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Design and Fabrication of Pressure Activated Wild Boar Trap

Harjit Singh[1], Somesh Negi[2], Ashish Thakur[3], Nelluri Shiva Sai[4]

[1]Assistant Professor, Mechanical Engineering, Lovely Professional University, Punjab

[2-4]Undergraduate, Mechanical Engineering, Lovely Professional University, Punjab

Abstract: All over the world including India; annually a lot of agricultural crops are eaten away by the feral pigs [1]. This causes a lot of capital losses to the farmers. This invention traps feral pigs/ wild boars automatically without the requirement of any human input whether manually using strings or via some remote control. This invention has a pressure sensor as a trigger which sends signal to the control unit when the pressure sensor reads weight; piezoelectric sensor is used for this purpose. Then the control unit (Arduino Uno r3) sends signal solenoid actuator which actuates the trap by disengaging a locking mechanism of the cage and the cage falls down under earth's gravity and catches the pigs of the sounder (a group of pigs) which are present directly under the above hanging cage.

Keywords: Wild boars, trap, piezoelectric, solenoid, feral pigs

1. INTRODUCTION

Population of wild boars has been increasing in many regions worldwide. Wild boars' population has evolved through translocation facilitated by humans; this has resulted in the natural growth of local populations. Due to a variety of circumstances, new invasive species frequently exhibit rapid and exponential population expansion when they first arrive in a new location [2].Wild boars can be found in a wide variety of habitats, where they graze on a variety of flora and fauna. Furthermore, among ungulates, wild boars have the greatest reproductive rates, and their population density in a year can become twice. As a result, this species' extensive rise in numbers and geographic range might have a significant influence on a variety of plant and animal species, habitat structure, and agricultural and livestock productivity. [3]. Reduction in the population of rural regions, agricultural techniques have changed, a smaller number of predators, decreased pressure of hunting, and changes in climatic conditions may all have contributed to the increase in wild boar numbers in recent decades. Expanding wild pig populations have had a severe influence on land and natural resources. Biodiversity and agricultural losses have come from their presence, as well as destruction of natural flora and fauna, habitat damage, disease transmission, and other public safety concerns. As a result of these activities, the wild pig has been added to the list of the worlds 100 most ecologically damaging invasive animals. Wild boars are the potential carriers of infectious illnesses like classical swine fever, brucellosis for domestic animals, and infectious illnesses like tuberculosis, hepatitis E for humans. For many invasive animal species, including wild boars, trapping is one of the most common management tactics, in some form or another. It is clear that trapping needs to be more effective and efficient. In past many traps have been built but, coral and box traps are two most commonly utilized traps for removing wild boars [4]. Bait is used to bring boars to a location where a gate or trigger is activated; the boars are trapped inside the perimeter. Trap avoidance, untargeted catches, misleading triggers, failure to trap complete sounder, and eventual training of boars in close proximity, on the other hand, may restrict the effectiveness of traditional trapping tactics [5]. Traditional traps like corral and box traps have a rich history of being used to catch wild boars since they have been commercially available and familiar to wild boar trappers. But due to manual input and construction, these traps become time consuming and less efficient increasing the chances of unsuccessful trapping of wild boar. In this paper, they have countered the problems like false triggering, non-target captures, etc. by changing the traditional methods where a trapper used to operate the trap manually by putting themselves in danger (as the wild boars in India are omnivores i.e., they eat both plants and animals). By making the trap automated, the traps have become a lot more efficient and less time consuming then the previous kind of traps as it removes the unwanted errors and traps the only targeted animal.

