Motion Sensor to detect animals

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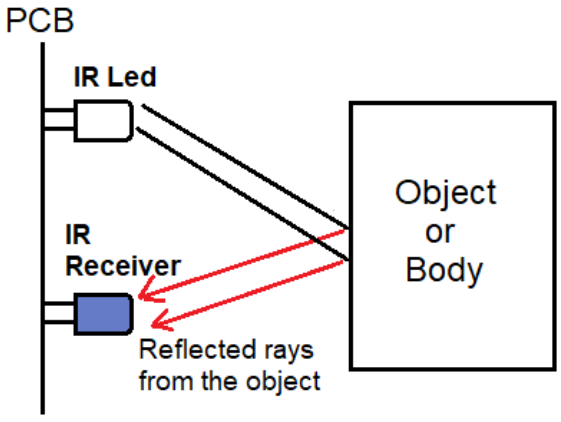
***Abstract* — A security system is an important need for agricultural land. A lot of attacks and threats will occur due to the wild animals to the crops. In case to get a good harvest and income, smart security systems should be well implemented. In this research, we made a motion sensor to detect wild animals by sending and receiving infrared waves. Built to accomplish the term of cheap, effective, reliable, and applicable sensors that have been contained extra features. The main process works by attaching the IR transmitter and photodiode. Normally it detects the motion by getting reflected IR waves from the objects. Already IR sensors are available in the market to detect the motion. But they have a short-range and small detection angle. In our research, we are trying to detect the motion at a higher range and higher angle. This result seems to satisfy a large area of the detection and inference from other IR sources can be eliminated here.**

I. INTRODUCTION

From ancient times, humans face a lot of challenges to survive and they need only shelter and food for their life at that time. So agriculture plays the main role in their lifestyle. But wild animals besides distributing the agricultural lands and also attack villagers and threaten the safety of the soul. Therefore, ancient people uses a lot of ways to detect and prevent the entering of wild animals. One way that they used was making of fence around the land but wild animals like elephants destroyed the fence and damaged the useful crops.

Then they made buffalo horns carried in such a way and able to make a sound that makes some wild animals uncomfortable and running. Nowadays population increases and scarcity of land has occurred. Due to this problem, humans smash the forests and take the land for their use. With the increase of deforestation, wild animals' lifestyles are also affected. If we disturb the wild animal's life cycle they will also disturb us. So people have face lot of threats by them.(3)

Now humans have to think, how to survive by avoiding wild animal attacks. So, it is necessary to have a system or device that can expel wild animals such as cows, goats, pigs, monkeys, and elephants from agricultural lands. By this time lot of technologies and sensors have developed to detect the motion of wild animals. In this research, we propose a sensor design to detect the motion of wild animals by avoiding disturbance of other factors.



In our design, we have used Infrared rays to detect the motion. Infra-red(IR) is a region of the electromagnetic radiation spectrum where have lengths range from about 700 nm to 1mm. It was first discovered by Fredrick William Herzl in the 1800s. when he was measuring the temperature of different colors. We use an infrared ray with a particular range of wavelength as the emitter wave. Our design consists of one IR emitter LED and a receiver of IR rays, that is the photodiode. IR emitter LED emits IR radiation always, if any motion, that IR wave is reflected and it will be received by the photodiode. The ability of the photodiode is, when it receives IR rays, it can change resistance and voltage. So we The voltage detected was changing according to the distance of reflection, the material of the reflected body, and some other small factors. By measuring the detected voltage in the resistor connected series to photodiode, we can detect the motion in our sensor design.(5)

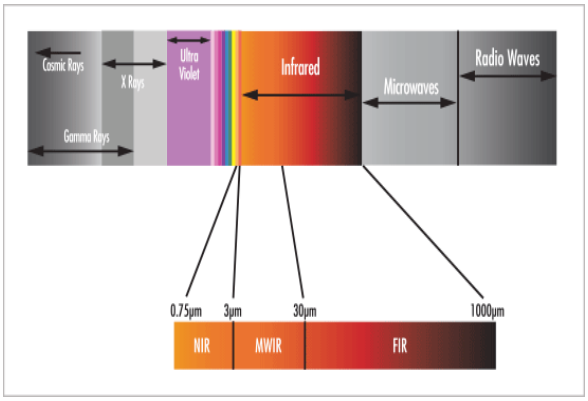
II. INITIAL SPECIFICATION

A lot of IR sensors are already found in the market. But they have a small range of detection 20-30 cm and have a detection angle of 35°. In our design, we have planned to implement a sensor with a range of up to 75cm and a detection angle of 360°. Here we have a facility to adjust to the detection range and sensitivity. The digital output is 0V (low), 5V (high) and the power supply is 5V.

