EE-396: Design Lab

Service Foul Detection in Volley Ball

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22-April-2025

- **Objective :**

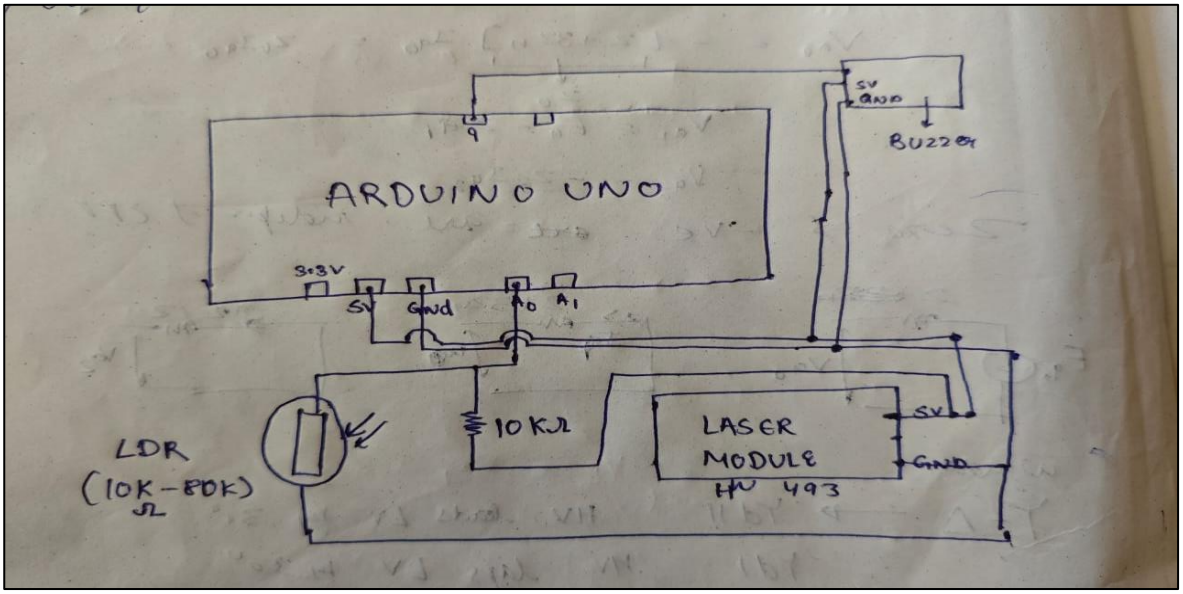
Development of Sensor for service foul detection in Volley ball by two methods:

