Arduino Navigator: Motor Direction Control and Distance Tracking with LabVIEW

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Abstract

This project is designed with key components including the L298N motor driver and the HC-SR04 ultrasonic sensor. LabVIEW virtual simulation software is utilized to manage the direction control. The DC motor of the wing is linked to LabVIEW through an Arduino Uno. The rotation direction of the wing is controlled through LabVIEW software. The HC-SR04 ultrasonic sensor is employed to detect the distance between the flapping wing model and nearby obstacles. Additionally, a Boolean expression in LabVIEW is implemented to enable motor shutdown. Overall, the flapping wing motor is capable of clockwise and counterclockwise movement, controlled through the custom-designed front panel of LabVIEW's virtual simulation software

1. INTRODUCTION

Flapping wing systems represent an intriguing convergence of robotics and aerodynamics, offering fertile ground for exploration and innovation. These systems, inspired by the graceful flight of birds and insects, hold immense potential across various applications, from surveillance drones to biomimetic robots. However, achieving precise control of motor direction and reliable obstacle detection remains a significant challenge. This project embarks on a journey to develop a sophisticated flapping wing system, integrating advanced technologies including LabVIEW virtual simulation software, Arduino microcontrollers, and ultrasonic sensors to address these challenges effectively.

1.1 LabVIEW Virtual Simulation Software

It is designed and developed by National Instruments. It is a virtual simulation software/platform for applications that need test, measurement, and control with rapid access to hardware and data insights using virtualization as the major key. It offers a graphical programming approach that helps the user to visualize both software and hardware. This software helps to take one's project to the next level because of its strong virtualization power which helps to complete all the software as well as the hardware aspects. With LabVIEW, we gain precise control over the direction of the DC motor, enabling us to fine-tune its behavior with unprecedented accuracy. Moreover, LabVIEW serves as a powerful tool for real-time data acquisition and analysis, allowing us to optimize the performance of our system iteratively.

1.2 ARDUINO

Arduino is considered to be the base of IOT (INTERNET OF THINGS) in an industry. Over the period of time it is seen that Arduino, as one whole technology, is very adaptive and dynamic in nature, which usually moulds its self very easily and conveniently in accordance to its application in wireless automation. It is considered to be the backbone of wireless automation and monitoring control. Arduino provides an open source environment to electronics which can be used very easily. Invented at the Ivrea Interaction Design Institute, Arduino is an easy tool used for fast prototyping, aimed at students to excel in electronics and programming. It helps us to understand and learn to implement electronics and programming simultaneously. Arduino is considered to be an edge over the other systems because of the following advantages-cheap, platform independent designing, easy and user-friendly programming environment, open source and extensible software as shown in FIGURE 1

Figure 1: Arduino Uno Board

1.3 COMPONENTS USED

The common components which are required for the successful implementation of the project was L298N Motor Driver.

1.3.1 HC-SR04 Ultrasonic Sensor:

HC-SR04 Ultrasonic (US) sensor has namely 4 pins which are defined as follows: there is the VCC, Ground, Echo and the Trig Pin. These sensors are quite popular for similar projects as they are easy to implement and quite inexpensive. Furthermore the Ultrasonic sensor has 2 eye like structure which are used for Transmitting and receiving. The sensor depends upon the basic formula:

Distance = Speed × Time

The Ultrasonic sensor transmits a wave of the following type , This wave then travels in the air and when it strikes an object it is able to reflect back. The time difference between the moment the ultrasonic sensor transmits and to that of where it receives it back is noted and displayed.

Operating Voltage	5V DC
Operating Current	15mA
Operating Frequency	40KHz
Min Range	2cm
Max Range	400cm
Accuracy	3mm
Measuring Angle	Greater than 15°
Dimension	45 x 20 x 15mm

Table 1: HC-SR04 Specifications.

