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Laser AI Based Fencing to Safeguard Animals and Farms

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Abstract *-India is called an Agricultural country as a big proportion of India's population are farmers. Farming is not an easy profession as they face many natural and consequential problems, stray animals are one of them. India has over 5 million stray cattle according to the livestock census data released in January 2020. The stray cow attacks on humans and crops in both urban and rural areas which is an issue for the residents. Apart from cows there are over 60 million dogs and other animals like boars, antelopes. Every year they destroy over 100 thousands acre land crops and farmers bear huge losses because of them.Farmers have to guard their crops day and night. At many places farmers use barbed wire fencing and electrocuted wire fencing to keep stray animals away from their fields but these wires can hurt innocent animals really badly and they are also very costly.*

Our solution Laser AI Fencing(LAIF) tackles this problem with minimalist efforts using the latest technology AI. LAIF uses high intensity lasers and light sensors to create a virtual fence across the farm. Farmers just need to place the sensor and laser bars across the boundary of the farm. LAIF is wirelessly connected to the smartphone of the user and sends an alert signal to the user whenever any animal or intruder enters the farm. It has multiple sensors which help in detecting the size of the stray animal and accordingly tell the farmer whether it is a big animal or a small animal. LAIF divides animals into 3 main categories: large category has cows, ox, buffaloes, antelopes, medium category has deers, pigs, boars and small animals have cats and dogs. It also tells us the numbers of animals entering the farm.

LAIF is connected to the cloud via mobile app and whenever it detects any intrusion it creates an entry on the cloud with the animal type and time of intrusion. After collecting data for at least one month, the same data is used to train a machine learning model using random forest method to predict the future intrusion threats with the timing of intrusion. This will help farmers to save their crops from stray animals.

LAIF on one hand is a smart solution for an irritable problem and on the other hand it is cheaper than the other fencing techniques as it can cover a big area easily with the minimum equipment. It also helps farmers save their crops and saves stray animals from getting injured.

***Keywords*- Artificial Intelligence, Laser fencing, Smart farm security system, Intrusion detection, Cloud data storage, Environment friendly technology**

1. Introduction:

The cattle, dogs, cats and donkeys that don't have any proprietor wander across the road or different public places and have no safe haven are referred to as stray animals. As residents of the same planet, humans and animals have usually coexisted. Even as some human beings like to romanticize the harmonious and peaceful coexistence between people and animals in early records, however, war among the 2 were omnipresent. Human Animal war includes each competition, predation and involves a lot of paperwork like crop-raiding, livestock predation, human injury or loss of life. In line with the country wide Institute of Communicable Diseases Delhi, almost all the cases of rabies in India are because of stray dogs, which act as a reservoir for the disorder.

1.1 Stray Animal Problem in india:

India being an agricultural country, the livestock performs a primary position as a spine of the rural region. The Britannica defines the term “livestock” as domesticated bovine farm animals raised for his or her milk, meat, disguise, delivery, energy, and amusement. farm animals encompass cows, bulls, oxen, or calves. In India, cows and bulls are revered as sacred. The cow, who's worshiped as Vahana of Lord Krishna and Bull or ‘Nandi’ as Vahana of Lord Shiva, holds

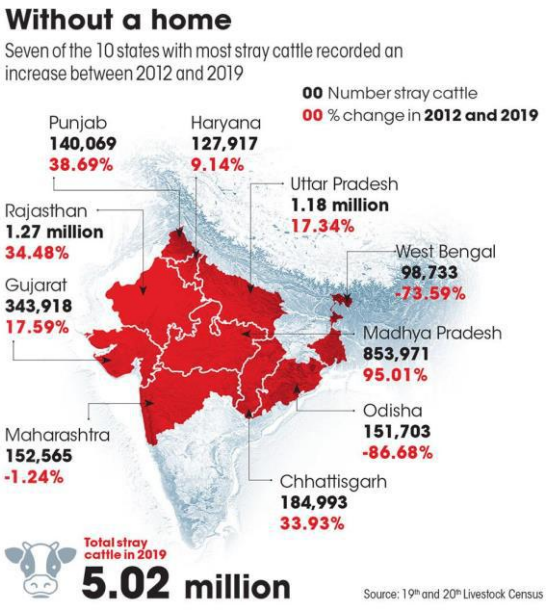
an ideal vicinity among the other deities in Hindu way of life. Drastically, India has the most important bovine populace, above 300 million, along with the biodiversity of 43 indigenous livestock breeds and 13 Buffalo breeds.