2. LITERATURE REVIEW

2.1 Area and Population Surveying

Population interpretation plays a major role in estimating trap effectiveness. Researchers have made various calculations on the density of feral boars by area/sites to capture feral animals more efficiently and maintain concerned

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factors throughout their research and testing of their methodologies and equipment. Pre-surveillance is performed on both sites for three-night sessions every day, soon after trap setup and at the end of all trapping. They have approximated the number of subjects inside the research zone with a 30-km restriction in a silent moving vehicle [6]. This could aid in simulating maximum efficiency. The other research was to determine the efficiency of drop nets and corral traps in 3 ranches which were divided into 2 units each, resulting in 6 units. Cameras were randomly installed throughout the ranches and were baited with corn for 14 days, daily. Sites were prioritised based on pig visits and were chosen for capturing operations [7]. Researchers gathered and GPS-tagged Sultana wallabies at sites of wallaby research to forecast detection probability for many ground-based and survey approaches. The GPS collars used were intended to provide quick updates, and their weight did not exceed 2% of the wallaby's overall weight [8]. Deer was taken in a zone, operations were carried out in both winter and spring, resulting in a large number of seasonal differences noted, as well as a large amount of geographical information near the location stuff taken into account, and population density stuff accessed via well-ventilated sampling [10]. Infrared cameras were installed along heavily used trails to finalise good regions for corral traps, and after 2 trap regions were selected that are roughly 2.5 km wide and where there is high pig density based on pig activity, tracks, and eating behaviour. They were pre-baited for about 10-14 days at each site with a tripod feeder machine filled with corn, and each camera was set for 24-hour continuous monitoring [11]. In this study, a large number of land boundaries were taken, and they conducted their research in a zone with varied landscapes and used two different study regions. In this study, wild pigs were at a density of 1.2 pigs per km-sq., a density that was comparable to the survey performed in that zone in previous research [13]. The other research was on a farm. The property consists of 2 distinct pieces of land with a lot of strips of forest and water bodies, where it is considered that the conditions would be ideal for wild animals [15].

2.2 Trapping Devices and Equipment

Modernisation and colonisation of forests and wildlife have led to the authentication of many feral animals and their population spreading into virtually entire neighbourhoods and farms, leading to an evaluation of designing various kinds of trapping devices like coral traps, drop nets, muzzle traps, mist nets, pitfalls, camera surveillance guided transmission traps, and variations of conventional trapping methodologies. In 1993, practical research on pigs' susceptibility to visiting trap sites was examined. The only equipment used here is a standard trap with supplies [6]. Coral traps with spring gates and tripwires, a drop net with infrared trail sensors, and suspended traps, all with a custom configuration with a camera or no camera [7]. The researchers mentioned that they've used net guns for ground netting and precisedarting on species [8]. A net-gun is used to facilitate the gunner with the least effort from a moving helicopter [9]. Net-guns with pre-made net canisters were carried for rapid capture [10]. Over time, research has also been conducted on the gate width of trapping systems that can have an impact on feral cats. Pigs' behaviour virtually dictates a trapping environment and setup that influences the success rate of trapping, and the gate widths were mostly the averages of corral trap configurations used throughout America [11]. As mentioned,there are "2 commonly used trap styles: a small, portable box-style trap and a larger, semi-permanent, corral-style trap." A set of portable cages and corral traps were used, and a couple of anaesthetic drugs were used for the immobilisation of the boars [13]. A specialised feral removal system named M.I.N.E.™ is used, which is a trademarked device [14].

