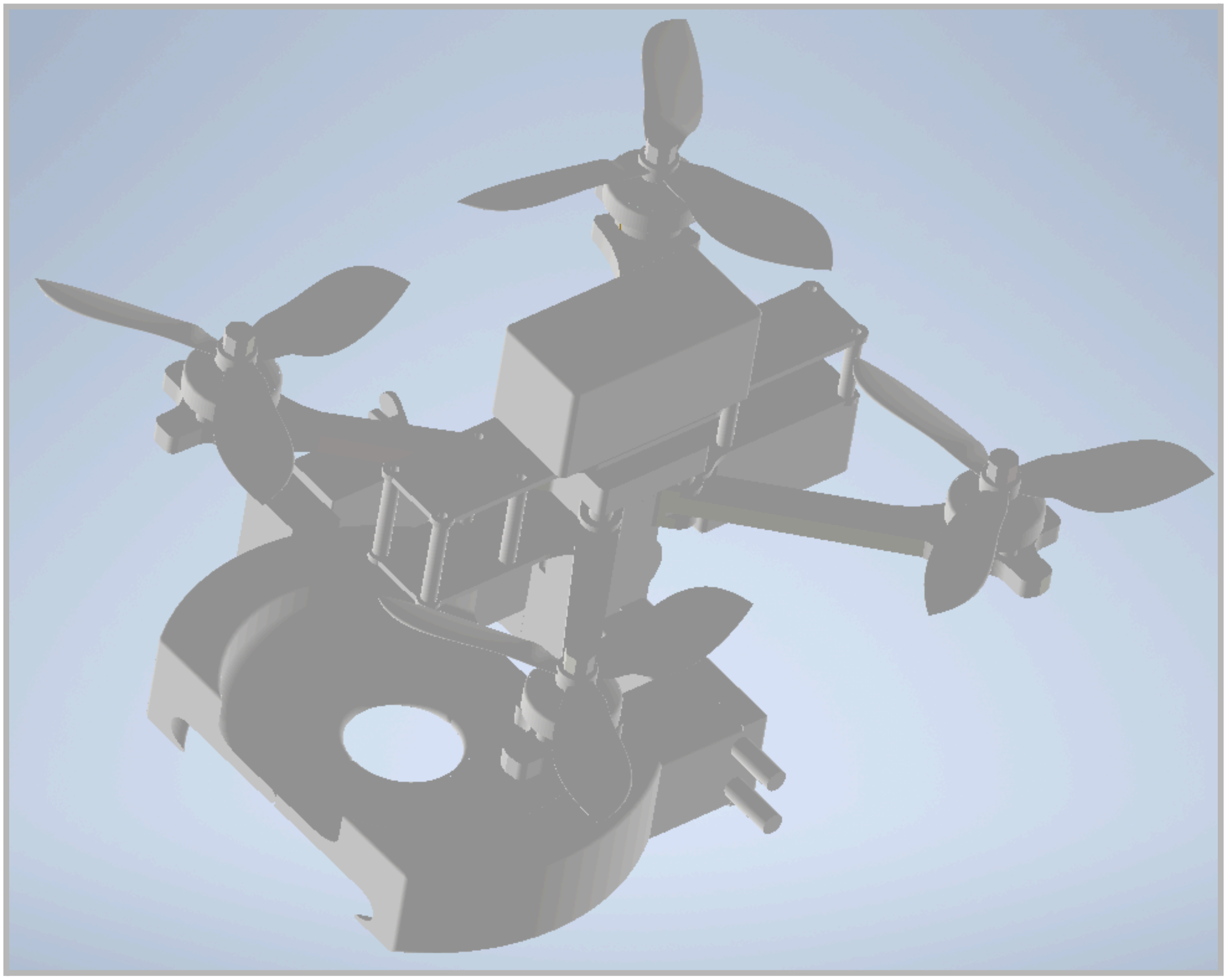
TSA Nationals 2024

Location: Orlando, Florida



Drone Challenge (UAV)

Team ID: #1790-1

Table of Contents

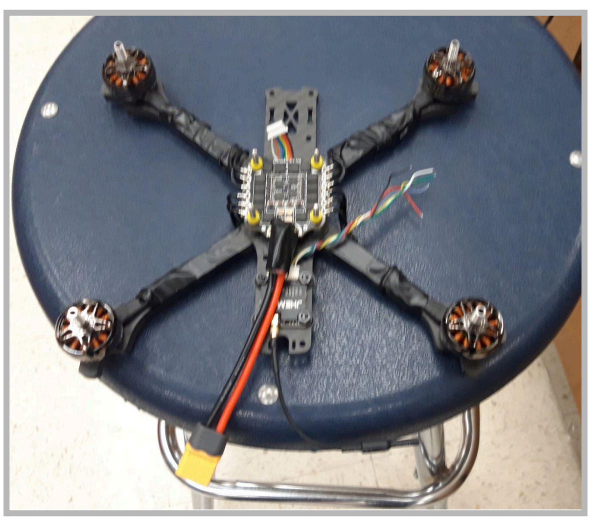
Full In-depth Photo Log with Captions

Note. Referenced as student taken images.