III. METHODS

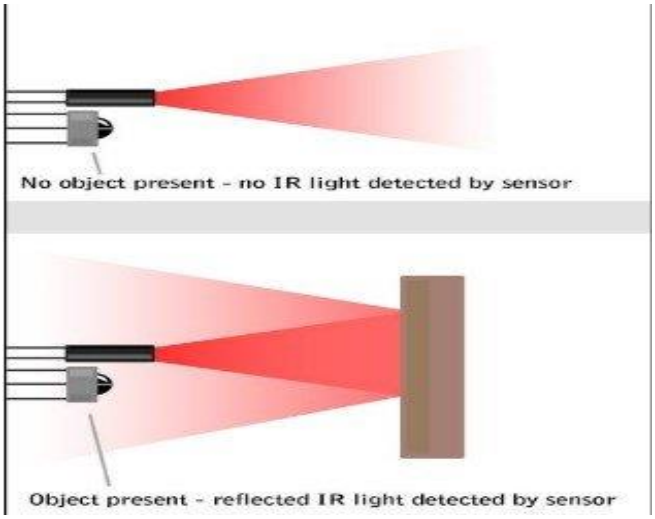
A. *Principle of operation*

In our design, we have used IR rays. This sensor is working according to plank's radiation law, Stephon Boltzmann's law, Win's displacement law. The main key elements of this sensor design are the IR transmitter, transmission medium, and IR receiver. IR transmitters act as a source for IR radiation. According to the planks radiation law, every object is a source of IR radiation at a temperature above 0 kelvin. In most cases, black body radiators, tungsten lamps, Silicon carbide, infrared lasers, LEDs of infrared wavelength are used as sources. But here we have used IR LED as the IR emitter.(6)



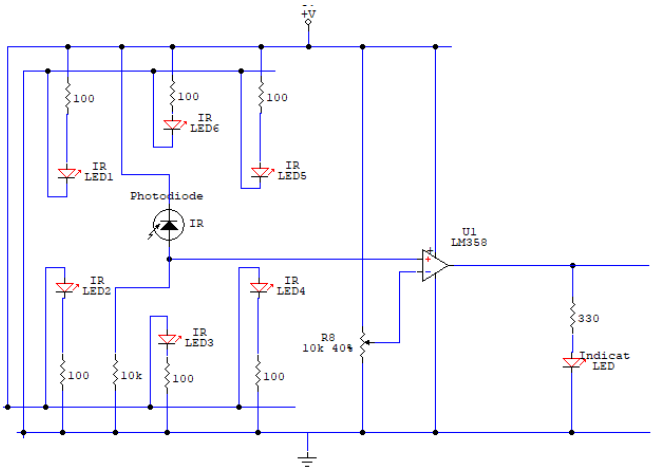
Transitions medium provides passage for the radiation to reach from the IR transmitter to the IR receiver. IR receivers are commonly photodiode and phototransistors. They are capable of detecting infrared radiation. We have used a photodiode as an IR receiver.