1. Using Light Detecting Resistor (LDR) and Laser transmitter Module
2. Using Infrared Receiver and Transmitter

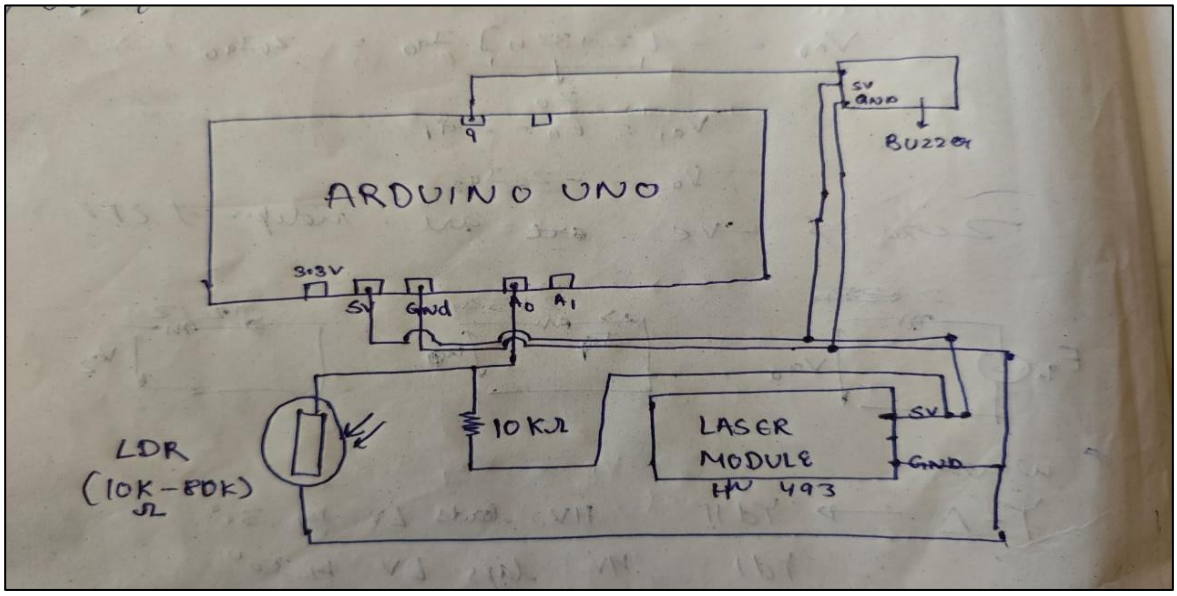
- **Material Required :**

1. Arduino Uno 2.
2. Laser transmitter module (650 nm)
3. Light Detecting Resistor
4. Infrared Receiver and Transmitter
5. Piezo buzzer module
6. Resistor (10 kΩ , 800 Ω & 1 kΩ)
7. 2 * Breadboard
8. Jumper Wires (male to male & male to female) & USB Cable

- **Circuit Diagram :**



Circuit Diagram of foul detection using LDR and Laser Module



Circuit Diagram of foul detection using Infrared Receiver and Transmitter

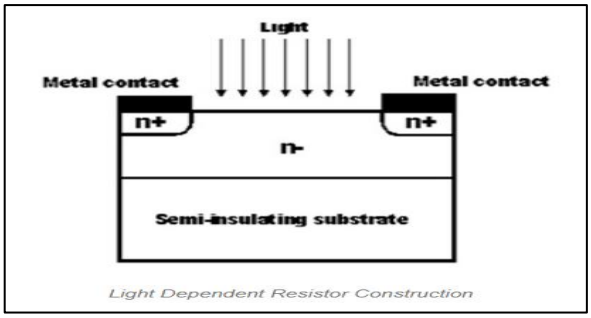
➢ Theory :

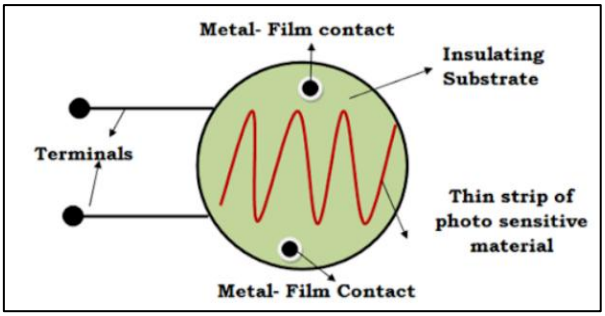
1. LDR Sensor :

- **Introduction :**

An LDR (Light Dependent Resistor), also known as photoresistor, is a device whose resistance changes based on the intensity of light falling upon it. It is usually made from semiconductor materials like cadmium sulfide (CdS). The working of LDR is as follows :