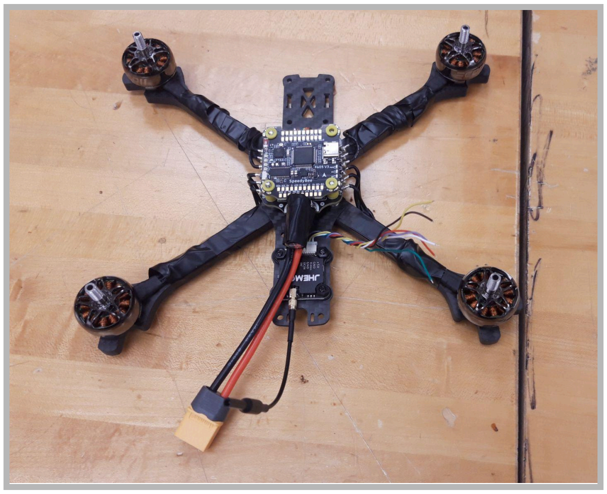
All individual pieces of drone assembly have arrived and are ready to be assembled.

The bottom frame and the four motors of the drone are assembled.

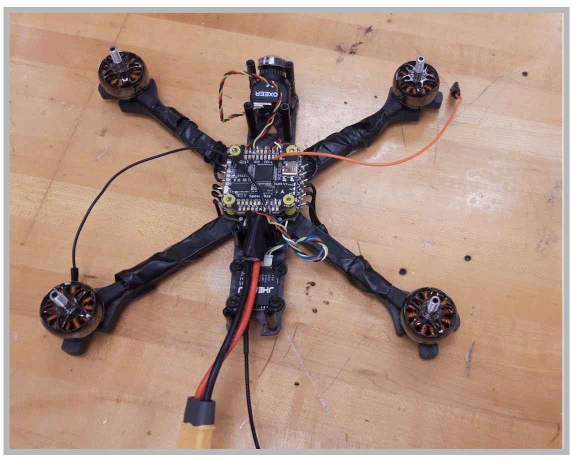
Note. M3 screws are sequential screwed in a star pattern.



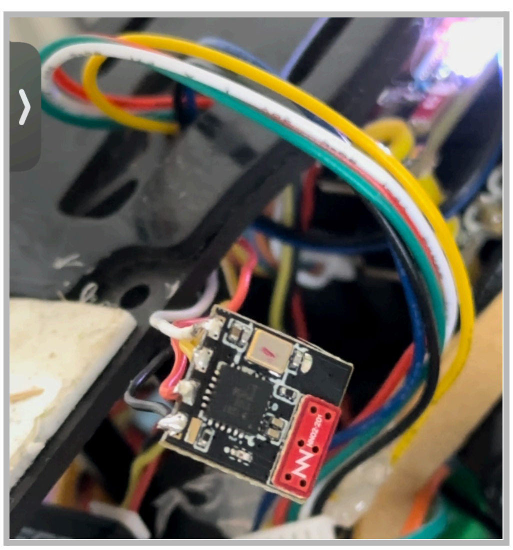
Main XT60 power cable, 100 picofarad capacitor, and brushless motors have been soldered to the Electronic Speed Controller 'ESC.'



The Speedy Bee Flight Controller and Video Transmitter ‘VTX’ have been assembled onto the drone. The flight controller has been connected to the ESC.



The First Person View ‘FPV’ camera has been installed and soldered to the flight controller. The VTX has been soldered to the flight controller.

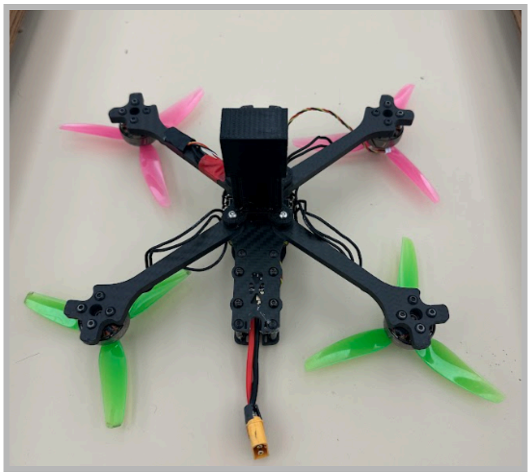


The ELRS receiver has been soldered to the flight controller and attached to the frame.

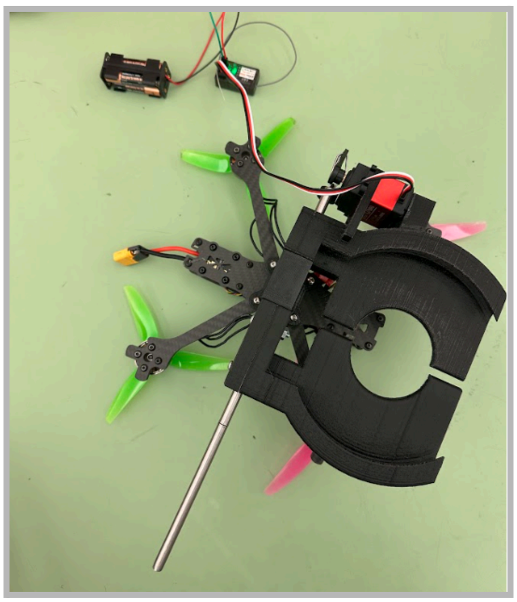
Construction of the drone is finished. Triple five inch blades and software has been installed; betaflight software is being programmed.