Figure 2: Sensor pinout

VCC	**5V**
Trig	**A4**
Echo	**A3**
GND	**GND**

Table 2: Ultrasonic Sensors Pin connection in Arduino Pin

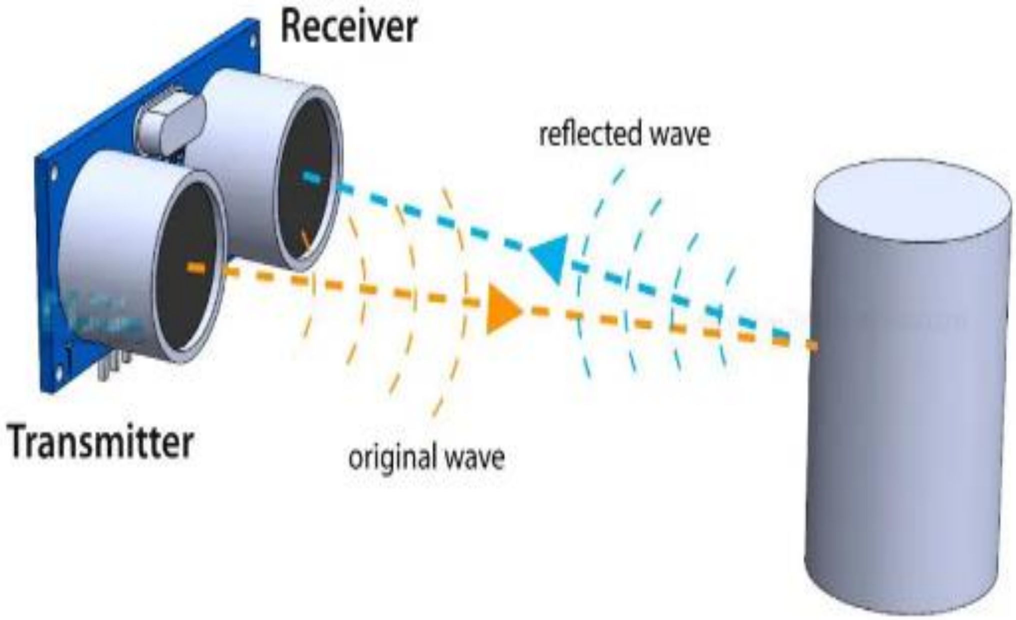


Figure 3: Working of ultrasonic sensor

2. IMPLEMENTATION OF THE PROJECT:

2.1 Integration with Arduino Microcontrollers:

The given series of steps are undertaken to measure the distance to the obstacle and send the data acquired to the VI Program. The first step of acquiring distance data of the obstacle, is to connect the Arduino to the computer

```
#include <NewPing.h>
#define trig_pin A3 //analog input 3
#define echo_pin A4 //analog input 4
#define maximum_distance 200

NewPing sonar(trig_pin, echo_pin, maximum_distance);
const int LeftMotorForward = 5;
const int LeftMotorBackward = 4;
char labview;

void setup()
{
Serial.begin(9600);
pinMode (LeftMotorForward, OUTPUT);
pinMode (LeftMotorBackward, OUTPUT);
}

void loop()
{
int data=readPing();
Serial.println(data);
labview = Serial.read();
if (labview == '1')
{
moveForward();
}
```

```
else if (labview == '2')
{
moveBackward();
}
else if (labview == 'S')
{
moveStop();
}
}

int readPing()
{
delay(10);
int cm = sonar.ping_cm();
return cm;
}

void moveStop()
{
digitalWrite (LeftMotorForward, LOW);
digitalWrite (LeftMotorBackward, LOW);
}
void moveForward()
{


digitalWrite (LeftMotorForward, HIGH);
digitalWrite (LeftMotorBackward, LOW);
}
void moveBackward()
{
digitalWrite (LeftMotorForward, LOW);
digitalWrite (LeftMotorBackward, HIGH);
}
```

2.2 LabVIEW

2.2.1 Front panel

In the front panel of LabVIEW, the user interface provides a visual representation of the control system. Here, users can access various controls and indicators to manipulate the direction of the DC motor and observe real-time feedback from the ultrasonic sensor.

The front panel design may include user-friendly buttons or switches to initiate motor direction changes, enabling clockwise or counterclockwise rotation of the flapping wing. Additionally, indicators such as LEDs or numeric displays may convey information about the system's status, including distance measurements from the ultrasonic sensor and any detected obstacles.