In this sensor design, the IR LED transmitter emits IR radiation at a particular range of wavelength continuously. If there is any motion, emitted infrared rays will get reflected in that moving object and come back. It is received by the IR receiver, which is the photodiode. That photodiode is capable of receiving that particular range of wavelength of IR radiation.(4)

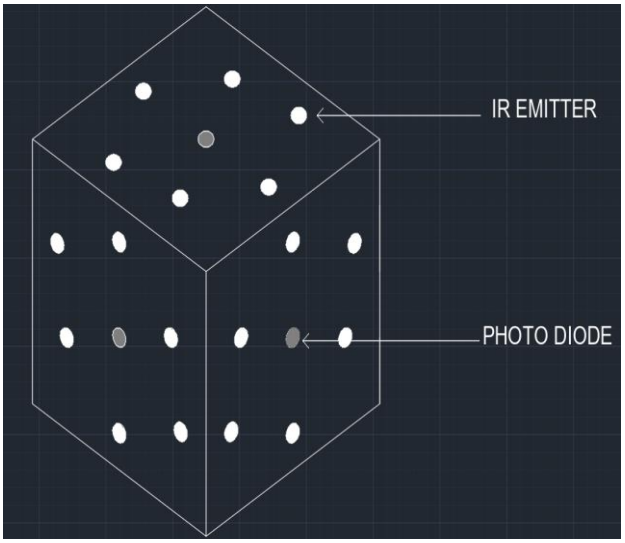


Photodiode will change resistance and voltage by the use of received IR radiation. By comparing voltage with the use of a potentiometer and operational amplifier we can get digital output.