Prototype gripper has been modeled in CAD and printed in MakerBot.

Final gripper piece has been modeled in CAD and printed. A 20 kilogram servo is attached to the mechanism as an opening unit.



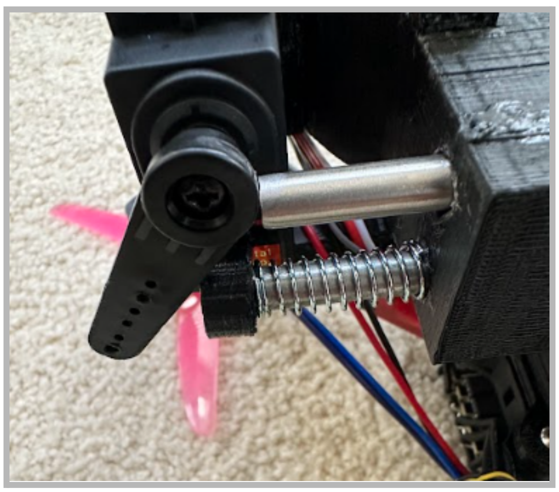
Final gripper mechanism attachment point has been assembled on a drone.



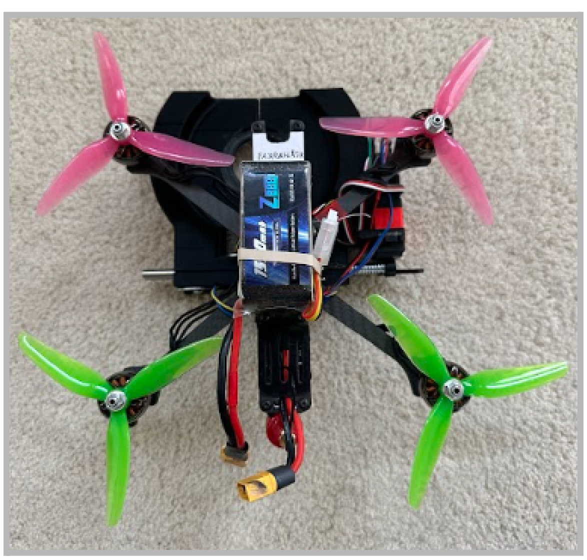
The complete gripper mechanism has been assembled and wired using a secondary circuit. Following, it is attached to the drone by ¼ inch metal structural rods.

The VTX antenna has been replaced due to computing error. The metal structural rods have been shortened as well as the bean bag gripper for optimal performance. The laser has been attached to a secondary circuit as well as the FPV camera drone mounted to the mechanism, for precision dropping.

The drone is at its final stage for TSA Technosphere States. This stage includes the addition of the 1500 milliampere lithium polymer battery. Fully assembled UAV drone equipped with gripper and precision dropping instruments.

