CSE316
Microprocessors, Microcontrollers, and Embedded Systems Sessional January 2021 Term

Drone-based Hardware

Group 10
Ridwanul Hasan Tanvir
ID:1705016
Shayekh Bin Islam
ID:1705009

Department of Computer Science and Engineering
Bangladesh University of Engineering and Technology

July 30, 2021

Contents

1 Introduction

Drones are aircraft that have no onboard, human pilot. Through the twentieth century, piloted aircraft made far greater progress than drones. During the twenty-first century, on the other hand, changes in both drone technologies and drone economics have been much more rapid ([Cla14]). Drone technologies gave shown promises in many field, specifically they are useful during the outbreak of contagious diseases such as COVID-19. In this project, we do not provide any solution, rather we ask pose a problem - *how can we make drones more affordable and useful, especially in underdeveloped regions on the world?*. So, we tried to build it using only two ATmega32 chips and low-cost components within our limitations of knowledge, resources and funding. We hope to improve the project later and apply it for COVID-19 thermal imaging, vaccine delivery, goods delivery and other general purpose applications.

2 Components

In this section, we present all the components used in this project. Two major modules are the remote controller and the drone with the flight controller.

2.1 Remote Controller

We have used one Atmega32 ([Ali19]) in the remote controller. It samples the voltage reading of two joystics to calculate the change in roll, pitch, yaw and throttle. The values are passed to the flight controller via the radio transmitter module. We connected a push button to it in order to stop the drone immediately.

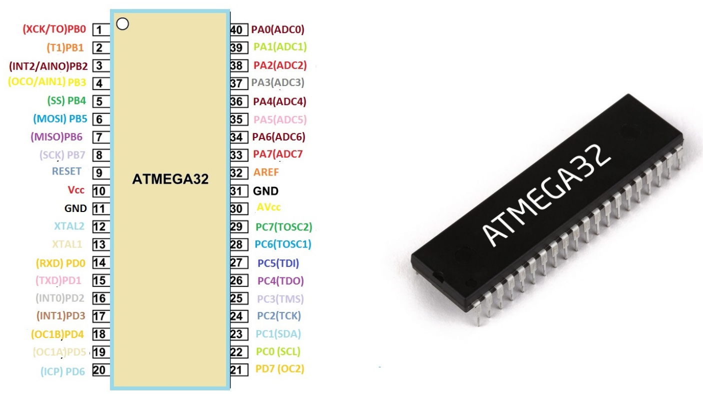

Figure 1: Atmega32 microcontroller

We have use two joysticks ([Robe]) to incrase or decrease roll, pitch, yaw and throttle of the drone. We total four voltage values from the joysticks. The remote controller send the corresponding digital values via the radio communication module.

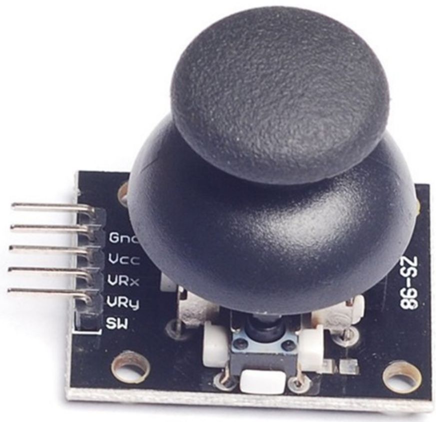

Figure 2: JoyStick 5Pin Breakout Module

We have use connected a push button ([Robg]) to the INT2 of the remote controller. This is useful for emergency sitation like crash, when we want to stop the drone immediately.

Figure 3: Push Button 4 pin

The LCD 16x2 Display shows the status of the drone to the remote controller.

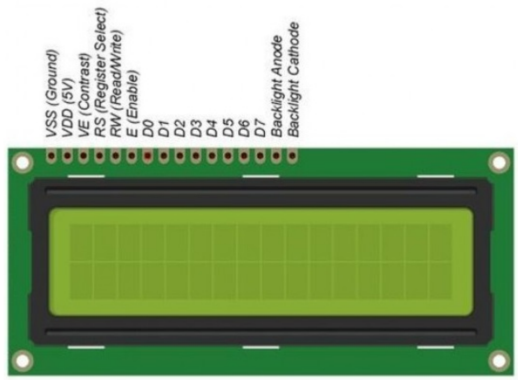

Figure 4: LCD 16x2 Display Module

2.2 Drone and Flight Controller

We have used one Atmega32 ([Ali19]) as the flight controller. An MPU6050 (Gyro + Accelerometer) is connected with it. The Atmega32 also produces four PWM signals of 240 Hz to provide control to the four ESCs. The microcontroller calculates the duty cycle of those PWM signal using the PID controller algorithm. Thus, the PID controller moves the motor keeping it balanced in the air.