2.3 Trapping Procedures

There were various kinds of procedures used by researchers, in terms of sequence or strategies, whatever they used to obtain the highest effectiveness and most reliable data for stipulating the final results. Oestrus lasts 4-5 days in feral sows, which is comparable to domestic sows. Oestrous sows were held in traps with welded mesh, which were then encircled by a silo trap with two gates as entry. To shift out any advances to the trap, each of the traps was encircled by a metre wide plot of sand. Two oestrous-sow traps were placed in the treatment zone in the spotlight [6]. The flipside setup is that corral traps were 9.75 metres long, 2.4 metres wide, and 1.5 metres tall, and were made of metal with two unshared gate openings. The system also included remote-controlled infrared-filtered illumination to improve overnight use. The device that they used was, like the drop net system, utilised solenoids and batteries, but it was linked to a compact computer. When captured, wild pigs were euthanized with a 5.6 mm calibre rifle [7]. Sultana wallabies were captured using net-guns shot from a helicopter by this study team. The nets they used for the ground were made of synthetic nylon strings twisted into a mesh in a diamond pattern. A semi-circular hoop and pegs were employed at the net's base [8]. The net-gun weighs approximately 10 kg when fully loaded and ready to fire. Nets with mesh diameters of 10, 13, and 18 cm were made from nylon for various uses. Standard military zippo trajectile was transiently used but failed due to insufficient power, and this was their strategy [9]. The deer were taken into sparsely treed regions where the net gun could be used to trap them. In the first search, an experienced shooter used a breakaway net pistol to hurl a 5.5-meter weighted net. Each deer was supplied with a GPS tracking collar and mortality sensors that ping a satellite warning without 12 hours activity [10]. On a ranch, the propensity of feral pigs to enter the traps was evaluated. A

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single 2.44m vent was setup, and a gate-frame was stock-still in each opening. They've adjusted the gate widths [11]. Clover traps operate the same as box traps except the mesh is knit over a steel frame. They have been employed to reserve a variety of ungulates and are lighter and drastically more compact than other box traps due to their ability to be simply deflated for travel,in the zones where animals might be rushed into tight passages [12]. Corral-style traps were made out of a wood-framed door piece that was tied on both sides to a panel filled with heavy-gauge wire mesh. Because door types can impact trapping success and pig behaviour, they placed and monitored 24 traps, 12 of each kind. They used contingency tables to examine the proportions of entries-to-visits were correct because a pig might conceivably enter and exit many times during a visit. [14].

2.4 Effectiveness of Traps

Most of the research work was done on the effectiveness of the traps, with trap methods and equipment tested in various environmental setups. There has been research on conventional traps using mainly fodder as a bait and just manually capturing feral animals, which has been remote tested in two sites where there's been a variation in population in an iterative process and overall efficacy is presented as a result. Following traditional trapping, an increasing number of pigs were captured at the treatment location, the proportion of wild boars in pre-oestrus sow trapping counts didn't make any difference with post-trapping counts [6]. In this article, they used drop nets, corral traps, and suspended traps to capture 90 and 81 percent of the identified feral pig population from 2010 to 2011. It requires 2.6 labour hours to set up the corral traps, 1.66 labour hours to drop nets, and 0.76 labour hours to suspend traps; CPUE (capture per unit effort) was 2.4 labour-hours per pig in 2010 when drop nets and corral traps were used, but it fell to 1.2 labour hours per pig in 2011. Drop net observation takes up 49 percent of the total time, regardless of capture success. CPUE was lowest with hung traps with only 0.64 hours of effort. Then drop nets (0.64 person hours) and finally 1.9 person hours. Corral traps took 9.79, 7.2, and 2.92 hours, respectively. Comparative research has been washed up on the traps [7]. A total of 36 wallabies were net-gunned, 26 of which were outfitted with GPS collars. Ground-based netting had a 17 percent fatality rate when it came to capturing. Checking times were decided by the number of wallabies taken each day. Ten ground-netted wallabies were chemically immobilised with tiletamine-zolazepam, while 22 unprotected wallabies were physically restrained [8]. Effectiveness based on animal species is mostly studied. For pronghorns and mule deer, the net-gun approach appears to be optimal. Two of the six bullets were useful in that they could be shot at a whitetail deer [9]. In all, 127 deer were targeted for capture, with nets launched at 64 of them (50 percent) and 27 animals taken, which is 21 percent. Within 30 days of capture, there was no mortality. The pursuit was 2 minutes and 46 seconds, while the average overall time from the start of the operation to release was 11 minutes and 19 seconds [10]. Researchers hypothesised that gate width may influence trap success, but their findings revealed no significant differences in gate widths. Sultana feral pigs can move into the trap with no touch versus the edges of the vent if the opening is at least 0.9 m wide [11]. In total, 310 pigs were taken in 25 sessions, where 19 were trapped and 6 thermal shots were fired. With 14 pigs, this operation had a combined success rate of 92.8 percent [13]. Corral traps had an effectiveness rate that was more than four times that of box traps. Some of the increasingly successful ways include well-ventilated culling via helicopter, hunting dogs, and the use of species-specific baits to deprecate toxicants [14]. The number of wild boars seized at each trapping event using corral traps was much higher than with muzzle traps. During capture and handling, the pre-release mortality was 6.5 percent [15].