Notwithstanding, the cow is considered sacred, the cows, bulls, calves, buffaloes, and oxen in India are lamentable. Humans have come to be mere mercenaries who would go to any extent to extract and make the most of the bovines. India, the world's largest milk producer, contributes 22% to international production and has a dairy market valued at INR eleven,357 Billion in the year 2020. But, behind this booming dairy industry lies a grim reality, i.e., the achievement is carried out at the cost of the lives of the cows and buffaloes. In step with a file through PETA India, it has been observed that many cows and buffaloes, which can be explicitly used for dairy functions, are manipulated genetically by way of-injecting with artificial boom hormones for you to have big udders. Those udders make a contribution to generating a bigger quantity of milk than what they might produce naturally. Also, it is stated that some of the farmers in India are engaged in the wrongful act of injecting the cows with oxytocin, which isn't simply unlawful but unnatural in addition to a dangerous way to boost the manufacturing of milk.

The proprietors of those cows and buffaloes fail to provide them with food and shelter; as a substitute, they are determined to roam within the middle of the street trying to find food. A not unusual sight in India is looking at the livestock consumed from roadside garbage, which consists of unhygienic stuff. The pathetic circumstance of the cattle does not give up right here; on every occasion any owner feels that those bovines are unprofitable to them, they sell them to slaughterhouses. Although legal guidelines are there to save the bovines from such suffering, inclusive of the Prevention of Cruelty to Animals Act, 1960, respective States have their own Acts to prevent the slaughter of cows and buffaloes, the directive of the ideal court in support of anti-slaughter legal guidelines, their struggling has now not ceased to exist. An evaluation of the trouble of stray cattle and the schemes launched via the government inside the purview of the prevailing state of affairs of the situation of the farm animals has been carried out in this article.

Stray Cattles in India:

It's far pertinent to be aware that the proprietors abandon livestock which have misplaced their utility. These farm animals are known as stray farm animals who roam in the streets in search of meals or are sighted sitting in the center of the street as they don't have any place or shelter. Cattle are kept in a shelter handiest till the time they offer benefit to their proprietors. It's far infelicitous that the cows and bulls who're worshiped as deities are forsaken or disregarded. Cattle are an important aid, aid the agricultural machine, and thereby contribute closer to dietary safety. In January 2020, the Union Ministry of Fisheries, Animal Husbandry, and Dairying had released the twentieth livestock Census, which said that there are over 5 million stray livestock in India.



In 2012, a farm animals census was performed in the state of Madhya Pradesh, and it is surprising to understand that the country has a populace of nineteen 7 million cows and bulls, that's one cow for every 0.33 character. In step with the director of Directorate of Animal Husbandry and Veterinary services, Madhya Pradesh, about 50% of the complete farm animals population is inside the non-breedable class and will be called unproductive, in the state of MP.`` These stray farm animals are deserted, and they must sustain themselves on their own. Rajasthan houses a

populace of thirteen million livestock. Notwithstanding appointing committees by way of the government of Madhya Pradesh to take into consideration the difficulty of stray cattle and concept of stringent punishment for abandoning farm animals, it's often observed to be insurmountable to apprehend the proprietors of the deserted cattle. Moreover, farmers can barely feed themselves, not to mention their animals, assailed by means of drought, famine, and flood-like calamities. In such cases, they're left with no other option however to desert their uneconomic cattle.

It is to be stated that, in the past a long time, the superfluous consciousness has been given to crossbreeding, and the indigenous ones are disregarded. That is also one of the factors contributing to the population of stray livestock. The trouble of stray cattle is mainly in towns as they emerge as a cause of concern as well as occasionally emerge as a risk for the delivery gadget and the majority. However, the abandoned cattle in villages raid crops to feed themselves, thereby inflicting harm to plants and the farmers. It has been asserted by means of the owners of those livestock, which includes marginal farmers, that once they become unfit, their rearing is economically non-beneficial. accordingly, they're either deserted absolutely or are sold to slaughterhouses to get financial gain from their flesh. The authorities have intervened in several instances to resolve the difficulty relating to stray farm animals. This draws our attention toward the need to examine whether or not these farm animals are honestly undeserving or vain as they may be called so.

2. Gaushalas for the protection of the Cattle:

A Goshala or Gaushala is a defensive refuge for cows in India. In step with Merriam Webster, Gaushala is a refuge supplied to the homeless or undesirable livestock that frequently additionally serve as a center for breed development and observation of bovine vitamins and welfare. The time period Goshala is composed of Sanskrit phrases, "Gau" or "cow" and "shala" or refuge, i.e., "Goshala," which is also a Sanskrit time period. Gaushala is an area in which cattle are handled with appreciation and dignity. In historical India, uneconomic, antique, deserted farm animals were given in Gaushalas.

3. Literature Review:

As per the solution given by the Government authorities, to cater to the need of an increasing number of stray cattle, the only viable option is to send them to the Gaushalas. This can be induced from the initiative "Rashtriya Gokul Mission," which the Central Government has undertaken to support Gaushalas and raise their numbers so that the stray cattle can be directed towards Gaushalas (Cow Shelters).

