MODULE-03

A simple photoresistor network

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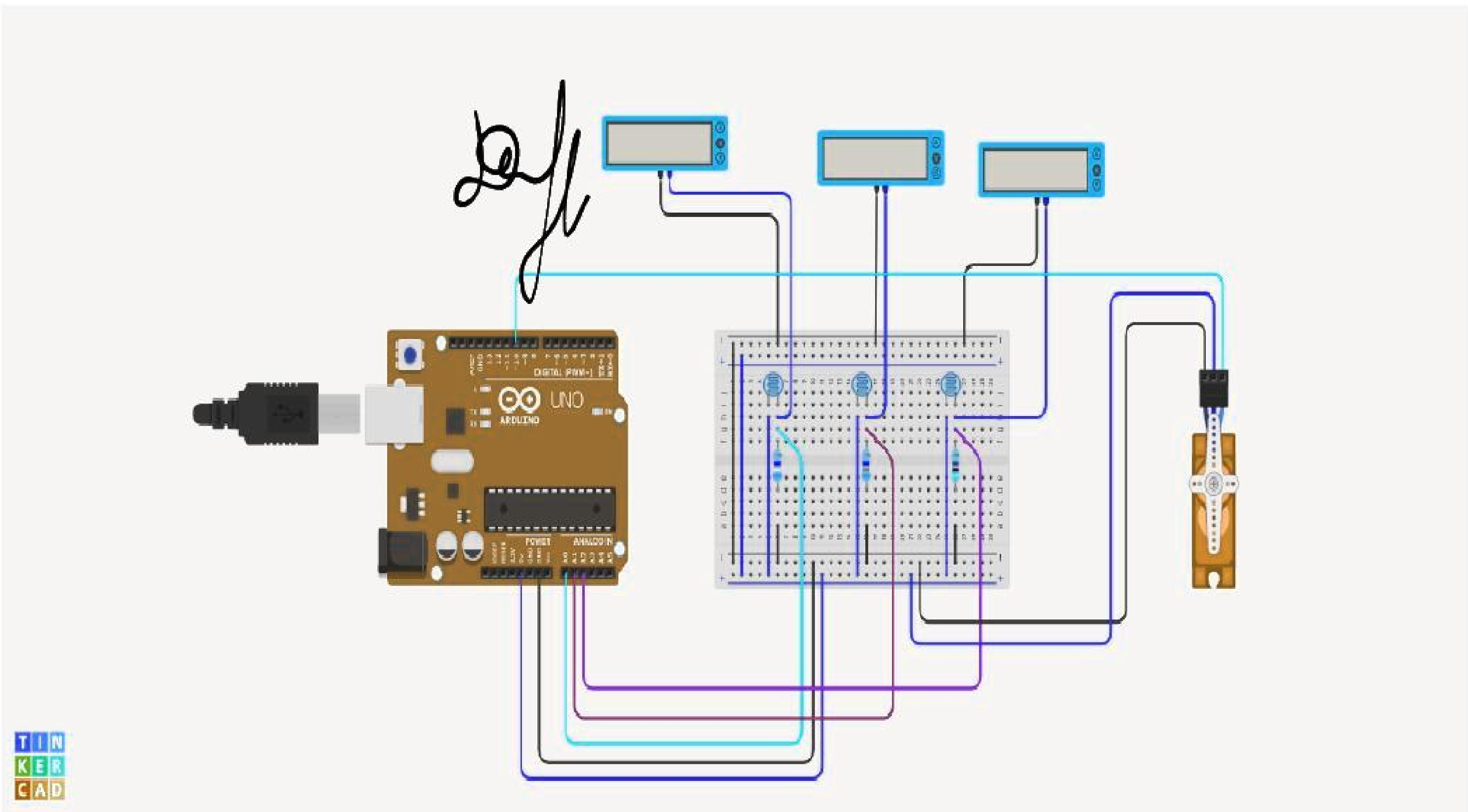
Objective: To design a circuit using Arduino-controlled servo motors and light dependent resistors (LDRs) in order to automate the Dino game by Google.