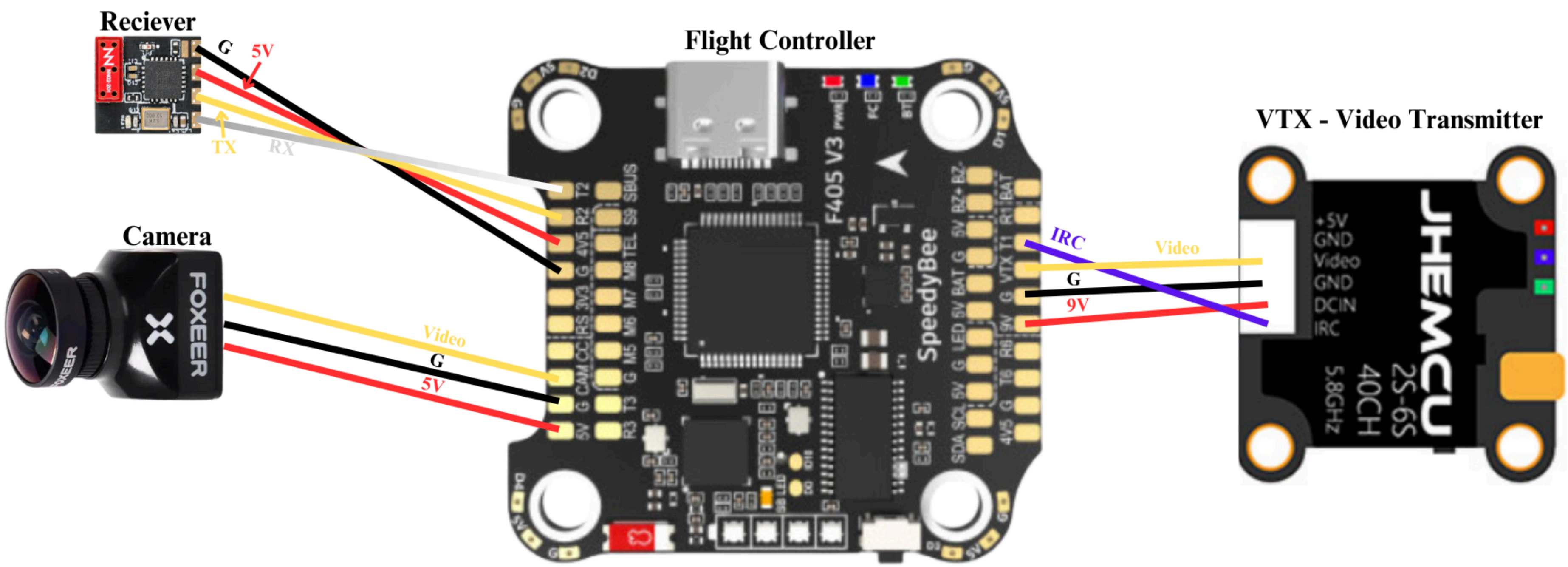


After TSA Technosphere States, new improvements on the drone's gripper mechanism were made. A compression spring was added to replace the metal wire on the gripper mechanism for added reliability.



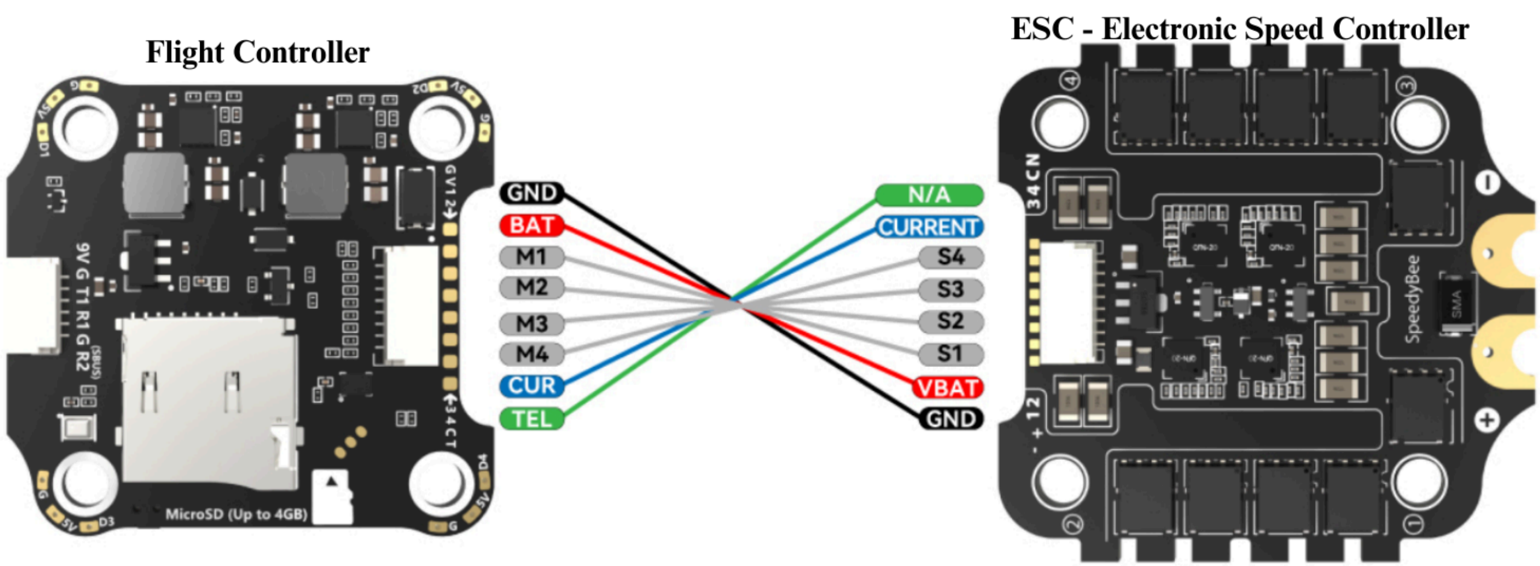
The drone is at its final stage for TSA Nationals. This stage includes the new improved gripper mechanism with the addition of metal washers to distribute the weight of the M3 bolts.