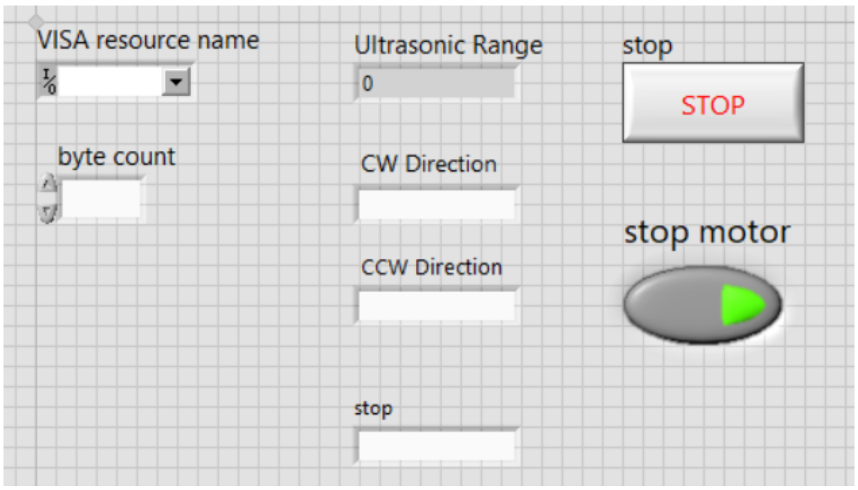


Figure 4: LABVIEW diagram (Front Panel)

2.2.2 Block Diagram

In the block diagram of LabVIEW, a logical condition is implemented to halt the motor's operation when a certain criterion is met. This condition, typically represented as a Boolean expression, serves as a safety mechanism to prevent the motor from continuing its rotation under specific circumstances.

When the logical condition evaluates to true, indicating that the predefined criteria are fulfilled, the motor control signal is deactivated, causing the motor to stop. This functionality is crucial for ensuring the safety and integrity of the system, particularly in situations where continued operation may pose a risk of damage or collision.

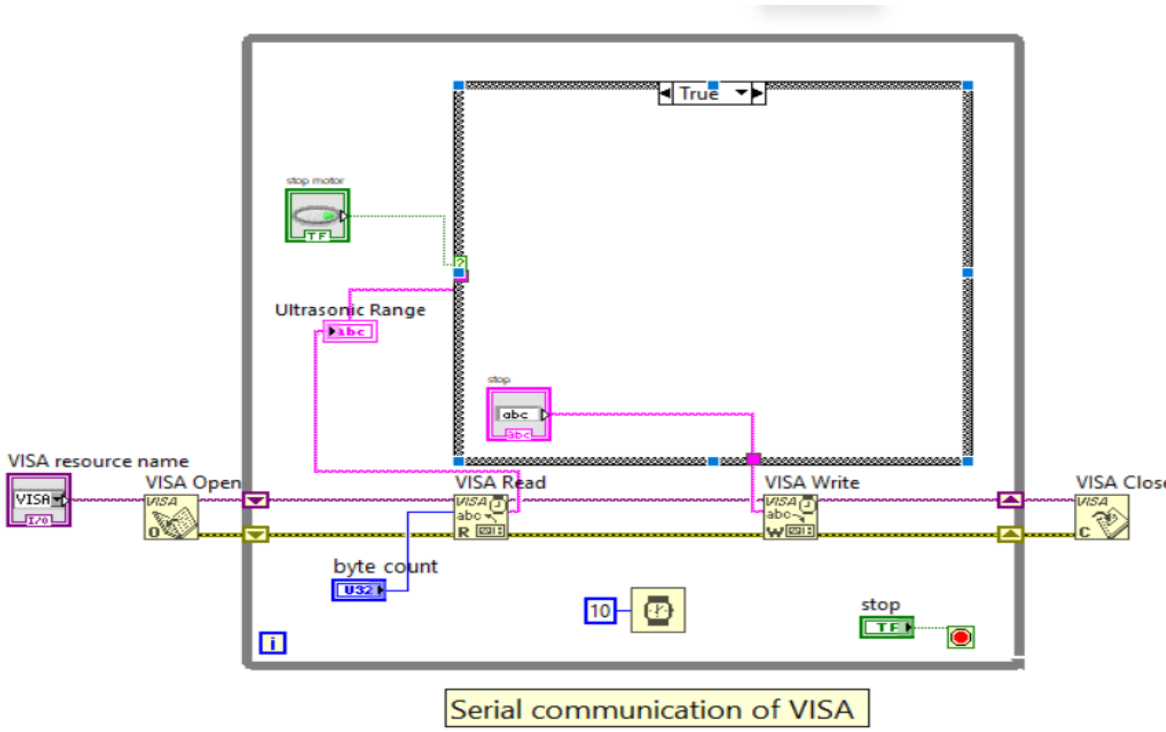


Figure 5: LABVIEW diagram (Block Diagram)