Rashtriya Gokul Mission (RGM):

The Rashtriya Gokul Mission was launched in December 2014, with an investment of Rs 2025 crore for the development and conservation of indigenous breeds through selective breeding in the breeding tract and genetic upgradation of nondescript bovine population. The scheme consists of two main elements viz. National Programme for Bovine Breeding (NPBB) and National Mission on Bovine Productivity (NMBP).

Objective:

The Rashtriya Gokul assignment has been launched to acquire the subsequent goals:

- To broaden and conserve indigenous breeds.
- To breed improvement programs for indigenous breeds to enhance the genetic make-up and boom the inventory.
- To decorate milk manufacturing and productivity of the bovine population through increasing disorder-unfastened high genetic merit woman population and take a look at the unfolding of sicknesses.
- To upgrade nondescript cattle the usage of elite indigenous breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar, crimson Sindhi.
- To distribute ailment-loose high genetic benefit bulls for natural carrier.
- To bring all breedable cows underneath prepared breeding via AI or natural provider the usage of germplasm of excessive genetic merits.
- Arranging first-rate artificial Insemination (AI) offerings at farmer's doorstep.
- Growing an e-market portal for bovine germplasm for connecting breeders and farmers.
- Growing change of cattle and cattle products via assembly out sanitary and picture sanitary (SPS) issues.
- Selecting breeding bulls of high genetic benefit at a young age through the application of genomics.

Implementation of RGM:

Under the Rashtriya Gokul challenge, the relevant government had sanctioned INR 197.67

Crores for organizing 21 Gokul grams (livestock Centers) all around INDIA However the government has failed to implement the task, which become prima facie added to preserve the local farm animals breeds. The scheme's failure to put in force the scheme can be inferred from the fact that no longer a Center can be seen at the ground until 2016. Furthermore, many states have no longer taken any endeavor for carrying out the program, which manifests their disinterest closer to the assignment. Until the year 2019, the best four Gokul Grams had been hooked up inside the following towns: Varanasi, Mathura, Patiala, and Phora, at the same time as the closing 17 Gokul grams are in development.

Rani et al. (2009), in research "**Injuries by Bull Horns: Patterns and Prevention Protocols"** :
It reveals that the maximum numbers of injuries are sustained in rural people while rearing the cows and bulls, during feeding, while tying them or milking the cows or buffaloes. Researchers advise wearing helmets and steel-toed boots as a simple and important safety strategy to prevent bull gore injuries. Dehorning can be encouraged when the calf is two months to two years old. In addition, traffic police should be directed to keep stray cattle away from road dividers and busy sections of the roads thus minimizing attacks.

Sharma and Shah (2016), in research named "**A Practical Animal Detection and Collision Avoidance System Using Computer Vision Technique**":
It suggests a simple warning system, efficient automatic animal detection and a low-cost approach for automatic animal detection on highways for preventing animal-vehicle collisions using computer vision techniques. The proposed method can alert the driver when the vehicle speed is up to 35 km/h. Though the system is tested on Indian highways but also can work in other countries

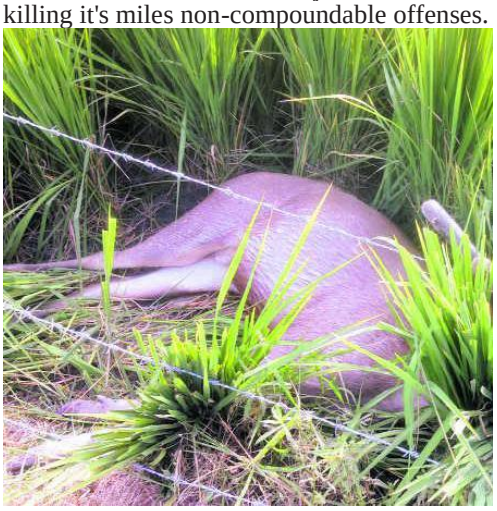
IMPACT OF STRAY ANIMALS ON PUBLIC HEALTH AND SAFETY
Human lifestyles are precious and must be saved at any cost. Stray animals roaming around freely inside the towns have emerged as a
serious menace. Several lives have already been lost and plenty have been injured due to accidents regarding stray farm animals and dogs.
Stray dogs provoke spread of disorder, causing wounds on people, adverse belongings, developing a hazard on roads and immoderate noise (Carding,1969) . Corporations of stray dogs may be witnessed roaming within the streets and the scenario is worst during nights
when the general public falls prey to their attack. Stray and roaming dogs and cows/bulls are typically not cared for and are often carriers of sicknesses. Many diseases of animals are
fairly contagious like rabies and leptospirosis are widely known whilst different sicknesses aren't so normally identified. When
positive stray puppies bite humans, they infect those human beings with rabies, a viral disorder that causes acute irritation of the mind.
Stray animals are commonly seen roaming in and across the residential areas and also on roads. Occasionally, the animals are seen all of
a sudden on the roads, jeopardizing the lives of those using motorbikes and different cars. Several mishaps have proved fatal,
ensuing in the lack of treasured lives. Some of instances are suggested in routine concerning stray cattle assaults and injuring humans
on the roads. Besides, many people sustain injuries within the accidents. Other than the inner roads, a huge quantity of stray animals
may be visible roaming on highways. Humans touring on national highways are usually on the threat of meeting with an accident due
to those stray animals. The chance of injuries increases manifold during the foggy days and at night time because it will become very tough for drivers to spot stray animals.