B. *Circuit diagram*



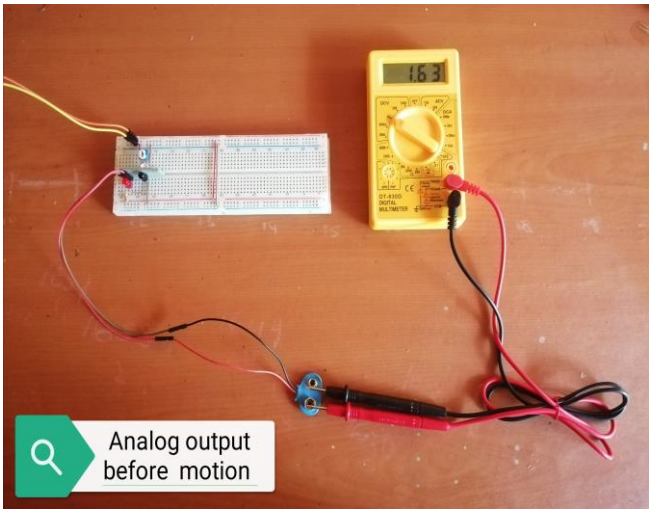
C. Final Design

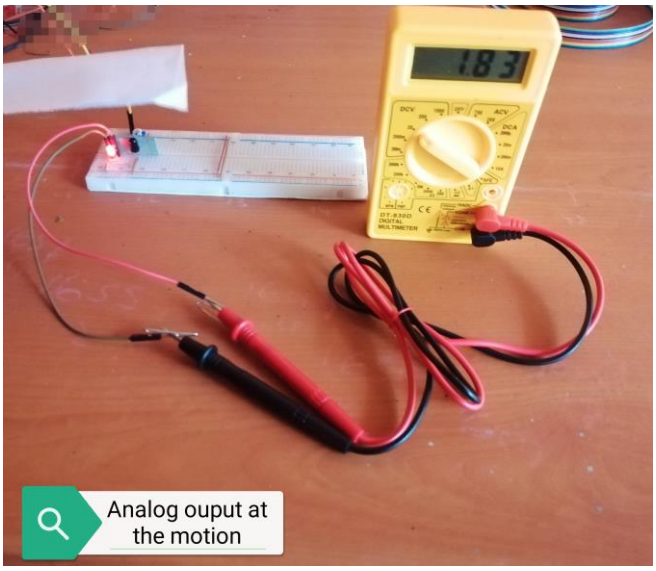


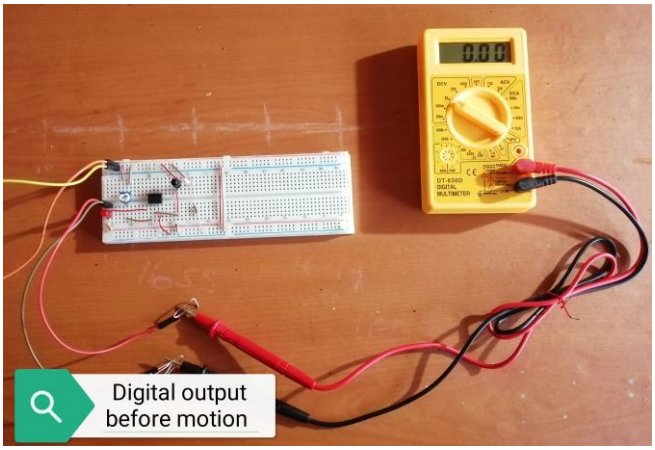
Final Design is in the shape of cube. Every face has six IR Emitter and one photo diode. Six IR emitters are arranged as shown above to have maximum intensity of radiation focus in one side. Here photo diode is in lower position than IR emitter to reduce the direct contact IR rays to the photo diode

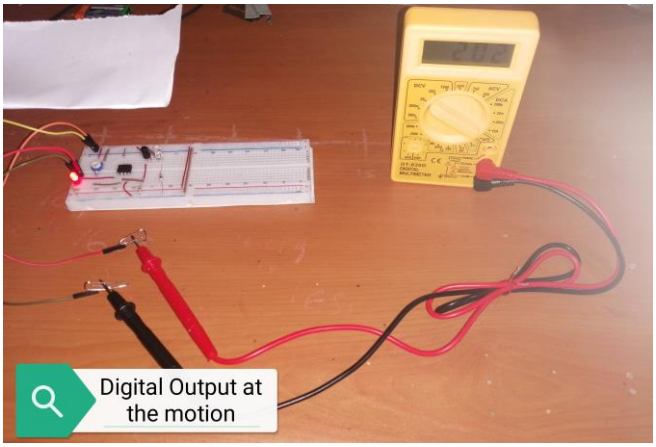
D. Testing setup

- Setup-1



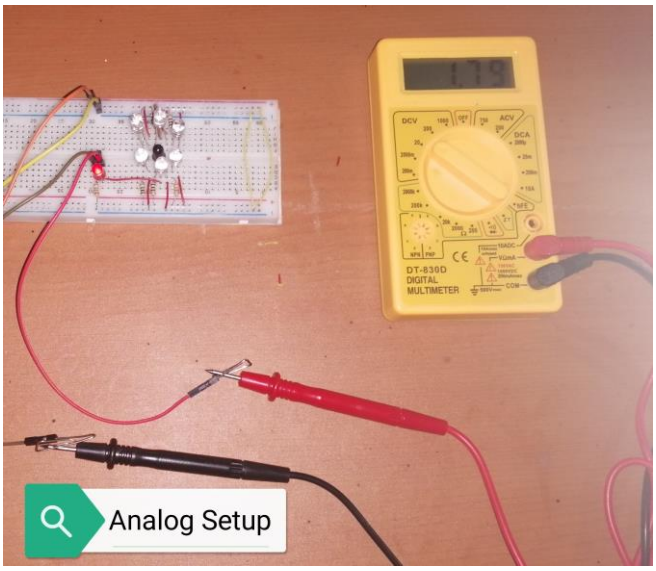


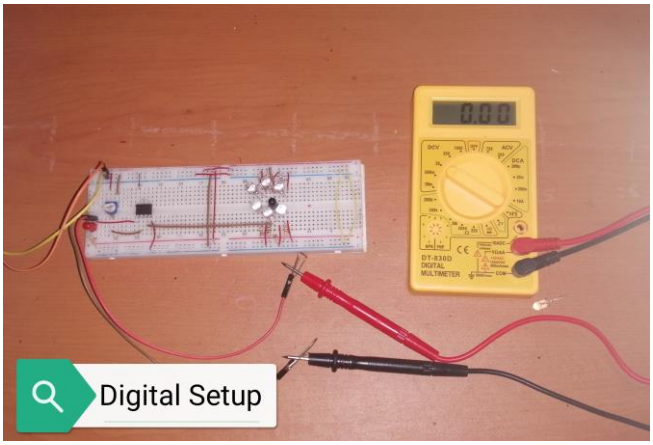




First, we tested the setup by increasing the current flow through the IR transmitter. So first IR transmitter was connected with a potential meter. Then object was placed and the distance was adjusted. After that resistance was decreased to increase the current flow and it was done similarly many times to get maximum distance. Finally, the maximum distance was obtained at 100Ω.