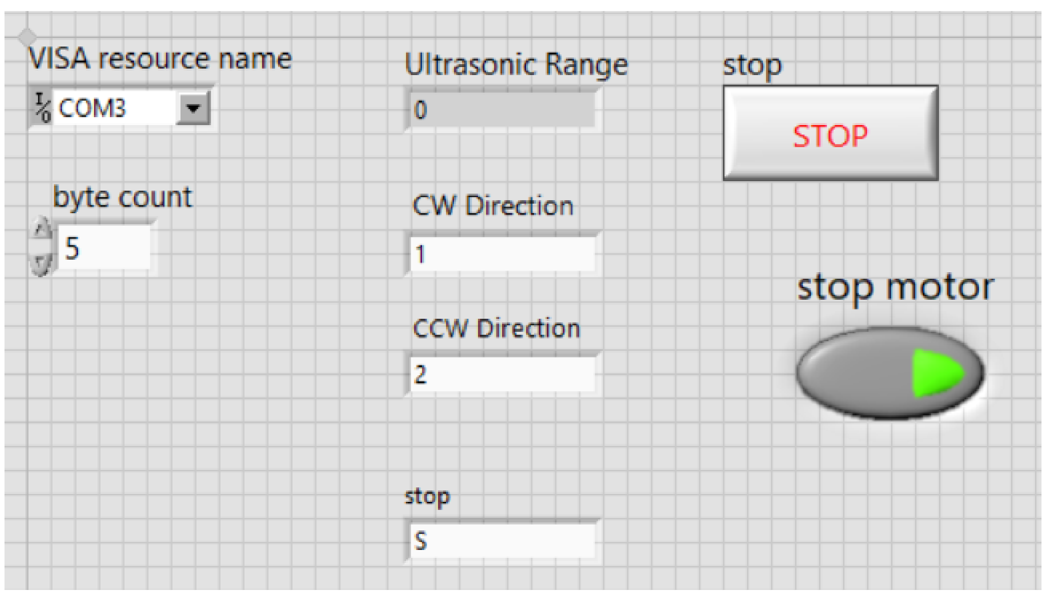
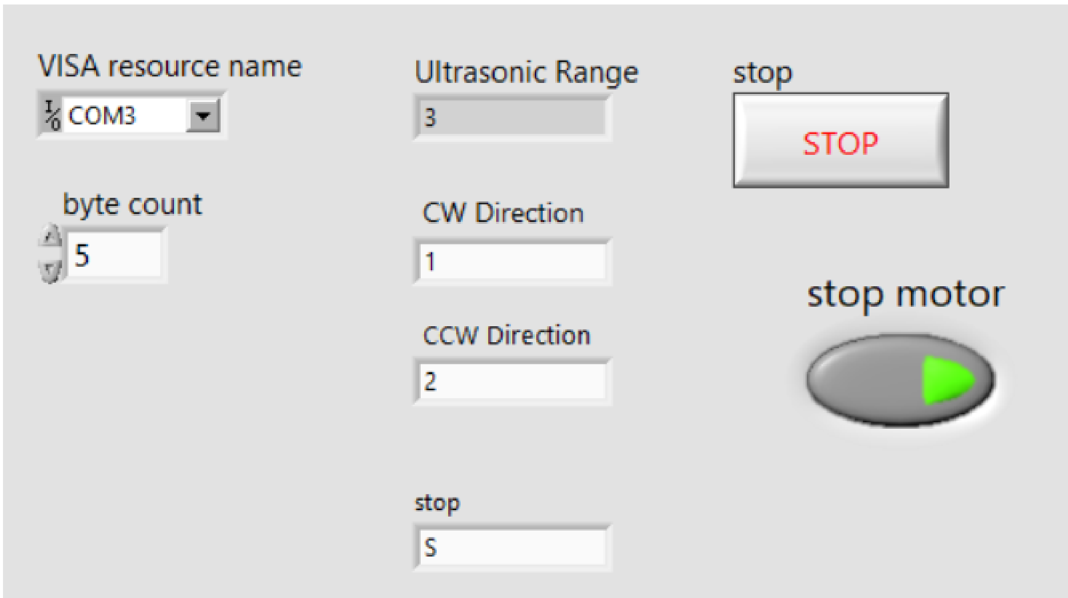


Figure 6: Front panel while program is running

Given Below Front panel and Block Diagram shows the distance less than 30. So motor will rotate in counter clock wise.