Safety Solutions and their effects on stray Animals:

Barbed wiring:
Barbed wiring is a very harmful solution. It protects the farms but at the same time it can be deadly for stray animals.

Case study –
Barbed Fencing :
Wildlife officers of Haryana in recent times are disposing of barbed wires from the agriculture fields in Hisar, Sirsa, Fatehabad , Jind and Bhiwani, which have a populace of around 2,785 blackbucks in those districts. The wires placed up by some locals to protect their fields from
farm animals have injured several blackbucks, the state animal of Haryana.
In neighboring Rajasthan, which has 30,530 blackbucks as per population census carried out within the country in 2016, the same year over 1,700 those who have been involved in wildlife

crimes had been arrested due to the efforts of this community. Grover, however, ruled out any incident of poaching of blackbucks saying that human beings are properly conscious that this is a schedule one animal below natural world safety Act wherein killing it's miles non-compoundable offenses.

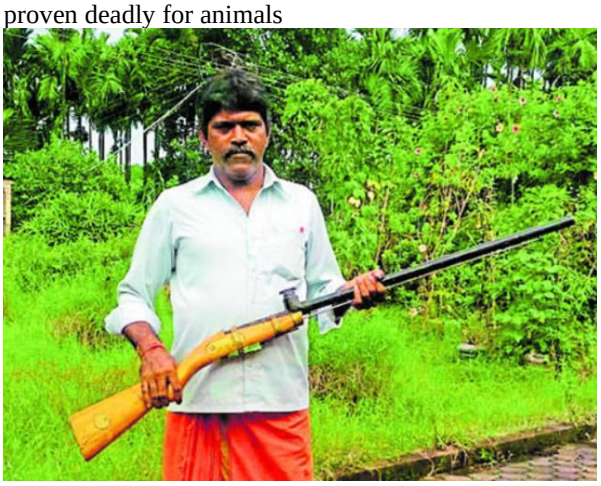


Electrocuted Wire Fencing:
Power lines and electrified fences are killing birds, monkeys, pangolins and even elephants in surprising numbers.

It often kills smaller animals, particularly birds and reptiles that scientists are eager to preserve. Journey wires are often to blame for this, positioned approximately half a foot off the floor, the wires are meant to ship a deterring zap to hungry lions and crop-raiding bush pigs.

However no longer all creatures respond by way of turning tail. Tortoises that hit a tripwire withdraw into their shells instead of retreat, even as pangolins curl over the twine right into a shielding ball. The animals that stay placed, greatly surprised until their hearts give out.
Electrocution impacts a numerous type of species; in some, it's so commonplace that it jeopardizes the survival of species. In southern African countries, electrocution is taken into consideration as a leading chance to endangered Cape vultures and seriously endangered white-sponsored vultures.
In imperative Asia, electrocution kills an estimated 4,000 endangered Saker falcons every year. In the United States of America, Dr. Loss and his colleagues have anticipated that tens of hundreds of thousands of birds are killed by using energy strains every year.

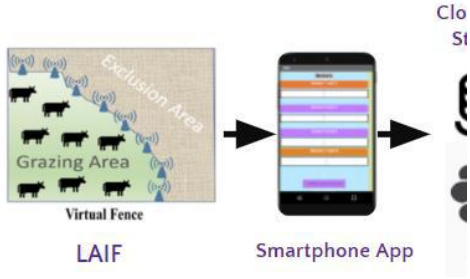
Use of Guns:
This is one of the oldest solutions to protect the farms from the animals. Many farmers use air rifles and pistols to scare animals, but there are people who use proper guns to shoot animals from their farms. Many a times these guns are proven deadly for animals



Farmers Guarding the farms:
At many places farmers guard their fields day and night to keep the stray animals away from the crops. This makes the farmer's life very hard as they need to stay awake most of the time. At many places they use scarecrows.