- Setup-2

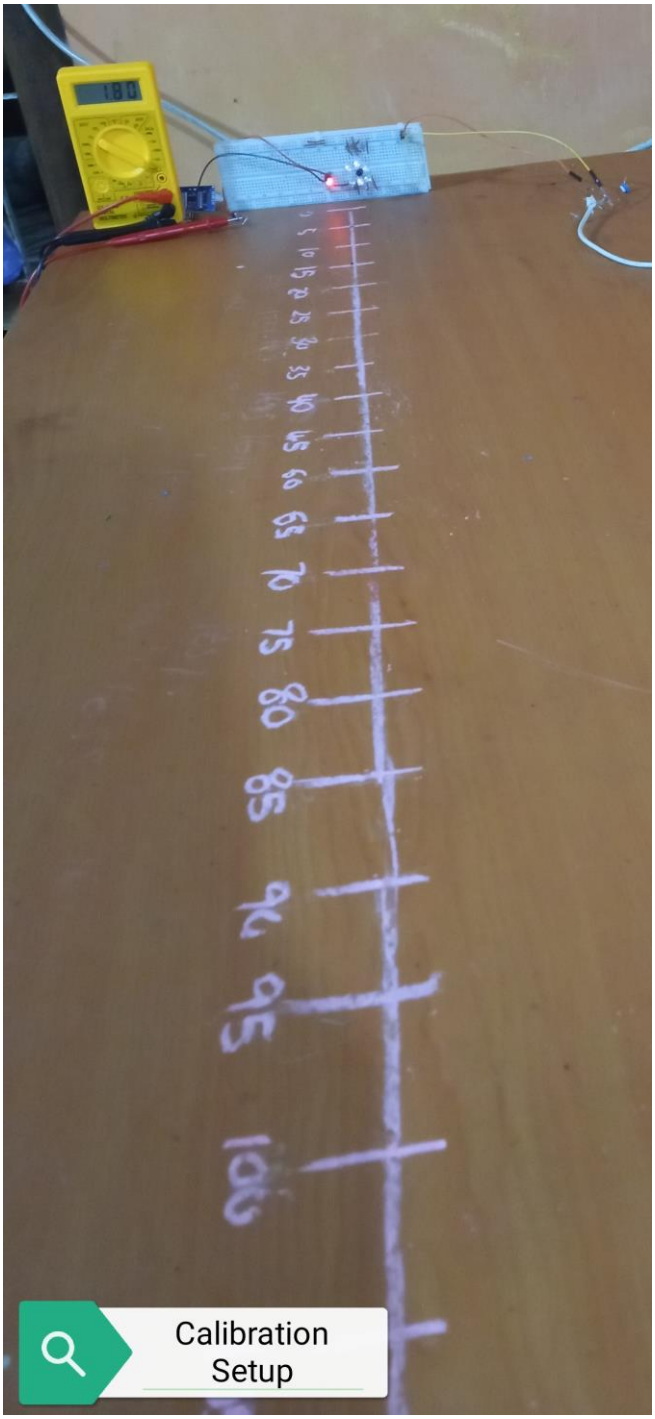




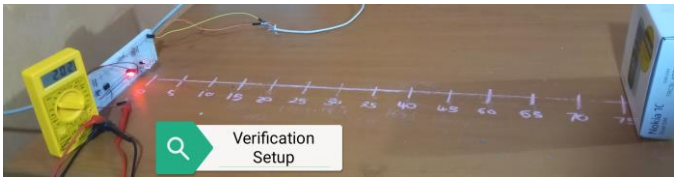
In test setup 2. We tested the setup by increasing the number of IR emitters. Initially, the IR emitter was connected with 100Ω resister was added parallel to the above one. Similarly, the above steps were done to get the maximum detectable distance.

E. Calibration setup

Calibration is done in this design to get higher accuracy and better sensitivity. From calibration we can find the type of animal and distance of animal from the sensor by measuring the voltage of reflected IR. We have took input as distance and output as voltage in this calibration. By changing the distance between sensor and object, output voltage is measured.