Schematic 1 - Flight Controller



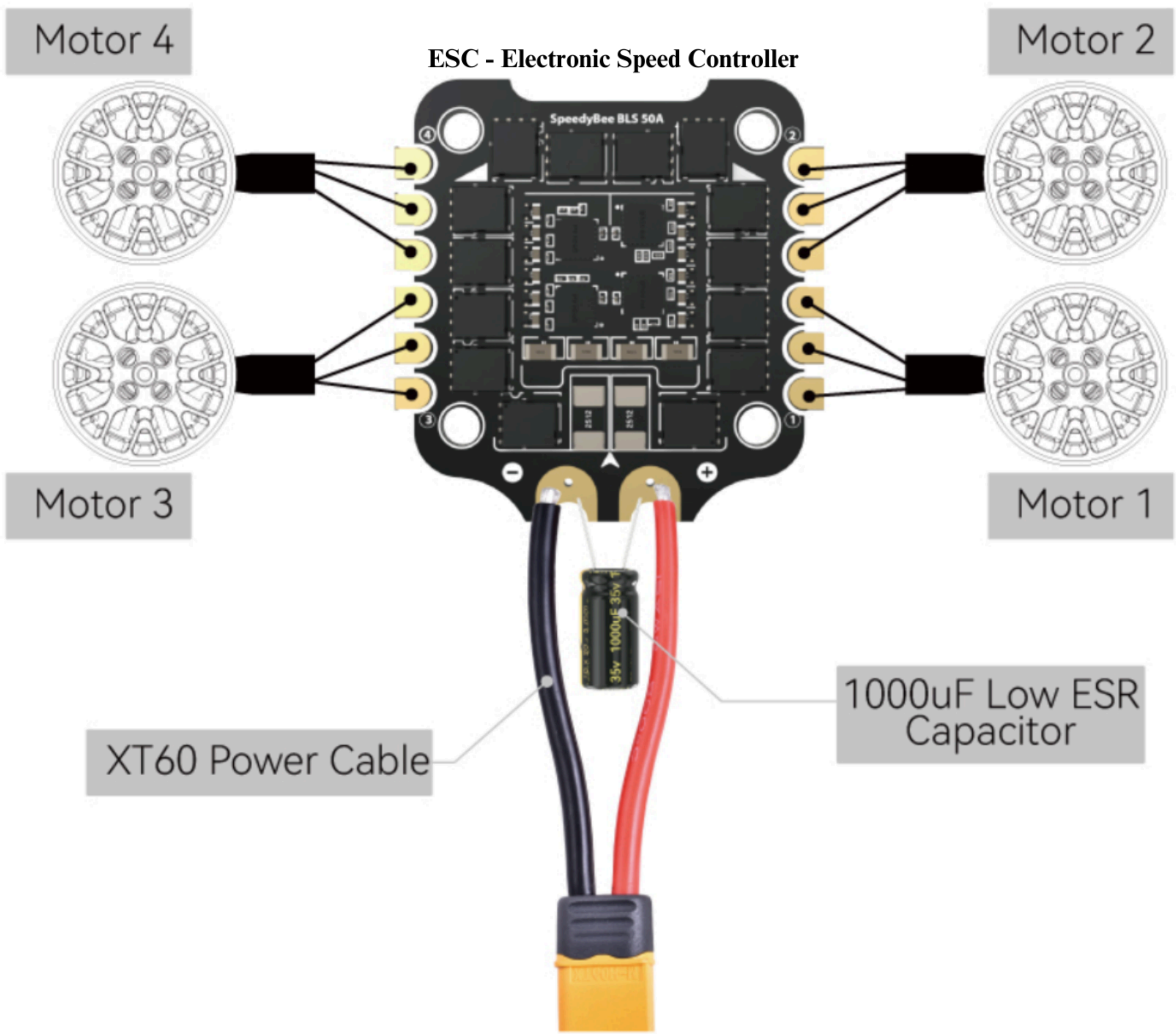
Note. **Reference images are from Speedybee, Banggood, Amazon, and Betafpv.**