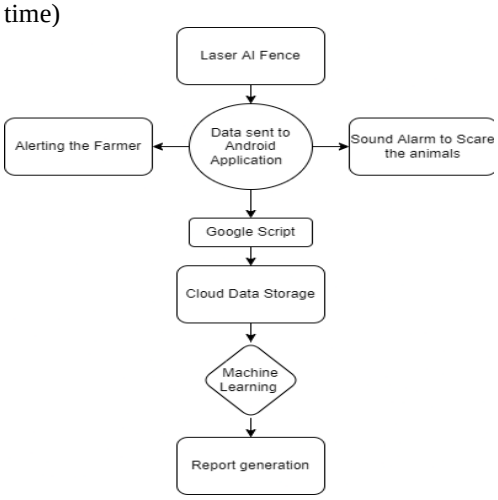
4. **Our Solution:**

Laser AI Fencing (LAIF) is our smart solution to the problem described above. LAIF is a safe, cheap and reliable solution to the problem and is different from any other solution described above.
There is a fence made with lasers and LDR sensors and anytime the value of the LDR sensor goes below that of the laser, an alert is sent to the farmer using bluetooth connection. The fence also has a speaker which plays sounds to scare the animal away and stores the data of the animal by comparing the data of the amount of lasers cut with a premade database which holds data for animals which are common to the area. It then composes a report of which animals are most likely to come and the time that is most common. Our solution is unique because it helps both the animals of the area and the farmer, and it provides an automatic solution and does not require manual labor or a lot of man hours.



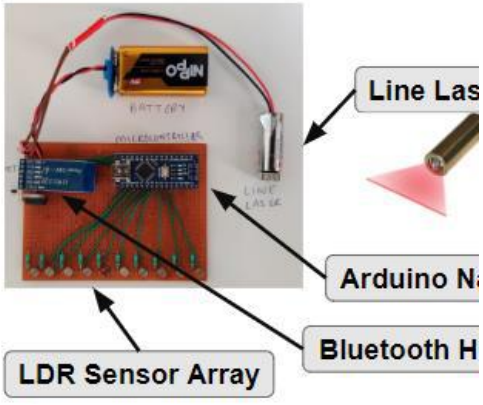
Flow chart:

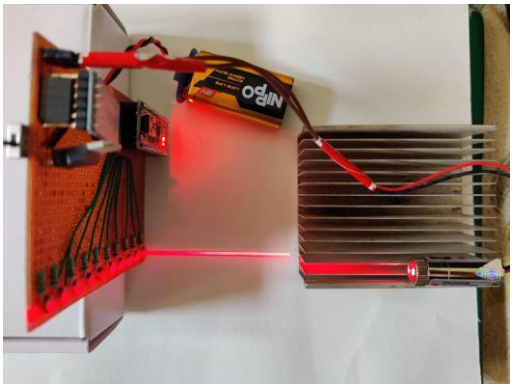
The flowchart below represents the working of the Laser AI Fence. The fence first gets the data, and with the data, when the animal crosses the fence, the farmer is alerted and an alarm is sounded. The data is then sent to a google script code which uses cloud data storage and machine learning to produce a report of the data of the animal. (Type and time)



Prototype:

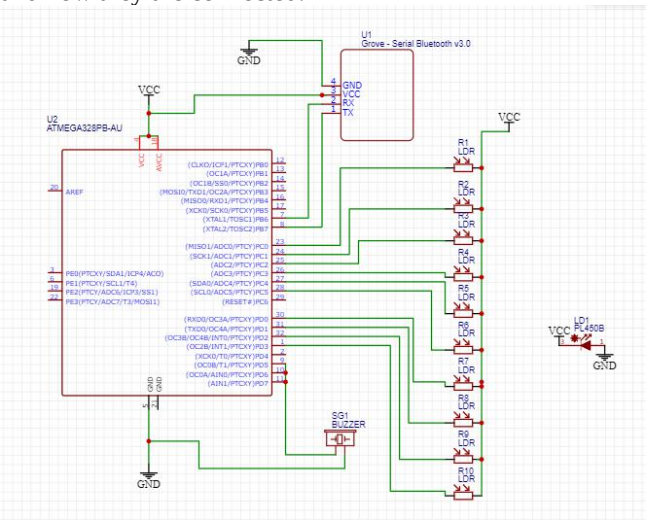
Our prototype entails line lasers, which are connected to individual LDR sensor arrays. When the LDR reading is below that of the laser, the bluetooth HC05 is activated and sends an alert to the farmer.





Circuit:

The circuit below shows the working of our prototype. We can see the connections of the LDR units, lasers, the Bluetooth HC05 and the Arduino Uno and where all the wires are going and how they are connected.



Components:

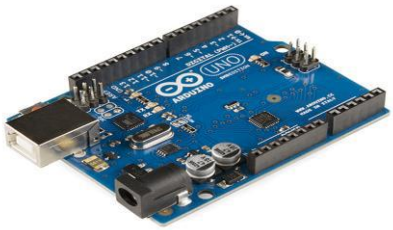
1. **Line Laser:**

We have used line lasers as the main light source for our sensors and the main benefit of using line lasers is that using this we can cover all the sensors using just one laser light and this laser provides a very concentrated and high intensity laser beam that provides enough light to even sense in full daylight.

2. **LDR array:**

We have made our own LDR sensor array to make it compact. It takes very less space as there is only a 1cm gap between the sensors. The full array covers the area of 10 cm which is more than enough to sense and differentiate between urination and defecation.