F. Verification method



The verification setup was arranged as shown above to verify the maximum detectable distance of 75cm and 360° of maximum detection angle.

G. Statical analysis

Eg: At 100cm

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
1591	1592	1590	1591	1591	1593	1590	1591	1589	1592

Stranded Deviation, σ: 1.095

No of readings (N): 10

Mean (μ): 1591.0

$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(x_I - \mu)^2$

$= \frac{(1591 - 1591.0)^2 + \ldots\ldots\ldots + (1592-1591.0)^2}{10}$

$= \frac{12}{10}$

$=1.2$

$\sigma = \sqrt{1.2}$

$= 1.0954451150103$

Mean Error = 0.346

- $\sigma_x = \frac{\sigma}{\sqrt{N}}$

$= 0.3461016151378$

Distance	Mean voltage	Standard deviation	Mean error	Voltage
0	1687.1	1.432	0.367	1687
5	1998.4	1.333	0.323	1998
10	1939.9	1.28	0.258	1940
15	1914.3	1.276	0.296	1914
20	1886.8	1.345	0.325	1887
25	1859.7	1.285	0.283	1860
30	1832.2	1.308	0.3	1832
35	1788.1	1.364	0.351	1788
40	1766.5	1.333	0.323	1767
45	1745.9	1.32	0.319	1746
50	1710.9	1.175	0.2	1711
55	1696.3	1.299	0.32	1696
60	1680.1	1.288	0.298	1680
65	1667.3	1.304	0.298	1667
70	1653.2	1.352	0.364	1653
75	1641.4	1.165	0.199	1641
80	1628.8	1.294	0.298	1629
85	1618.9	1.412	0.399	1619
90	1608.2	1.324	0.323	1608
95	1659.6	1.1	0.28	1600
100	1591.0	1.095	0.346	1591
105	1582.3	1.088	0.111	1583
110	1575	1.283	0.233	1575
115	1569.2	1.356	0.379	1569
120	1562.9	1.054	0.12	1563
125	1558	1.011	0.145	1558
130	1553.3	1.056	0.168	1553
135	1548.9	1.078	0.132	1549
140	1544.5	1.256	0.244	1545
145	1533.9	1.147	0.156	1534
150	1530	1.344	0.321	1530
155	1526.9	1.457	0.411	1527
160	1526	1.255	0.283	1526
165	1525.6	1.024	0.132	1526
170	1525	1.036	0.148	1525
175	1524.4	1.027	0.123	1524
180	1524.2	1.254	0.156	1524
185	1524	1.269	0.178	1524
190	1523.9	1.22	0.211	1524
195	1523.7	0.925	0.1	1524
200	1523.5	0.524	0.09	1524

IV. RESULTS

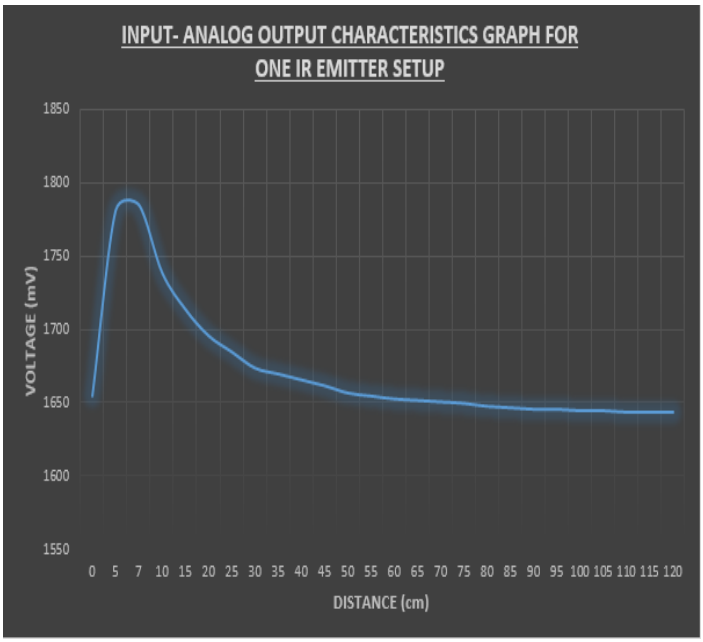
A. Observations

In setup1 when decreasing the resistance of using the potential meter, the maximum detectable distance was increased. At 100Ω maximum distance of 17.5cm was obtained. When decreasing the resistance below 100Ω, the IR emitter was burnt.