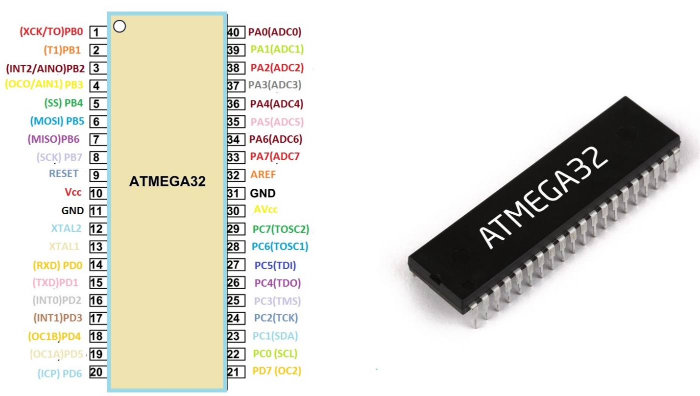

Figure 5: Atmega32 microcontroller

MPU-6050 is a Six-Axis (Gyroscope + Accelerometer) MEMS Motion-Tracking Device ([Inv]). When an angular rate is applied along the Xaxis, it is called Roll Mode. Similarly if angular rate is applied along the Y-axis and Z-axis they are call Pitch Mode and Yaw Mode respectively. It also gives complete 3-axis acceleration measurement. Using these data, the flight controller calculates the angle of the drone, and produces the necessary PWM signal to keep the drone balanced.

Figure 6: MPU-6050 Gyroscope-Accelerometer

A2212 is a brushless outrunner DC motor specifically made to power Quadcopters and Multirotors. It is a 2200kV motor. It provides high performance, super power and brilliant efficiency. These motors are perfect for medium size quadcopters with 8 inch to 10 inch propellers ([Eleb]). We use this to build powerful and efficient quadcopters. Our 30A ESCs can be used to drive the motor.

Figure 7: 2200 kV BLDC Motor

Two pairs of six-Inches propellers (clockwise and anti-clockwise) are connected to the four BLDC motors ([Roba]).

Figure 8: Six-Inches Propeller Pairs

30A BLDC ESC Electronic Speed Controller is specifically made for quadcopters and multi-rotors and provides faster and better motor speed control giving better flight performance compared to other available ESCs.
It can drive motors which consume up to 30A current. It works on 2S-3S LiPo batteries. It has an onboard BEC which provides regulated 5V(2A max draw) to power the flight controller and other onboard modules ([Elea]).

Figure 9: 30A BLDC ESC

Typically, a LiPo battery has 3.7V for its energy. Only one cell is needed for such an amount of voltage. So, if a LiPo battery has 3S, it means that the voltage is tripled to 11.1V ([Hob]).

Figure 10: 3 Cell 11.1 V Lipo Battery

RF modules are widely used for wireless data transfers and remote control applications. These days, cost of RF modules are very low and are compact in size. Most of these RF modules are operating around 433MHz ([EEE]). Amplitude Shift Keying (ASK) or Frequency Shift Keying (FSK) are mainly used for wireless data transfers.
Operating frequency: 433 MHz
Transmission distance: 3 meters (without antenna) to 100 meters (maximum)

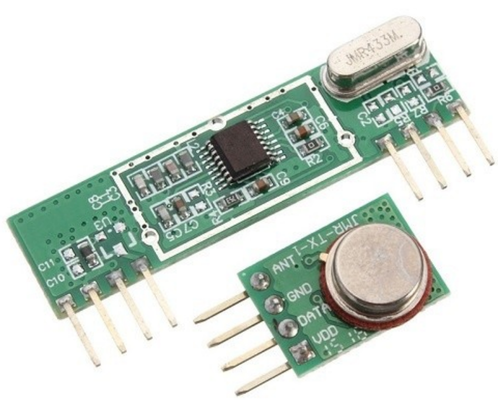

Figure 11: Rx-TX Module 433Mhz

F330 Drone Frame is a 4-Axis 330mm Quadcopter Frame Kit with Landing Skid Gear. Even though it is compact, the F330 is substantial and can easily carry a battery that will permit 15 minute flights ([Ard]). We mounted the LiPo battery, ESCs, motors and the flight controller on this frame.