Schematic 2 - Flight Controller to ESC



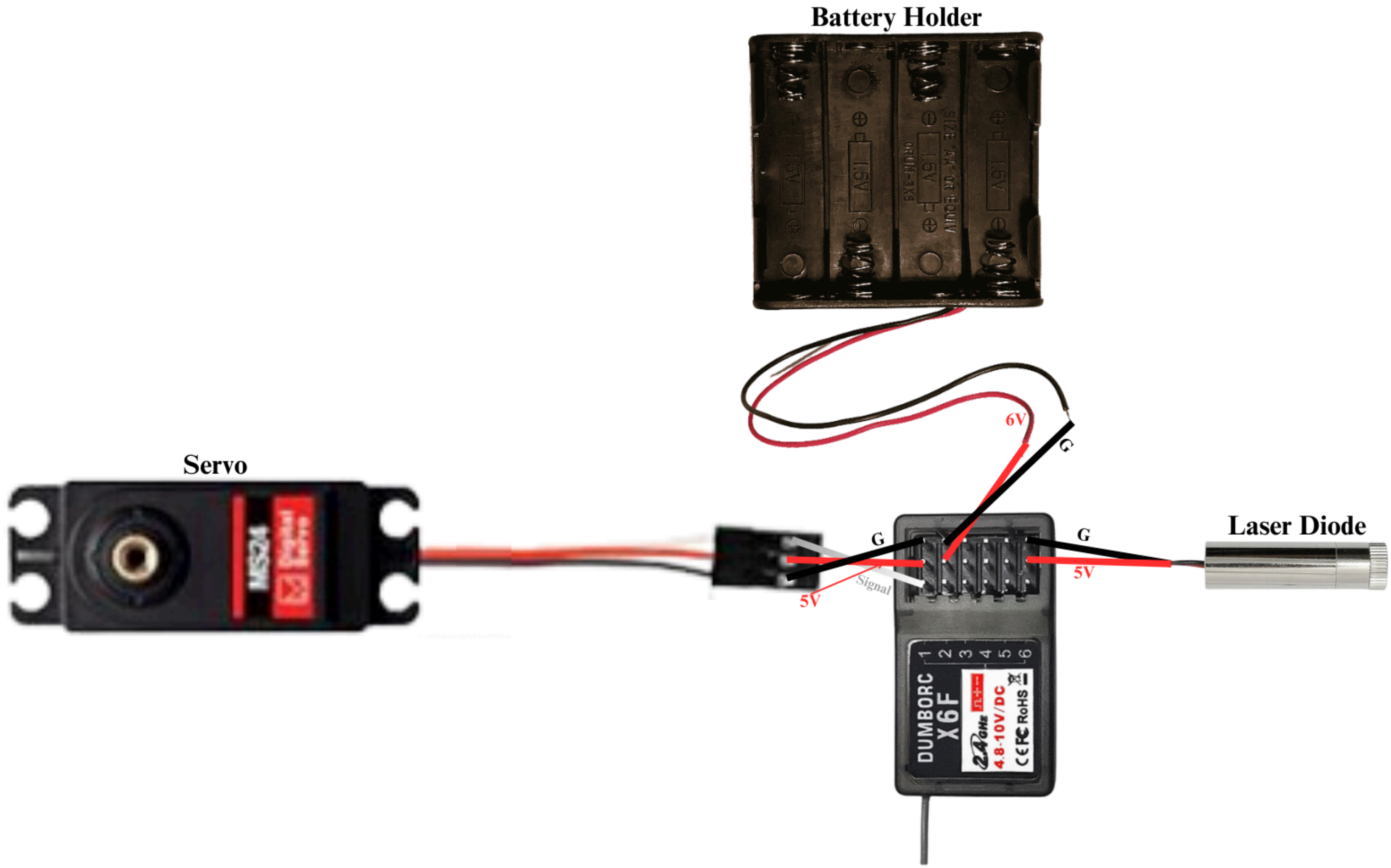
***Note*. Reference images are from Speedybee, Banggood, Amazon, and Betafpv.**