2.5 Monetary and Labour Expenses:

Aside from all of the technical research, a monetary and labour time estimate for the overall period is calculated for commercial purposes. Financial expenses will be an important element in the trap diamond that users select, but should not determine trapping system selection. At the time of this study in 2011, the cost of the trap systems was roughly $3,500 for a drop net, $500 for a corral trap, and $1,500 for a suspended trap, including all small components and technology. The hung trap, moreover, had cellular data [7]. The cost-effectiveness of each method varied, with net-gunning stuff the most expensive for wallabies and the least costing for red deer. When the helicopter was removed, the efficiency and cost-effectiveness of physically restraining and ground-netting wallabies that were somewhat dosed were comparable [8]. Currently, the vital equipment required for this procedure can be purchased for less than $5,000 USD. The main factor of this treatment, however, is the helicopter rent [9]. When sparsely populated by 20 animals, the initial expense of helicopter net-gunning for capturing bighorn sheep may be mitigated by labour savings [10]. This includes four traps at a price of $3,500 apiece, as well as excess of $15,500 in labour expenditures. When the whole investment was subtracted from the loss avoided, the result was a 320-percent return on investment (ROI). The total number of hours invested was 49.75 [13]. Corral traps outperform box traps in terms of efficiency, both temporarily and economically; that is, corral traps powerfully reserve more pigs caught per trap at a cheaper per pig than box traps [14].

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2.6 Research Gaps

A variety of methodologies are researched in previous studies. Population density estimation is essential to calculate overall effectiveness, which is also needs some labour. Trapping devices are conventional so far and are of slightly different configurations. The procedures and strategies followed to attain highest efficiency are all labour intensive, although some of them needed just timely check-ups. Effectiveness of them was higher than the previous devices since the inception of research on traps, but the costs weren't the same and became expensive. Although there's extensive research on various factors such as feral animal behaviour, chemical response, trap effectiveness, mortality rate, and different setups of traps; There is a lot of research that can be done on the design of trap and its technology rather than employing a labour intensive and expensive equipment to achieve greater success rate, and need for equipping traps with advanced components that could reduce costs as well as labour hours.

3. METHODOLOGY

3.1 Working of the invention

This invention has a pressure sensor as a trigger which sends signal to the control unit when the pressure sensor reads weight; Piezoelectric sensor for this purpose. Then the control unit (Arduino Uno r3) sends signal solenoid actuator which actuates the trap by disengaging a locking mechanism of the cage and the cage falls down under earth's gravity and catches the pigs of the sounder (a group of pigs) which are present directly under the above hanging cage. Finally, the control unit sends a message to the farmer that the trap has been activated.