- **Diagram :**



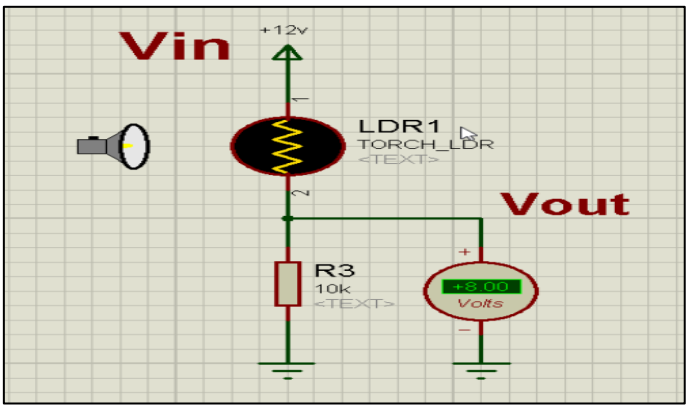


- **Working of an LDR sensor :**

The working principle of an LDR is **photoconductivity**, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the LDR, then the **electrons in the valence band** of the material are eager to the **conduction band**. But, the photons in the incident light must have energy superior to the bandgap of the material to make the electrons jump from one band to another band (valance to conduction).

Hence, when light having ample energy, **more electrons are excited to the conduction band** which grades in a **large number of charge carriers**. When the effect of this process and the flow of the current starts flowing more, the **resistance of the device decreases**.

- **Implementation :**



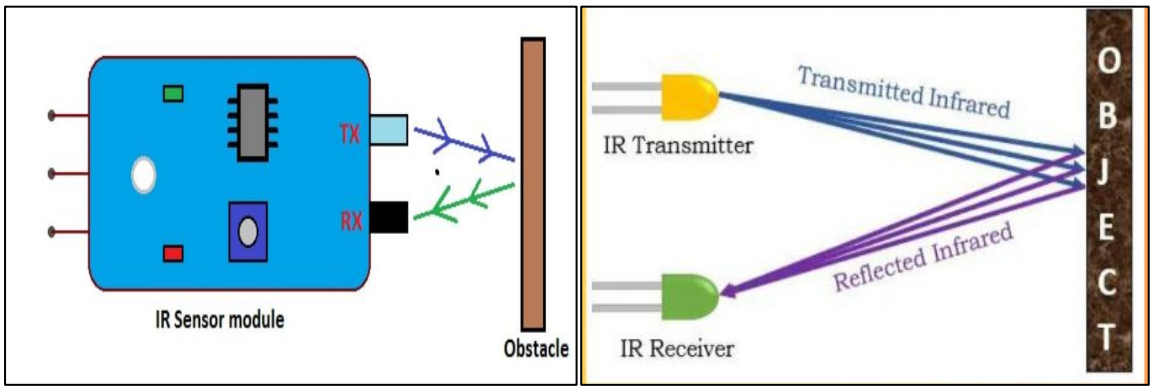
In a circuit, the LDR is typically placed in a **voltage divider** with a fixed resistor. As light changes, the resistance of the LDR changes and hence the voltage at the middle of the divider changes. This voltage can then be read by a microcontroller or used to control other components like a transistor.

2. IR Sensor :

- **Introduction :**

An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and or the detecting infrared radiation. Infrared sensors are also measure or observe the heat of an object as well as by detects the motion. An **IR sensor** typically detects **infrared radiation**, usually in the 700 nm – 1000 nm range. It consists of an **IR photodiode** or **phototransistor** that is **sensitive to IR light**. Just like an LDR, the photodiode's behaviour depends on light — but in this case, **infrared**.

- **Diagram :**



- **Working of an IR sensor :**

An Infrared (IR) sensor uses a component like an IR photodiode or phototransistor that is sensitive to IR light. When the IR light falls upon the sensor charge carriers in the junction increase resulting in an increased current flow.

However, in the absence of IR light the number of charge carriers is minimal and hence the current flow is reduced. This change in electrical behaviour allows the sensor to detect the presence or absence of IR light. Similar to an LDR, which responds to visible light, an IR sensor responds to infrared light, making it useful in applications such as remote controls, obstacle detection, and proximity sensing.