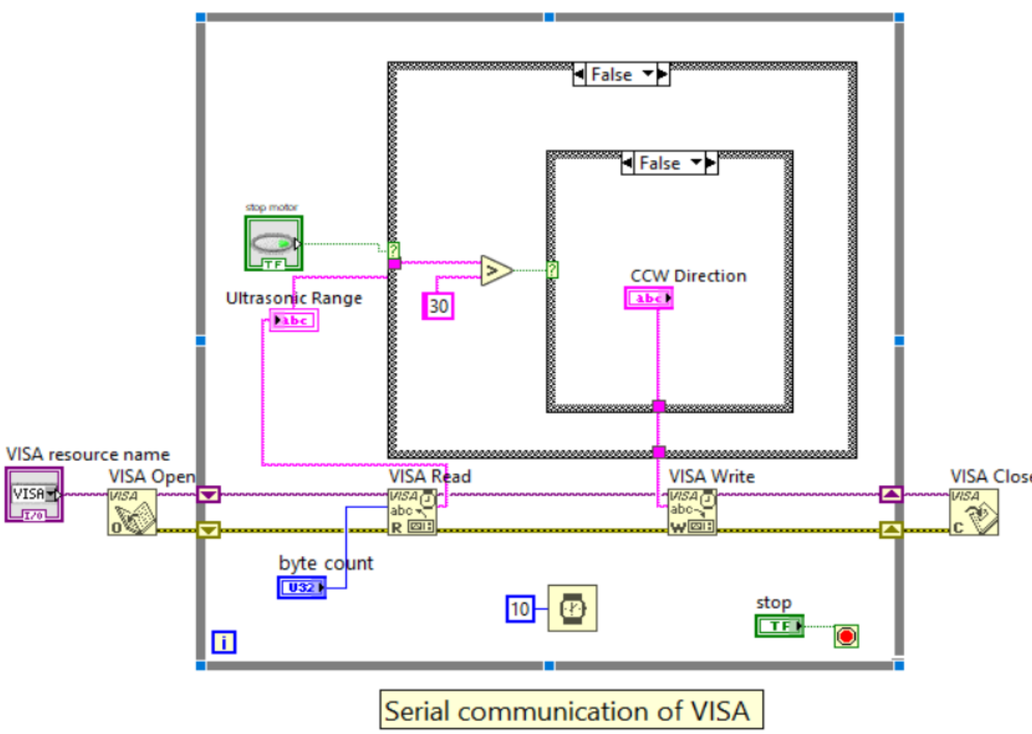
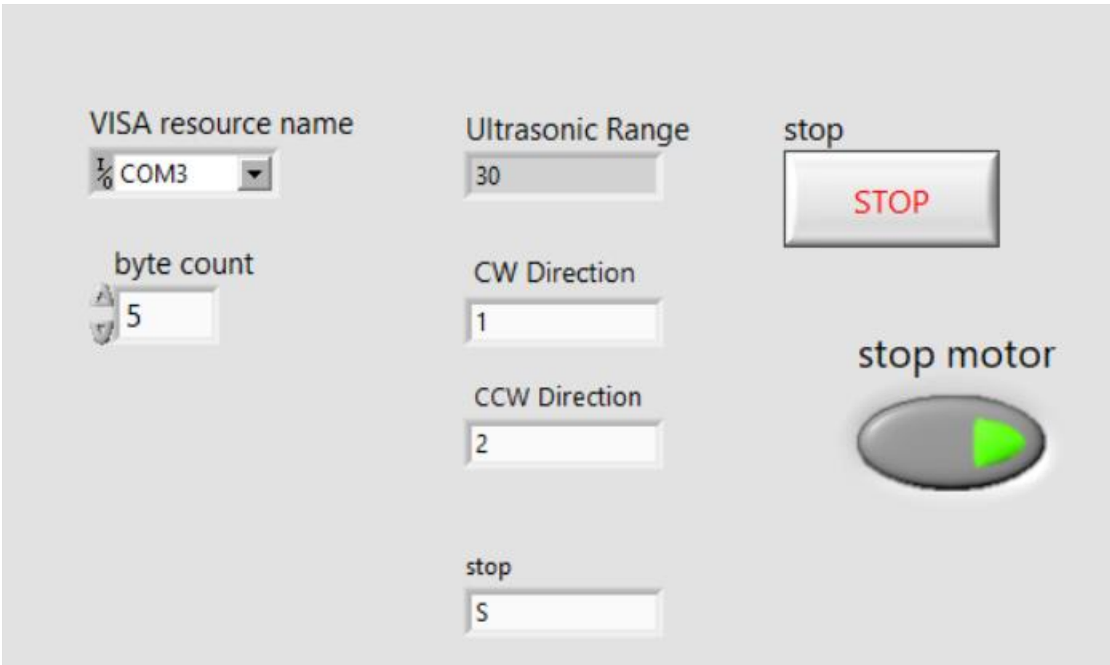


Figure 7: Case (false) for the DC motor

Given Below Front panel and Block Diagram shows the distance greater than 30. So motor will rotate in clock wise.