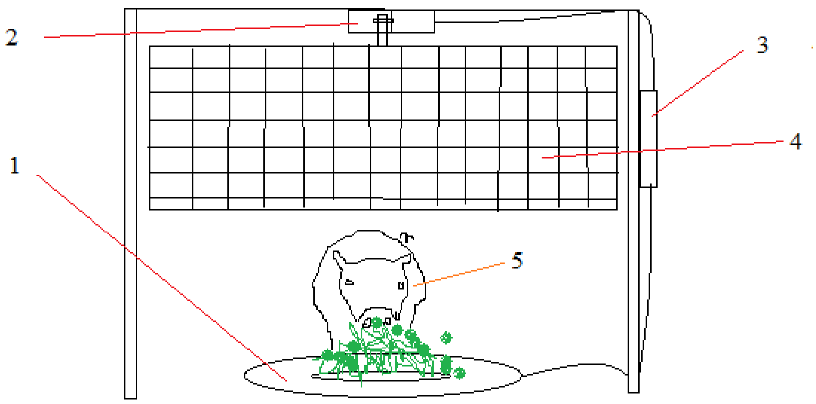

Fig. 1. Representing the Invention

1. Piezoelectric sensor
2. Solenoid actuator
3. Control unit
4. Cage
5. Feral pig/Boars

3.2 Main parts of the invention

a) Piezoelectric sensor:27mm piezoelectric sensor is used in this invention the sense the pressure generated by the feet of feral pigs and sends electric signal to Arduino Uno r3 via analog pin 0.

b) Control unit: The control unit is made up of Arduino Uno r3 and breadboard, diode (1N4007), Zener diode (5v), different types of resistors (1k ohm, 1 mega ohm, and 330 ohm), logic level MOSFET (IRFZ44N), jumper wires, led.

c) Solenoid:12v solenoid is used in this invention as an actuator that releases the above hanging cage on the sounder of feral pigs/boars in order to catch them. It works on the principle of electromagnetism.It has an iron rod that it either pulls in or pushes out when electricity is given to it through control unit.

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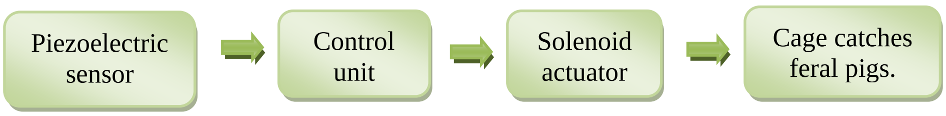
d) Cage: It can be constructed by using wood and plastic net or metal net and metal frame for better sturdiness.

3.3 Block diagram describing functioning of the invention



3.4 Code used in the control unit

```
final_code_for_boar_trap | Arduino 1.8.19
File Edit Sketch Tools Help
final_code_for_boar_trap
const int ledPin = 13;      // LED/solenoid connected to digital pin 13
const int piezoSensor = A0; // the piezo is connected to analog pin 0
const int threshold = 100;  // threshold value to decide when the detected sound is a knock or not

int sensorReading = 0;      // variable to store the value read from the sensor pin
int ledState = LOW;         // variable used to store the last LED/solenoid status, to toggle the light and to actuate the solenoid

void setup() {
  pinMode(ledPin, OUTPUT); // declare the ledPin as as OUTPUT
  Serial.begin(9600);       // use the serial port
}

void loop() {
  // read the sensor and store it in the variable sensorReading:
  sensorReading = analogRead(piezoSensor);

  // if the sensor reading is greater than the threshold:
  if (sensorReading >= threshold) {
    // toggle the status of the ledPin:
    ledState = !ledState;
    // update the LED pin itself:
    digitalWrite(ledPin, ledState);
    // send the string "boar!" back to the computer, followed by newline
    Serial.println("boar!");
  }
  delay(100);  // delay to avoid overloading the serial port buffer
}
Done Saving.
```

Fig. 2. Represents the code used in the control unit.