Figure 12: F330 Drone Frame

2.3 Miscellaneous

We have USBASP USBISP AVR Programmers to program the flush storage of ATmega32 chips ([Robc]; [Robb]). The programmers are connected to PC using USB port and to the ATmega32 chip via SPI serial communication ports.

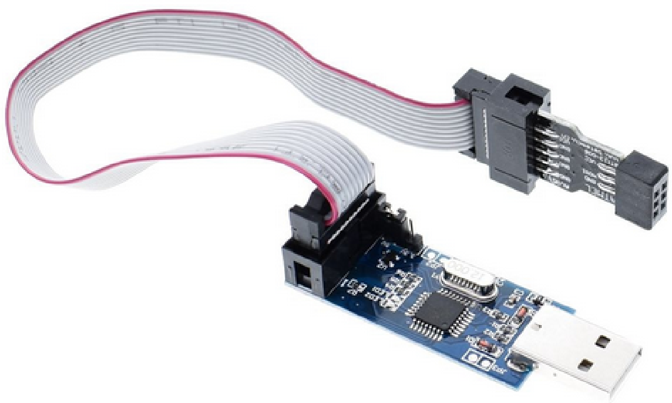

Figure 13: USBASP AVR Programmer

The FTDI USB to TTL serial converter module is a UART (universal asynchronous receiver-transmitter) board used for TTL serial communication ([Del18]). It is a breakout board for the FTDI FT232R chip with a USB interface, can use 3.3 or 5 V DC and has Tx/Rx and other breakout points. We have used this module during debugging at the development phase of the project.

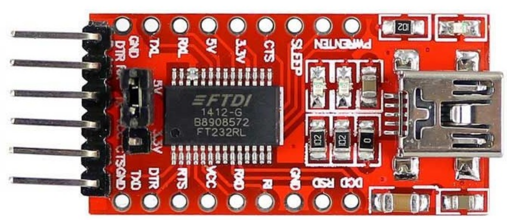

Figure 14: FTDI Module

To charge the LiPo battery, we have used an Imax B3 Compact Charger ([Rcp]). It takes about 6 hours for fully charging the battery.

Figure 15: Imax B3 Compact Charger

We have used many jumper wires - male-Male, male-female and female-female to connect different components ([Robf]).

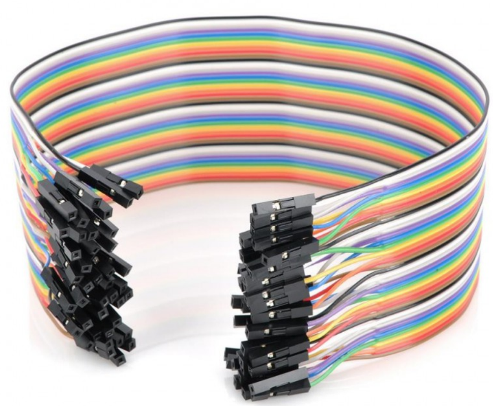

Figure 16: Female-Female Jumper Wire Set

We use a solding iron kit ([Robh]) to join two components permanently, such as XT60 connectors and gold connectors to the drone body. The kit includes a 60W soldering iron, a soldering stand, soldering lead and solder resin.

Figure 17: Solding Iron Kit

Next, we use multimeter ([Robi]) to monitor voltage, current and resistance of different components.

Figure 18: Multimeter

Then, we use breadboards ([Robd]) of different sizes to connect components using jumper wires.

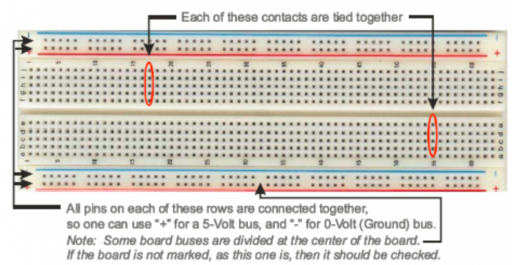

Figure 19: Breadboard

3 Circuit Diagrams

We present the circuit diagrams of the remote controller and the flight controller (drone) in the following:

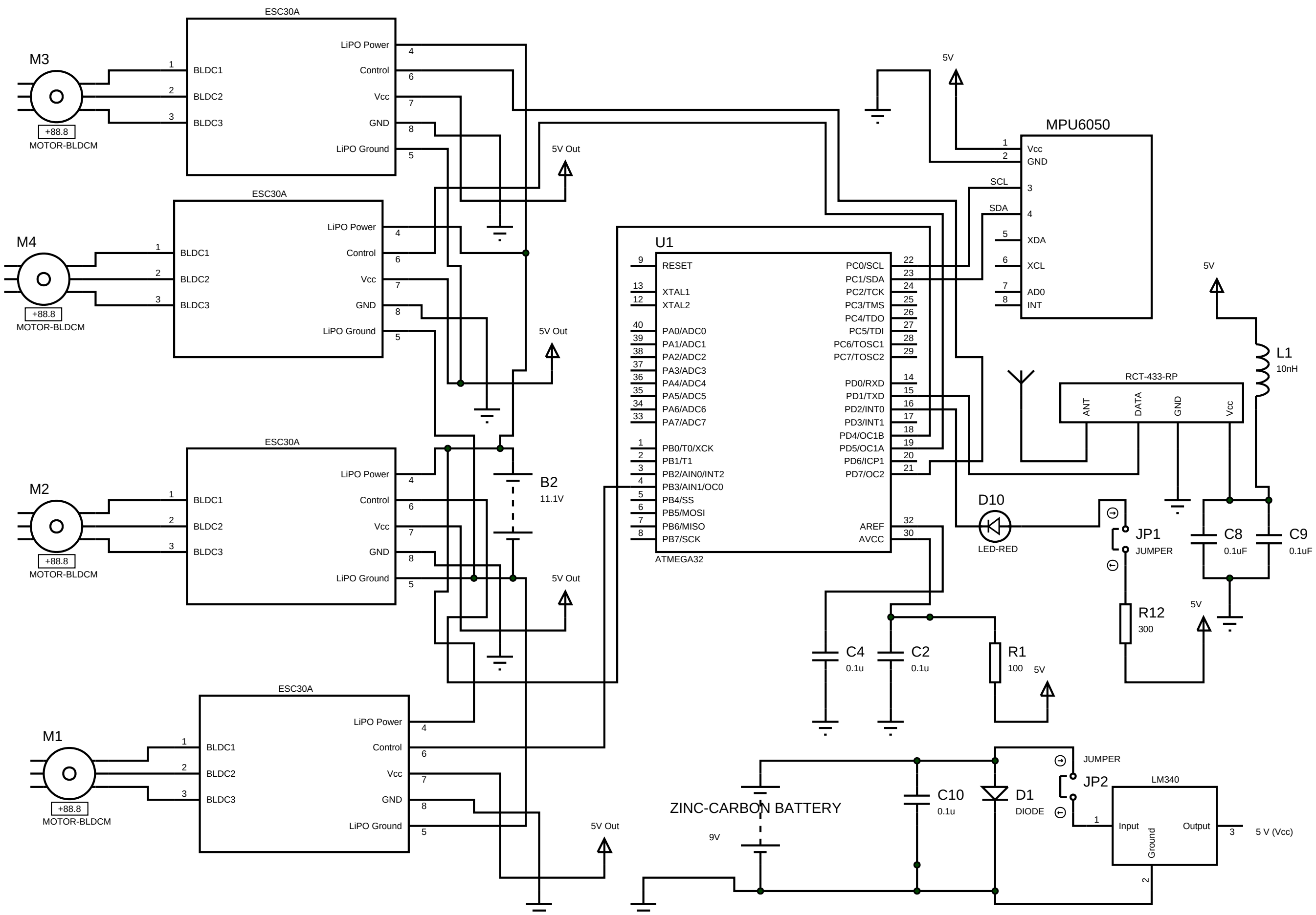

Figure 20: Circuit Diagram of Drone with the Flight Controller

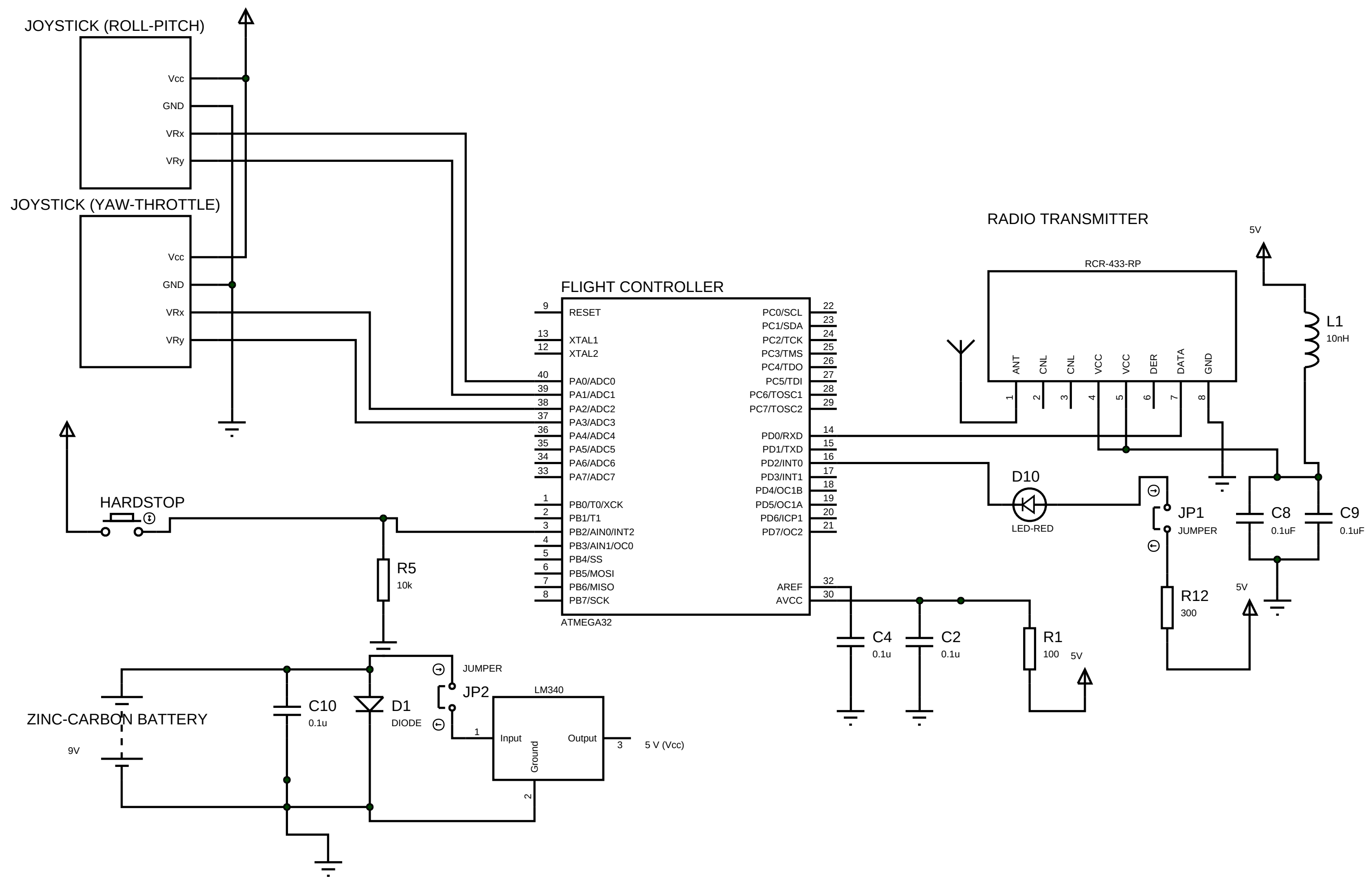

Figure 21: Circuit Diagram of Remote Controller

4 Challenges

The LCD module was not working at first. The fuse-bits got changed and we adjust the fuse bit as per the definition of `F_CPU` in the source code.
The shouldering of some circuits was loose; it was causing bad connection in the circuit. We shouldered some parts to make appropriate connections.
ESCs were not working, as the ground of the ESCs were not connected with the same ground of the ATMega32 chip. After connecting appropriately, the module worked.
ESCs were working alone, but not working after connecting MPU6050. As ground connection was not via a resitor, it was causing a lot of noise inside ATMega32, and the noise was hindering the I2C protocol of MPU6050.
After connecting appropriately, the ESCs worked.
One of the ESC was damaged after a crash during calibration. We replaced that ESC with a new one.
It was very tough to calibrate the PID controller of the drone. The drone did not fly, though the motors rotated. Then, the deadline of the project approached. So, we kept the project upto this and submitted.

5 Motivation

- Delivary in Covid19 Pandemic

Figure 22: Drone Delivery

- Vaccine Delivary for Covid19

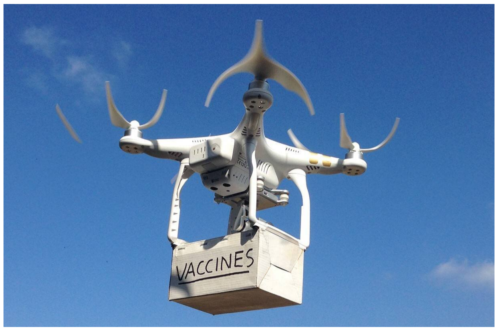

Figure 23: Vaccine Delivary

6 Conclusion

References

[1] Zahid Ali. *Introduction to ATmega32*. https://www.theengineeringprojects.com/2019/07/introduction-to-atmega32.html. [Online; accessed 30 July, 2021]. 2019.