In setup 2, the maximum detectable distance was increased when connecting the IR emitter with 100Ω resister parallel. But an increase in the detectable distance was decreased gradually when connecting more connections parallel. After connecting six IR connections parallel maximum detectable distance of 75cm. when adding more than six parallel connections, an increase in the detectable distance was dropped largely and a comparatively higher amount of power was also consumed. So six parallel circuit was taken as a final circuit by us.

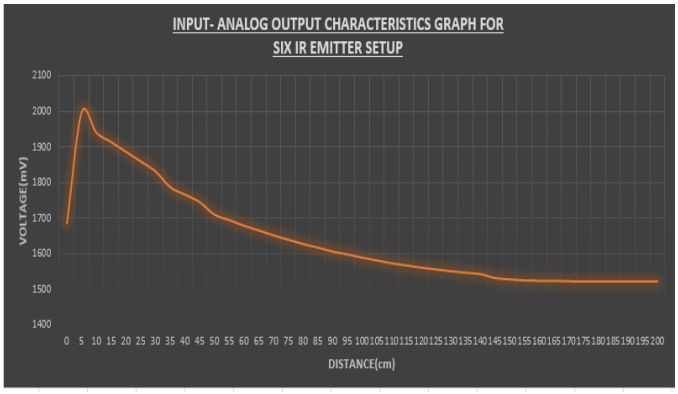
B. Input-Output characteristics graphs

1. When using one IR emitter we got this Voltage vs Distance graph (Analog Output)

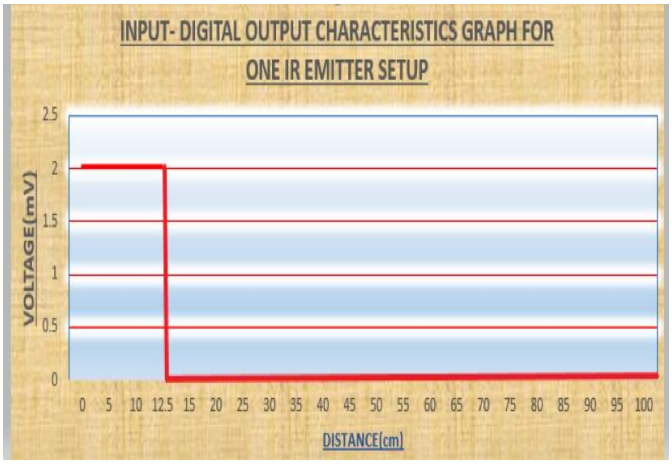


C. *Calibration Results*

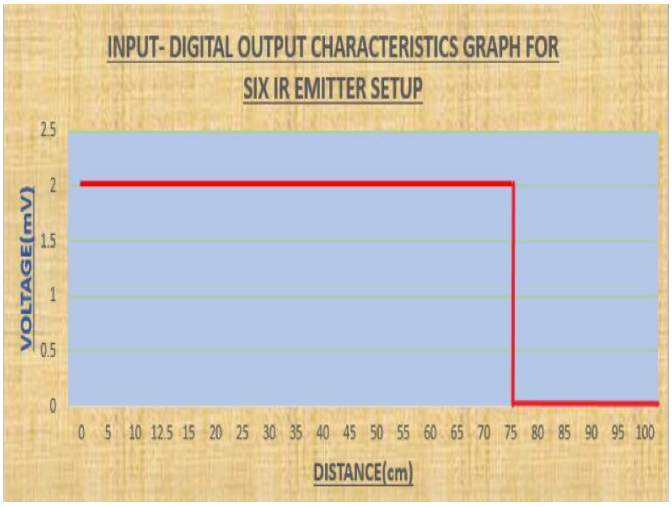
2. When using six IR emitter we got this Voltage vs Distance graph (Analog Output)