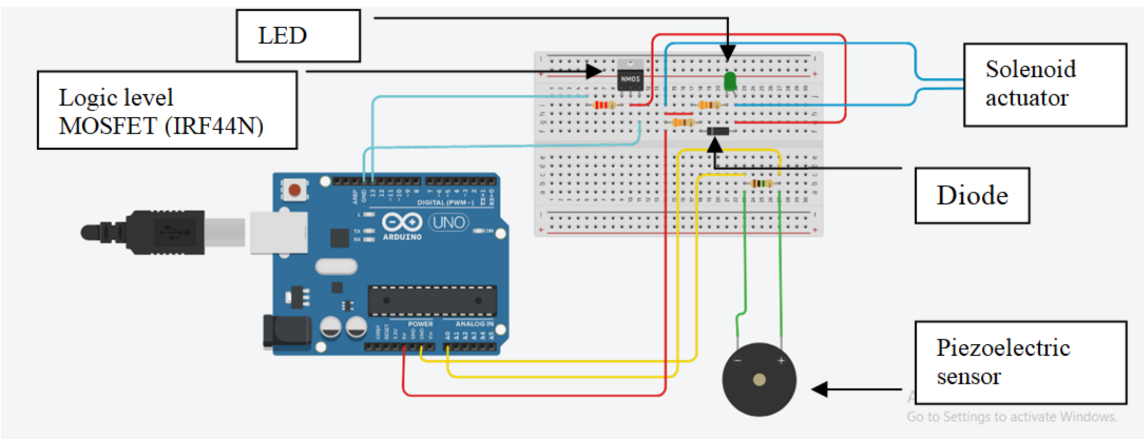


Fig. 3. represents the final working circuit.

3.5 Part of the circuit for actuating solenoid

The circuit made here is to control solenoid. It includes a diode (IN4007), a 330ohm resistor, logic level MOSFET

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(IRFZ44N), and a 2k ohm resistor. The logic level MOSFET has three connections/pins Gate, Drain, Source. The gate is connected to a 2k resistor; the resistor is connected to digital pin13.The source of logic level MOSFET is connected GND pin on the Arduino. A330-ohm resistor is connected to 5v power supply from the Arduino after this the resistor is connected to the diode –ve side of the diode (diode here acts as a kickback). The drain is connected to the +ve side of the diode. The one end of the solenoid is connected to the common connection where one end of the 330-ohm resistor is connected and also a jumper wire is connected (the jumper wire is further connected to the 5v volt power supply from the Arduino). Other end of the solenoid is connected to the +ve side of the diode.

3.6 Part of the circuit for piezoelectric sensor

The second circuit made here is to read the electric signal from the 27mm piezoelectric sensor. The positive of the piezoelectric sensor (red wire) attached to the analog in 0/pin A0. The negative of the piezoelectric sensor (black wire) is attached to the ground/GND. 1 mega ohm resistor attached from analog in 0 to ground. The use of Zener diode and led in second circuit is optional.

The following is the Fig. 4 represents the pressure activated wild boar trap made under the project, “design and fabrication of the pressure activated wild boar trap”. This trap has piezoelectric sensor at its bottom which can be hidden under the soil when being planted at the fields, at its left/ right side control unit is present. On the top most part of the frame it has solenoid actuator and the locking mechanism which hold the cage. Finally, the cage hanging above the ground can be seen which is situated at the top part of the frame.