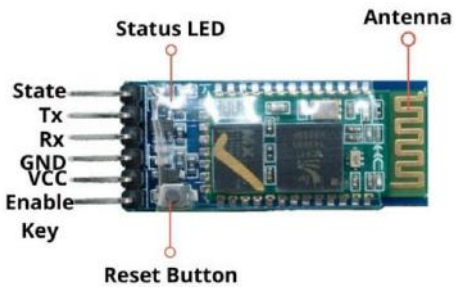
3. **Arduino Microcontroller:**



We have used an Arduino Uno microcontroller to control the full circuit. It takes input from the sensors and controls the solenoids using NPN transistors.

4. **Bluetooth Module(HC05):**

We have used the HC05 module in our circuit to connect with the mobile phone application.



Algorithm:

The whole software part of the project consists of four different platforms which are:

1. Circuit coding using arduino ide
2. App development
3. Google Script for drive communication
4. Python coding for machine learning

Circuit coding using arduino:

We are using arduino as main controller of the circuit. We have connected 8 LDR sensors in a row and then connected them to all the analog ports of the controller board.

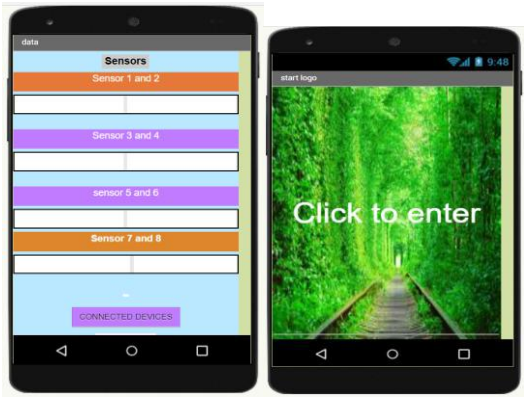
Code:

```
#include <SoftwareSerial.h>
SoftwareSerial bt(11, 12); // RX, TX
int a=0;
int b=0;
int c=0;
int d=0;
int e=0;
int f=0;
int g=0;
int h=0;
void setup() {
  // initialize serial communication at 9600 bits per second:
  Serial.begin(9600);
  bt.begin(9600);
}
// the loop routine runs over and over again forever:
void loop() {
  int sensorValue0 = analogRead(A0);
  int sensorValue1 = analogRead(A1);
  int sensorValue2 = analogRead(A2);
  int sensorValue3 = analogRead(A3);
  int sensorValue4 = analogRead(A4);
  int sensorValue5 = analogRead(A5);
  int sensorValue6 = analogRead(A6);
  int sensorValue7 = analogRead(A7);
//Converting all the analog values into digital values
  if (sensorValue7<150){ h=1; }
  else{ h=0;}
  if (sensorValue0<500){ a=1;}
  else{ a=0;}
  if (sensorValue1<500){ b=1; }
  else{ b=0;}
  if (sensorValue2<500){ c=1; }
```

```
  else{ c=0;}
  if (sensorValue3<500){ d=1;}
  else{ d=0;}
  if (sensorValue4<500){ e=1; }
  else{  e=0;}
  if (sensorValue5<500){  f=1; }
  else{ f=0; }
  if (sensorValue6<500){ g=1;}
  else{  g=0;}
int val = a+b+c+d+e+f+g+h;

// Detecting animal size and accordingly sending a signal via bluetooth terminal and serial terminal at the same time
if(val>=2 && val<4){
  digitalWrite(4,HIGH);
  Serial.println("SmallAnimal");
  bt.println("SmallAnimal");
  delay(1000);
}
else if(val>=4 && val<=7){
  digitalWrite(4,HIGH);
  Serial.println("MediumAnimal");
  bt.println("MediumAnimal");
  delay(1000);
}
else if( val>=8){
  digitalWrite(4,HIGH);
  Serial.println("LargeAnimal");
  bt.println("LargeAnimal");
  delay(1000);
}
else{
   digitalWrite(4,LOW);
}
}
```

Mobile Application:

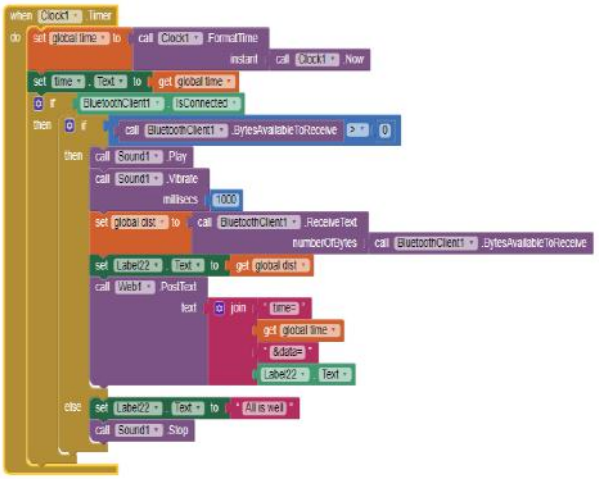


We have designed a small android application which connects with the device and collects all the data along with alerting the user when needed.