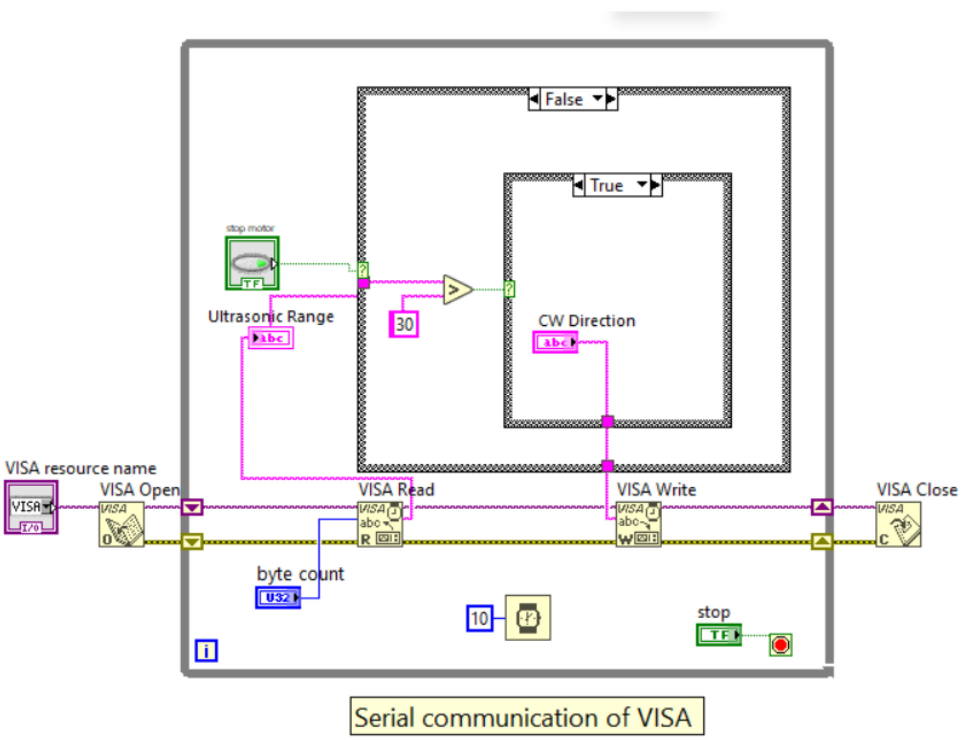


Figure 8: Case (True) for the DC motor

2.2.3 DC motor control using LabVIEW:

The basic implementation of our given project included a method in which we are able to run the program in such a method that not only are we able to control the Direction of motor but even the measure the distance. There are mainly two methods in which the motor is able to rotate, namely the clockwise and anti-clockwise direction. The clockwise direction gives the capability to the vehicle as a whole to move forward and the anti-clockwise direction gives the capability to the vehicle as a whole to move backwards. We used the L298N motor driver to the control the direction of the given vehicle. The left hand side motor was connected to second terminal.

The first challenge we faced was to connect the system with motor. To compact this problem we were able to incorporate the case structure in the Lab VIEW Block Diagram. Hence the case structure allowed us to incorporate a switch which allowed us to quickly change between Clock- wise and counter clock wise direction with the help of Ultrasonic Sensor.

One of the major disadvantages which we found as we were working on our design was that we were not able to use the read and write commands simultaneously in LabVIEW when it was associated with the Arduino Uno Board.

3. CONCLUSION:

In conclusion, our project has successfully demonstrated the integration of advanced technologies such as LabVIEW virtual simulation software, Arduino microcontrollers, and ultrasonic sensors to create a sophisticated system capable of precise motor direction control and reliable obstacle detection. The intuitive user interface provided by LabVIEW's front panel facilitates seamless interaction with the system, allowing for easy adjustment of parameters and real-time monitoring of performance. The implementation of logical conditions ensures the safety and integrity of the system by automatically halting motor operation under predefined criteria. Looking forward, the versatility of motor systems presents numerous opportunities for applications in fields such as aerial surveillance and environmental monitoring. Through continued research and innovation, we are poised to unlock further advancements in robotics and aerodynamics, shaping the future of intelligent and adaptive systems inspired by nature.