Components Used:

* Arduino Uno * Photo Resistors *Servo motor

*Resistors *Multimeter *Breadboard

Circuit:



Methodology:

- LDR-01 Bright pixel-2800 ohm, dark pixel-6100 ohm, grey pixel-3800 ohm
- LDR-01 is placed at around head height of the Dino.

- LDR-02 Bright pixel-2900 ohm, dark pixel-5600 ohm, grey pixel-3900 ohm
- LDR-02 is placed slightly above the ground.
- LDR-03 Bright pixel-300 ohm, dark pixel-600 ohm, grey pixel-500 ohm
- LDR-03 is used to detect the background colour, placed left hand side end of the screen.
- Used LDR-01 & LDR-02 for Obstacle Detection & LDR-03 used for Background Detection.

- To determine values of the series resistors and thresholds for ADC, assume that the obstacle is of same(grey) colour during both day and night.
- In order to allow a range of resistance values for detection of obstacle(grey pixel), we take around 5% tolerance lime on both sides.
- Use a voltage-divider setup in order to measure voltage changes across LDR
    - Therefore, V_s=5x($R_S R_S$+R_{LDR})/($RsRs+RLDR$)
    - To achieve maximum sensitivity, we must set R_S equal to R_{LDR}
    - Sensitivity = DV_S/dR_S =dVs/dRs = 5R_{LDR}/(R_S+R_{LDR})2 =$5RLDR/(Rs+RLDR)2$
    - Set $R_S=R_{LDR}$, For maximum sensitivity while measuring
- To measure Resistance of LDR at grey pixel in case of LDR's 01 & 02 and black pixel in case of LDR-03. Values of series resistors as follows:
    - R_{S1}=3900 ohm (in series with LDR-01)

- Rs_2=3800 ohm (in series with LDR-02)
- Rs_3=400 ohm (in series with LDR-03)

- We use the ADCs in full scale mode i.e., 0-5v. The ADC output will be of 10bit range, i.e., 0-1023, where 0 corresponds to 0v & 1023 to 5v
- **For Background Range: LDR-03:**
  - Range of ADC

    $1024*400/400+500$ (grey) to $1024*400/600+400$ (dark) = 456 to 490.6 = 433
  - Background < 433 → bright & Background > 433 → dark
- **For LDR-02:** (Obstacle plants)
  - Range of ADC = midway between

    $1024*400/400+500$ to $1024*3.8/3.8+6.1$

    = 456 to 393 = 425
  - Plants > 425 → obstacle will be detected
- **For LDR-01:** (Obstacle birds)
  - Range of ADC = midway between

    456

    to

    $1024*3.9/3.9+5.6$ = 456 to 420.37 = 438
  - Birds > 438 → obstacle will be detected
- **If dark background detected**