➢ Code :

```
➢ #define transmit 6     // Laser transmitter module pin
➢ #define ldr A0         // LDR input pin
➢ #define irPin A1       // IR sensor input pin
➢ #define buzzer 7       // Buzzer pin
➢
➢ void setup() {
➢     Serial.begin(9600);
➢     pinMode(transmit, OUTPUT);
➢     pinMode(ldr, INPUT);
➢     pinMode(irPin, INPUT);
➢     pinMode(buzzer, OUTPUT);
➢
➢     digitalWrite(transmit, HIGH);  // Laser always ON     // Buzzer OFF
  initially
➢ }
➢
➢ void loop() {
➢     digitalWrite(buzzer, HIGH);
➢     int ldrval = analogRead(ldr);
➢     int irval = analogRead(irPin);
➢
➢     Serial.println("LDR Signal");
➢     Serial.println(ldrval);
➢
➢     Serial.println("IR Signal");
➢     Serial.println(irval);
➢
➢      int threshold_ldr=210;
➢      int threshold_ir=1000;
➢     if (ldrval > threshold_ldr || irval > threshold_ir) {
➢         digitalWrite(buzzer, HIGH);  // Alert condition
➢
➢         digitalWrite(buzzer, LOW);   // No alert
➢     }
➢
➢     delay(2000);
➢ }
```

➢ Procedure:

1. Circuit Setup:

- Connected an LDR (Light Dependent Resistor) to analog pin A0 through a voltage divider circuit using a fixed resistor (47kΩ).

- Connected the output of the IR receiver (like a photodiode or IR module) to analog pin A1 along with a pull down resistance of 23kΩ. IR transmitter was connected to 5V at positive terminal with a pull down resistance (approximately 1kΩ). Made sure that the transmitter and receiver are properly aligned.
- Connected the buzzer to digital pin 7, with the negative terminal connected to GND and positive terminal at 5V.
- Connected the laser module or transmitter to digital pin 6, and make sure it's aimed at the LDR for obstruction detection.
- Ensured all components share a common GND and are powered via the Arduino's 5V supply or an external power source if required.

2. Arduino Initialization:

- Upload the Arduino sketch to the board.
- In the setup() function:
  - Serial communication was started at 9600 baud rate.
  - Laser pin (transmit) was set as OUTPUT and was turned on using digitalWrite(transmit, HIGH).
  - Configured the LDR, IR sensor, and buzzer pins with appropriate pinMode() functions.

3. Sensor Monitoring:

- In the loop() function, we continuously read:
  - The analog value from the LDR using analogRead(A0).
  - The analog value from the IR sensor using analogRead(A1).

4. Signal Analysis and Output:

- Printed the values of both sensors to the Serial Monitor for observation.
- Checked if either of the sensor values is below a predefined threshold (e.g., 1000), indicating light interruption (LDR) or IR detection.

- If the threshold condition is met, turn on the buzzer using digitalWrite(buzzer, HIGH) to indicate an alert.

5. **Testing the System:**
   - To test the LDR, we blocked the laser beam with an object and observe the drop in analog value and the buzzer activation.
   - To test the IR sensor, we brought an object close enough to reflect IR light back to the sensor or break the IR beam if it's a beam-break type.

Observation :

LDR Sensor and IR Sensor :

- The threshold value for foul detection was found to be 220 while the threshold value for IR sensor was found to be 1000.
- This values were decided based on the readings obtained from Arduino analog pins.

```
IR Signal
977
LDR Signal
46
IR Signal
977
LDR Signal
46
IR Signal
1023
LDR Signal
48
IR Signal
1023
```

Change in IR Values

```
978
LDR Signal
46
IR Signal
978
LDR Signal
44
IR Signal
977
LDR Signal
410
IR Signal
978
LDR Signal
420
```

Change in LDR Values

Based on this changes, the threshold values were calculated as:

- Threshold for IR Sensor : (977+1023)/2 = 1000
- Threshold for LDR Sensor : (20+400)/2 = 210