Schematic 3 - ESC

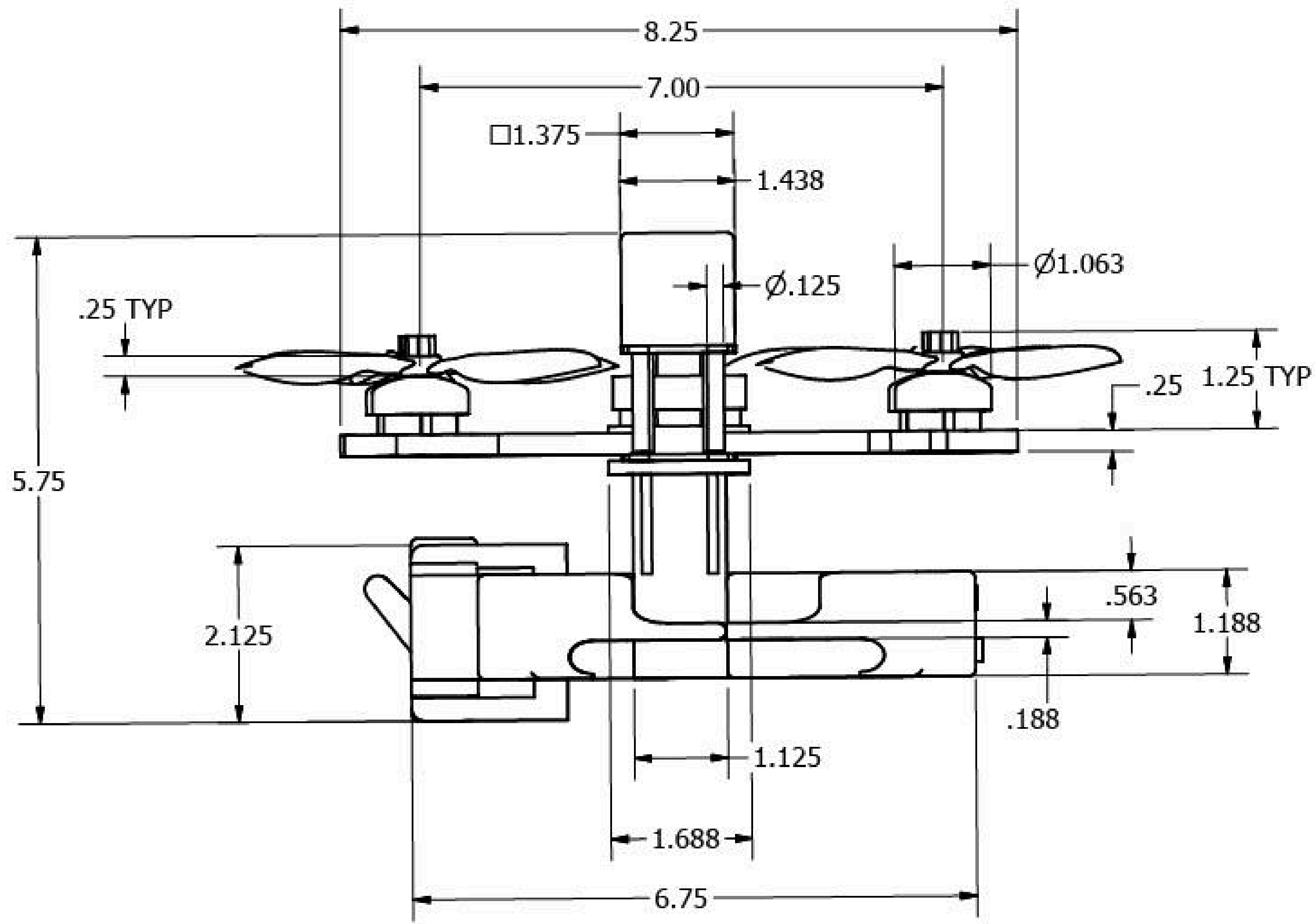


***Note*. Reference images are from Speedybee, Banggood, Amazon, and Betafpv.**

Schematic 4 - Secondary Circuit

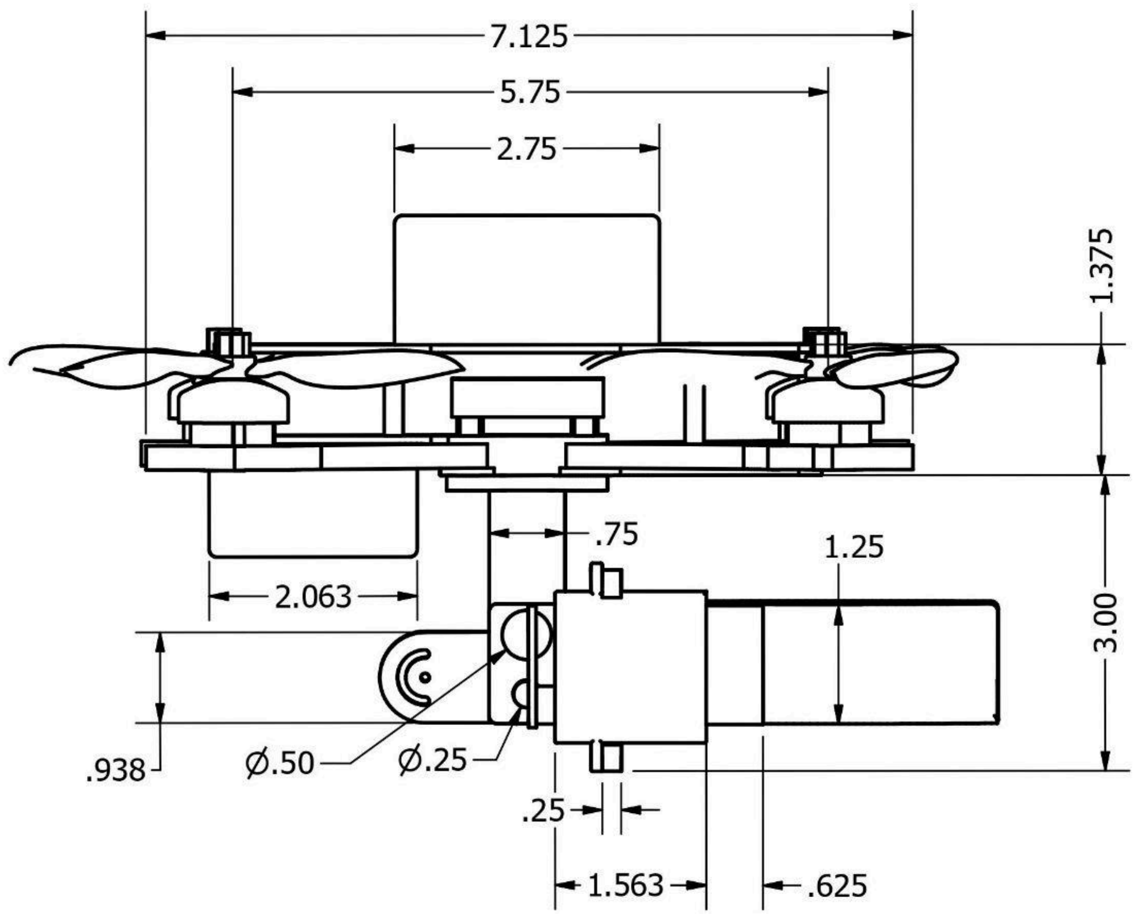


Note. Reference images are from Speedybee, Banggood, Amazon and Betafpv.