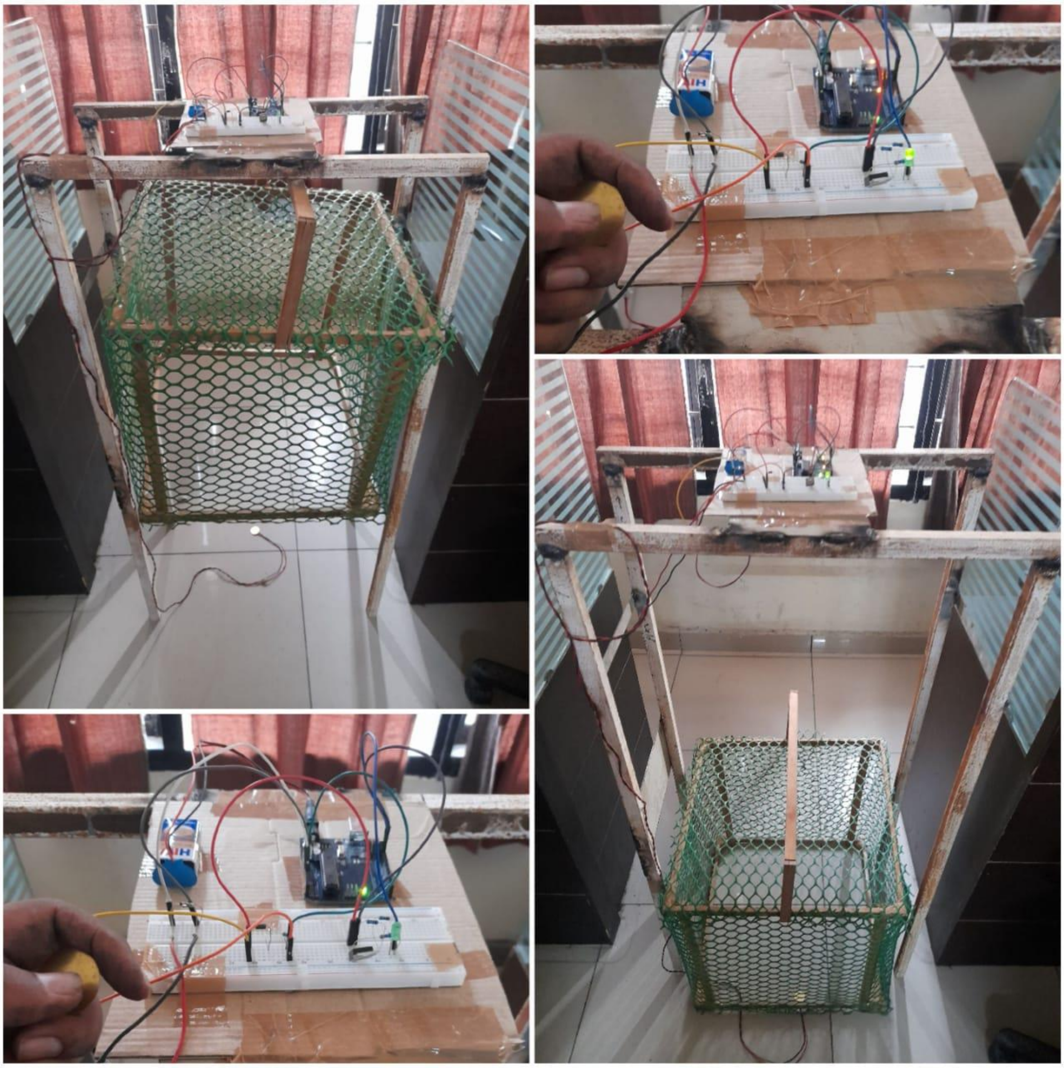

Fig. 4. Pressure activated wild boar trap

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4. CONCLUSION

Most of the already trapping method uses drop nets and corral traps. These traps are either manually actuated using strings or remote control operated integrated with motion sensor which require human operator to actuate the trap. In this invention piezoelectric sensor is used as trigger which removes the need of a human operator for capturing the feral pigs/wild boars. This invention doesn't require man in a loop to actuate the trap. It thus saves human effort and time. Furthermore, it is cheaper than the available boar traps which use motion sensing cameras integrated with remote control/actuation features. This invention also has an advantage over the conventional trip wire traps as pigs can easily see trip wires and learn to avoid them in future encounters with the trip wire traps. While this invention uses piezoelectric sensors which can be hidden much more effectively like they can be hidden under the ground hence improving the chances of the pigs falling for same trap much more times compared to the trip wire traps. In this invention the cage hangs above the ground, as the pigs do not have any predator which can attack them from above like eagles who hunt rabbits, they generally don't get spooked by hanging cage. Overall, this invention will greatly solve the feral pig/wild boar infestation problem.

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