3. When using one IR emitter we got this Voltage vs Distance graph (Digital Output)



4. When using six IR emitter we got this Voltage vs Distance graph (Digital Output)



Calibration Results	
Distance (cm)	Voltage (mV)
0	1687
5	1998
10	1940
15	1914
20	1887
25	1860
30	1832
35	1788
40	1767
45	1746
50	1711
55	1696
60	1680
65	1667
70	1653
75	1641
80	1629
85	1619
90	1608
95	1600
100	1591
105	1583
110	1575
115	1569
120	1563
125	1558
130	1553
135	1549
140	1545
145	1534
150	1530
155	1527
160	1526
165	1526
170	1525
175	1524
180	1524
185	1524
190	1524
195	1524
200	1524

D. *Verification Results*

At 75 cm analog output voltage of 1641 mV was obtained. Digital output of 2V was obtained at 75 cm.

E. *Final Specifications*

❖ Maximum detectable distance	75 cm
❖ Maximum detectable angle	360°

V. DISCUSSION

Wild animals' detection using motion sensor research is a very interesting one. We have learned a lot of things from this research. We have got a lot of experience in handling sensors, multi-meters and other electrical components. In this sensor design, we faced a lot of difficulties. First, we had planned to make an IR emitter that has a higher range. So, a tungsten bulb was taken by us, and we here trying to find the range of IR wavelength that was emitted by that bulb. But we couldn't have the facility to measure range of wavelengths in this pandemic situation. Therefore, this plan was dropped. Then we were searching for an IR emitter with a higher power. But couldn't get that IR emitter. Only one type of IR emitter had available in the market.

Considering the covid19 situation in our country. We planned to get maximum power by using that available IR emitter. When increasing the current flow through the IR emitter sometimes it was burnt. IR emitters also have absorbed the other IR radiation in the surrounding environment. So it was difficult to measure the readings as the temperature changed. Therefore, we had planned to test, calibrate, and verification at a specific time at room temperature. From that, we have reduced the error percentage.

When connecting a lot of IR emitters, it was a very complex one. Photodiode had received IR radiation directly from IR emitters here. So we had lowered the position of the photodiode and kept all the IR emitters at an upper position as shown below. .In our motion-sensor design lot of strengthens are found. We can prevent other wavelength IR radiation. So other disturbances from the environment can be neglected.

Infrared is an emerging technology and has great potential to be employed in critical situations. This motion sensor has a flexible design to satisfy a large variety of applications. We have used mature, well-understandable technology. Our sensor has a large experience base and Provides basic traffic parameters. It is Insensitive to inclement weather such as rain, fog, and snow. Our IR sensor Provides the best accuracy for counting data as compared with other commonly used techniques and it can be used in very harse environments having irregular heat cycles. The main strength of this motion IR sensor detects motion in light and dark conditions reliably indoors and outdoors and is easy to install.

Some weaknesses also have been found in our design. It supports comparatively shorter range and hence its performance degrades with longer distances. Infrared frequencies are affected by hard objects, dust, and sunlight. So very rarely false alarms may occur. First, we had planned to send IR at high power but Infrared waves at high power can damage the eyes. The transmission data rate is also low in this sensor.

Item	Our IR sensor	IR sensor in the market
Maximum detectable distance	75cm	20cm
Detecting angle	360°	35°
Accuracy	High	Comparatively low
Detectable target	Influence of type of material is low	Influence of type of material is comparatively high
Response speed	High	Low

VI. CONCLUSION

By using our active IR sensor, we can get more accurate motion detection than PIR sensor. PIR sensor has high range of detection but when considering the use of PIR sensor in the wild animal detection, high chance of false alarms because of temperature change, moving of trees, wind etc. So, to get more accurate and sensitive detection active IR sensor is more useful. But its range and detectable angle is very small. To overcome these problems we made some solutions. To get higher angle of detection, our final design is very useful. It gives 360° angle of detection. By increasing the current flow through the IR emitter, using powerful emitter, increasing the number of IR emitters, we can get very much higher range than normal IR sensor.

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