We have made this prototype application using the MIT app inventor platform which provides easy to use tools to build an application.

We have made the code using block coding where the main function of the code is to collect information from the device and then upload it on the sheet stored on the drive.

Codes:



Google Script:

We have used google script to connect our mobile application with the google drive

We have written a google script that launches as an web application and then using the link of the web app we can upload the data directly on the google sheet :

```
function doGet(e) {
var ss = SpreadsheetApp.openByUrl("https://docs.google.com/spreadsheets/d/1l-PqcepdpEgU-
```

```
NdQvtBCpRidJ-
kZ9rlPwAWS0VJY9sE/edit#gid=0");
var sheet = ss.getSheetByName("Sheet1");
 addUser(e,sheet);}
function doPost(e) {
 var ss =
SpreadsheetApp.openByUrl("https://docs.go
ogle.com/spreadsheets/d/1l-PqcepdpEgU-
NdQvtBCpRidJ-
kZ9rlPwAWS0VJY9sE/edit#gid=0");
 var sheet = ss.getSheetByName("Sheet1");
 addUser(e,sheet);}
function addUser(e,sheet) {
 var time = e.parameter.time ;
 var data = e.parameter.data ;
 sheet.appendRow([time,data]);
}
```

Data on the sheet:

We are saving the type of animal along with the time of intrusion and making a big data set for making a prediction for future intrusion

time	data
1:18:53 PM	LargeAnimal
1:18:54 PM	LargeAnimal
1:18:55 PM	MediumAnimal
1:18:56 PM	MediumAnimal
1:18:57 PM	MediumAnimal
1:18:58 PM	MediumAnimal
1:18:59 PM	SmallAnimal
1:19:00 PM	SmallAnimal

Python Code for machine learning:

After collecting the data we have used python to analyze the data and apply machine learning for future predictions.

We have used multiple libraries like numpy, panda, matplotlib, scipy etc for data analyzing

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
```

After that we are using the sklearn library and module to implement the machine learning model.

```
import pickle
from sklearn import svm
from sklearn import tree
from sklearn import metrics
from xgboost import XGBClassifier
from sklearn.metrics import accuracy_score
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import confusion_matrix
from sklearn.naive_bayes import
MultinomialNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report
from sklearn.ensemble import
RandomForestClassifier
from sklearn.model_selection import
train_test_split
```

Reading the data:

```
data = pd.read_csv(r"C:\Users\User\Vikramjeet\Animal\animal.csv")
print(data.tail())
```

```
          time  time.1          data
318  8:39:16 PM   74356  LargeAnimal
319  8:39:17 PM   74357  MediumAnimal
320  8:39:18 PM   74358  LargeAnimal
321  8:39:18 PM   74358  LargeAnimal
322  8:39:20 PM   74360  LargeAnimal
```

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 323 entries, 0 to 322
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
```

```
data.data = pd.Categorical(data.data)
data['data'] = data.data.cat.codes
print(data)
```

```
          time  time.1  data
0    1:14:46 PM   47686     0
1    1:14:47 PM   47687     0
2    1:14:47 PM   47687     0
3    1:14:49 PM   47689     2
4    1:14:49 PM   47689     0
..          ...     ...   ...
```

Separating the test and train data:

```
x_train, x_test, y_train, y_test = train_test_split(x, y, test

print(x_train.shape)
print(x_test.shape)
```

```
(226, 1)
(97, 1)
```

Training the model:

```
rf_model = RandomForestClassifier(n_estimators =

rf_model.fit(x_train, y_train)
```

```
C:\Users\User\AppData\Local\Temp/ipykernel_15352/19
(n_samples,), for example using ravel().
  rf_model.fit(x_train, y_train)

RandomForestClassifier()
```

```
# save the model to disk
filename = 'random_forest'
pickle.dump(rf_model, open(filename, 'wb'))

# load the model from disk
loaded_model = pickle.load(open(filename, 'rb')
```

Creating the confusion matrix:

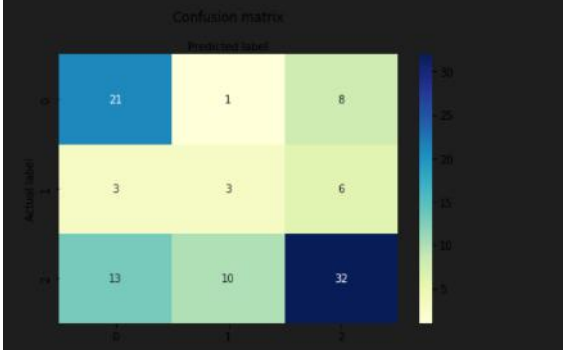
```
y_predict = rf_model.predict(x_test)

cnf_matrix = metrics.confusion_matrix(y_test, y_predict)
cnf_matrix
```

```
array([[21,  1,  8],
       [ 3,  3,  6],
       [13, 10, 32]], dtype=int64)
```

```
class_names=[0,1] # name  of classes
fig, ax = plt.subplots()
tick_marks = np.arange(len(class_names))
plt.xticks(tick_marks, class_names)
plt.yticks(tick_marks, class_names)
# create heatmap
sns.heatmap(pd.DataFrame(cnf_matrix), annot=True, cmap="YlGnBu" ,fmt='g')
ax.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion matrix', y=1.1)
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
```

```
Text(0.5, 257.44, 'Predicted label')
```

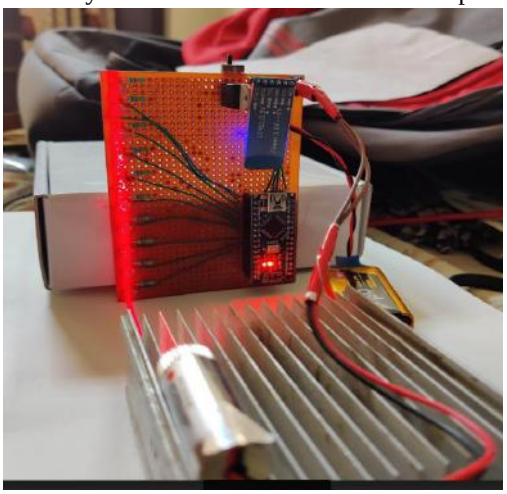



```
print("Accuracy:",metrics.accuracy_score(y_test, y_predict))
```

```
Accuracy: 0.5773195876288659
```

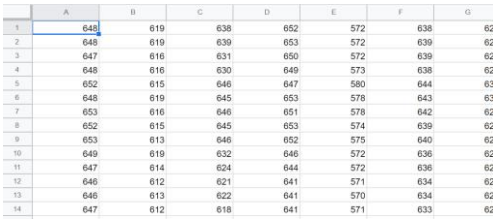
Testing and result:

We have made a very small prototype to test the accuracy and consistency of the sensor. All the testing that we have done was in-house testing we haven't done any field test of our prototype but during in house testing the data set that we have created was very small so we were getting the accuracy of almost 60% with the 500 data points



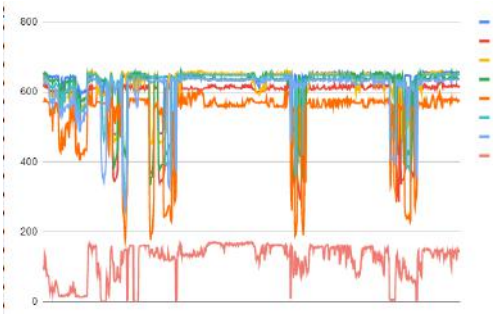
But later on we have created a data set of more that 2000 values and then we were getting the accuracy of almost 87% which is quite good for the lab testing.

As we are only recording the data during the time of intrusion, we are getting the data at random time. But the maximum data sample rate that we have is 80 samples per second.



	A	B	C	D	E	F	G
1	648	619	638	652	572	638	62
2	648	619	639	653	572	639	62
3	647	616	631	650	572	639	62
4	648	616	630	649	573	638	62
5	652	615	646	647	580	644	63
6	648	619	645	653	578	643	63
7	653	616	646	651	578	642	62
8	652	615	645	653	574	639	62
9	653	613	646	652	575	640	62
10	649	619	632	646	572	636	62
11	647	614	624	644	572	636	62
12	646	612	621	641	571	634	62
13	646	613	622	641	570	634	62
14	647	612	618	641	571	633	62

Above is the sample data that we can collect on the serial monitor.



Conclusion:

We have built a working prototype which is giving us consistent and accurate results all the time. Our prototype works with an accuracy of almost 100%. We need to work on the accuracy of the early detection of the intrusion using machine learning as right now we are getting an accuracy of almost 87%, but we need to increase the size of the dataset to increase the accuracy of the model to above 90%.

We can come to the conclusion that our solution LAIF is a smart and new age solution to deal with the stray animal problem INTRUDING THE FARM AND DESTROYING CROPS. It only costS less than the 10% of the other solutions like barbed wire fencing or electrocuted wire fencing.

Future Scope:

There are many things that need to be done to make it customer ready. Right now it is at the prototype stage. We need to start its field testing and we are going to start that soon as it is the next step to test the implementation and complications during implementation. Another is to make a sturdy design so that it can withstand the outside environment of the farm which will have sun, rain, wind etc. Along with that we need to increase the dataset to increase the accuracy of the model for early prediction. We are also going to improve the mobile application and its user interface to make it more easy to use and interactive

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