[2] Ardupilot. *DJI F330 FlameWheel QuadCopter Assembly*. https://ardupilot.org/copter/docs/dji-f330-flamewheel.html. [Online; accessed 30 July, 2021].

[3] Roger Clarke. "Understanding the drone epidemic". In: *Computer Law & Security Review* 30.3 (2014), pp. 230–246. ISSN: 0267-3649. DOI: https://doi.org/10.1016/j.clsr.2014.03.002. URL: https://www.sciencedirect.com/science/article/pii/S0267364914000545.

[4] Renier Delport. *The FTDI USB to TTL serial converter module*. https://behind-the-scenes.net/ftdi-usb-uart-module/. [Online; accessed 30 July, 2021]. 2018.

[5] EEEShopBD. *RF Module 433 MHz (Tx & Rx)*. https://www.eeeshopbd.com/product/rf-module-433-mhz-tx-rx/. [Online; accessed 30 July, 2021].

[6] Electronicscomp. *30A BLDC ESC - Brushless Motor Speed Controller*. https://www.electronicscomp.com/30-amp-esc-brushless-motor-india. [Online; accessed 30 July, 2021].

[7] Electronicscomp. *A2212 - 2200KV BLDC Brushless Motor*. https://www.electronicscomp.com/a2212-2200kv-bldc-brushless-motor-india. [Online; accessed 30 July, 2021].

[8] Hobbyzone. *11.1V 3300mAh 3S 35C LiPo Battery with XT60 Connector*. https://www.hobbyzone.com/batteries/lipo/3-cell/ARWSB33003S.html. [Online; accessed 30 July, 2021].

[9] Invensense. *MPU-6050 Six-Axis (Gyro + Accelerometer) MEMS MotionTracking™ Devices*. https://invensense.tdk.com/products/motion-tracking/6-axis/mpu-6050/. [Online; accessed 30 July, 2021].

[10] Rcproductbd. *Imax B3 Compact Charger*. https://rcproductbd.com/product/imax-b3-compact-charger/. [Online; accessed 30 July, 2021].

[11] Robodocbd. *8x45 Plastic Propeller Set (Pair)*. https://store.roboticsbd.com/quadcopter/748-8x45-plastic-propeller-set-robotics-bangladesh.html. [Online; accessed 30 July, 2021].

[12] Robodocbd. *USBASP AVR Programmer*. https://www.electronics.com.bd/usbasp-avr-programmer-parts-ic-module-sensor-arduino-transistor-resistor-capacitor-robotics-project-electronics-bangladesh. [Online; accessed 30 July, 2021].

[13] Robodocbd. *USBISP AVR Programmer*. https://robodocbd.com/product/detail/USBISP. [Online; accessed 30 July, 2021].

[14] RoboticsBD. *Breadboard*. https://store.roboticsbd.com/robotics-parts/133-breadboard-large-robotics-bangladesh.html. [Online; accessed 30 July, 2021].

[15] RoboticsBD. *JoyStick 5Pin Breakout Module For Arduino*. https://store.roboticsbd.com/robotics-parts/393-joystick-5pin-breakout-module-for-arduino-robotics-bangladesh.html. [Online; accessed 30 July, 2021].

[16] RoboticsBD. *Jumper Wire 40 Pcs Set*. https://store.roboticsbd.com/robotics-parts/31-3-jumper-wire-arduino-bangladesh.html. [Online; accessed 30 July, 2021].

[17] RoboticsBD. *Push Button 4 pin*. https://store.roboticsbd.com/tools-accessories/1415-push-button-4-pin-robotics-bangladesh.html. [Online; accessed 30 July, 2021].

[18] RoboticsBD. *Soldering Kit*. https://store.roboticsbd.com/instruments/833-soldering-kit-robotics-bangladesh.html. [Online; accessed 30 July, 2021].

[19] RoboticsBD. *Uni-T 33A+ Multimeter*. https://store.roboticsbd.com/instruments/911-uni-t-33a-multimeter-robotics-bangladesh.html. [Online; accessed 30 July, 2021].