sensor. The sensor outputs a 5V signal for a period of one minute as

soon as it detects the presence of bird. The signal is being sent to the assigned pin of the arduino. Microcontroller processes the signal and raises the output level of pins A3 and A5. The microcontroller activates the relay which in turn connects the industrial siren to the standby battery. Meanwhile in the absence of birds and other infrared emitting creature, the output of the sensors is 0V. The microcontroller also conditions the signal and lowers the level of the output pins A3 and A5 and the relays therefore disconnect the battery and hence the siren. The circuit diagram of the constructed bird repellent is shown in figure 5.

5. Testing and Result

The constructed device was tested by placing a bird at different distances from one of the sensors. On detecting the presence of the bird, the siren produced sound loud enough to scare the bird. The table 1 shows the result of the test.

Table 1: Sensitivity of the Constructed Bird Repellent

S/N	Distance (CM)	PIR Sensor Response
1	10.0	Active
2	20.0	Active
3	30.0	Active
4	40.0	Active
5	50.0	Active
6	60.0	Active
7	70.0	Active
8	80.0	Active
9	90.0	Active
10	100.0	Active
11	200.0	Active
12	300.0	Active
13	400.0	Active
14	500.0	Active
15	600.0	Active
16	700.0	Partially Active
17	800.0	Not Active
18	900.0	Not Active
19	1000.0	Not Active

6. Discussion and Conclusion

The constructed bird repellent was set up in an open field and a bird was positioned at different marked points from one of the sensors. The device actively detects the presence of birds up to a distance of 6.5m from the sensor as shown in the table 1 above. It then activated the industrial siren which in turn produced loud sound of sound pressure level (SPL) of about 150 dB that scared the bird. Even another bird placed at about 20 metres away from the siren was scared by the sound of the siren. The number of sensors and sirens can be increased to cover wider area especially in a very large farm. It is recommended that that the sensors should placed clearly above the vegetation to avoid any obstruction which may affect its sensitivity.

7. Acknowledgement

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