- LDR-01: Background > 433
- LDR-02: Plants midway between

456

to

1024∗3.8/3.8+2.8= 456 to 590 = 523

- Plants > 523 → obstacle will be detected
- LDR-03: Birds midway between

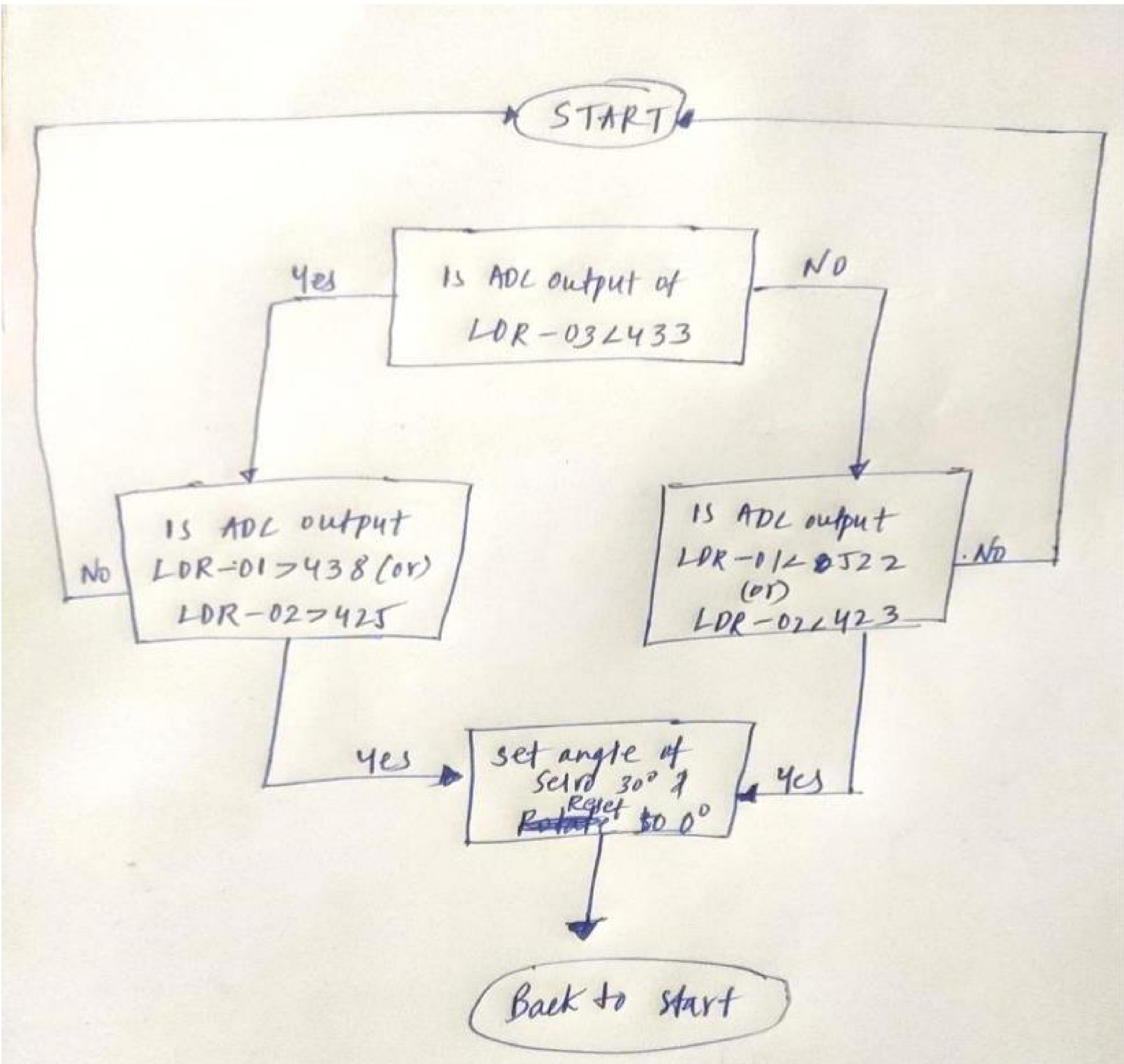
456

to

1024∗3.9/3.9+2.9 = 456 to 587 = 522

- Birds > 522 → obstacle will be detected

Flow Chart:



Answers to the questions asked in module

1) The designed system is overall an open-loop system. The servo in itself is closed loop but it is only a subsystem. The input to the open-loop system is pixel colour/light intensity. The LDR acts as the sensor. The servo acts like an actuator and the process are the rotation of servo to 30^o angle in order to press the spacebar button and then unpress it (back to 0^o)

Input → pixel colour/light intensity

Sensor → LDR-voltage divider setup

Actuator → Servo motor

Process → Rotate the servo to 30^o & back to 0^o

2) The servo motor is a closed loop system which uses position feedback to control its motion and achieve the final position. The input is the final position desired and is converted into a reference voltage. The instantaneous position of the shaft is also converted to its corresponding voltage and then compared with the external input(reference voltage), to generate an error signal. The error signal is amplified and serves as input to the actuator. The new position of the shaft is converted to a voltage by a potentiometer and serves as the feedback is used to achieve desired output.

A servo motor is controlled by sending a PWM(pulse width modulated) signal through a control wire. The time period of each pulse is fixed. The width of the pulse determines the angle of rotation of the servo. By changing the pulse-width, the angle of the motor can be controlled. Since the servo resists to immediate change, repetition of pulses is needed for the servo to reach and then hold a certain position.