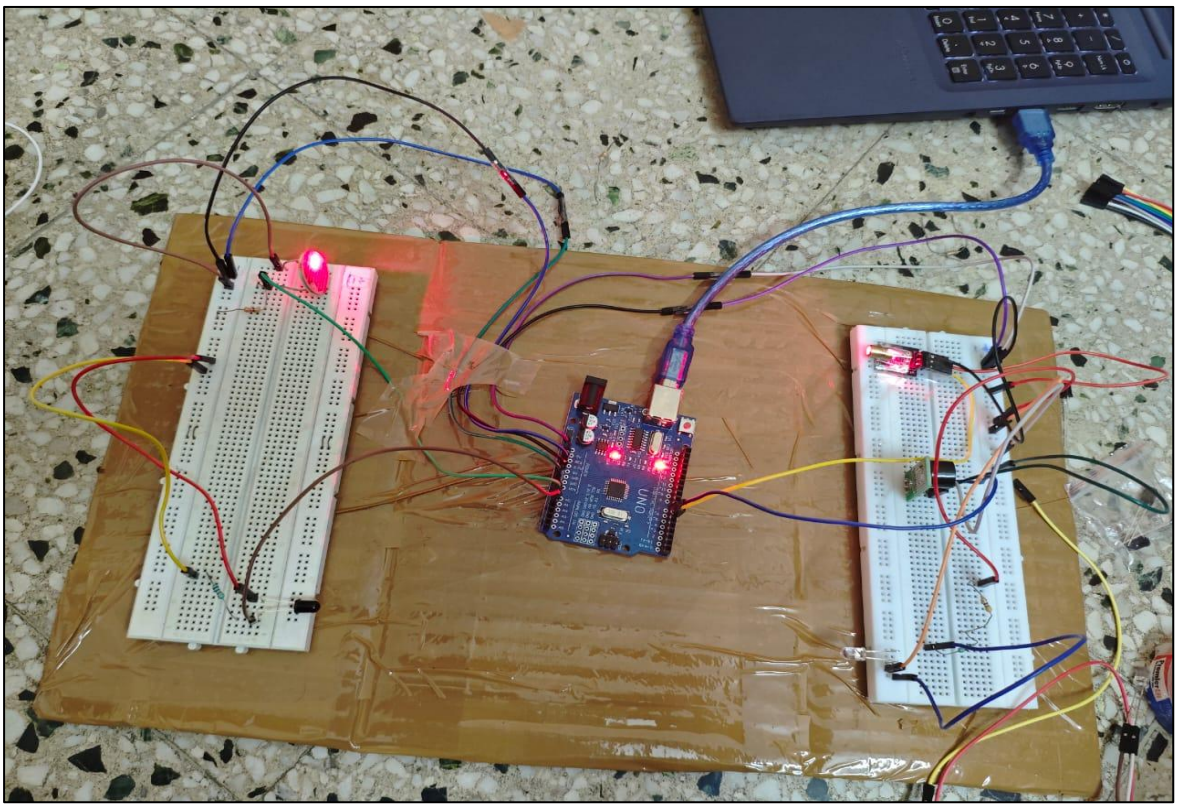
Results and Conclusion :

- LDR was found to be more reliable for due to the high gap between ON and OFF states. This made detection easy as compared to IR sensor receiver module.
- However, as laser module emits light in the visible region, it may cause interference with visible light present in the stadium. Hence, there are some practical limitations with respect to LDR sensors.
- IR sensor receiver module emits light in the infrared range. So, it causes lesser interference with the visible light present.
- Also, if we look at the scenario according to a player IR light will not be visible to them. Hence, this causes lesser distraction to the play.
- However, as laser emits light in visible range this may cause distraction for players present on field.

  The present systems present for volleyball foul detection cause long delays in the play. They basically use image processing and motion

sensing techniques. However, the system developed by us delivers rapid results due to analog and IoT concepts used.

Image of the overall project :



Video tutorial of the project.mp4