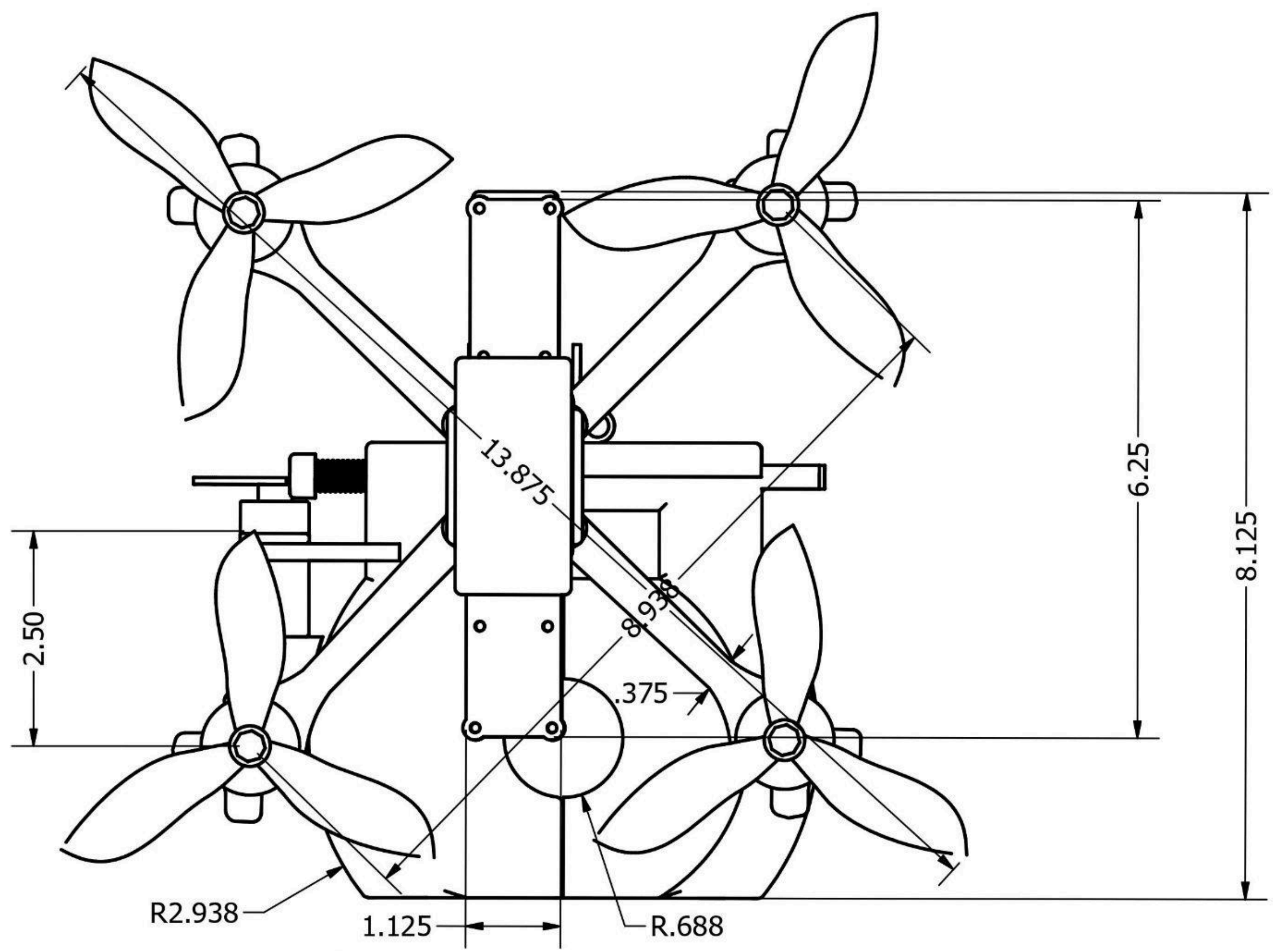
Note. Complete use of M3 hardware.

DRAWN 1790-1	6/20/2024	TSA Nationals - Orlando FL
CHECKED		
QA		TITLE
MFG		Drone Challenge UAV
APPROVED		
		SIZE A; DWG NO Drone Drawing Front View; REV
		SCALE 1 / 2; SHEET 1 OF 1



Note. Complete use of M3 hardware.

DRAWN 1790-1	6/20/2024	TSA Nationals - Orlando FL	
CHECKED			
QA		TITLE	
MFG		Drone Challenge UAV	
APPROVED			
		SIZE A	DWG NO Drone Drawing Side View	REV
		SCALE 1 / 2	SHEET 1 OF 1



Note. Complete use of M3 hardware.

DRAWN 1790-1	6/20/2024	TSA Nationals - Orlando FL			
CHECKED					
QA		TITLE			
MFG		Drone Challenge UAV			
APPROVED					
		SIZE A		DWG NO Drone Drawing Top View	REV
		SCALE 1 / 2		SHEET 1 OF 1	

Software and Power Sources

BetaFlight Software Functions

BetaFlight is a free to use and open source software program that the active community contributes and develops new features and improvements to ensure BetaFlight properly communicates to the drone. This also allows the drone to operate within parameters set by the users. The SpeedyBee flight controller lets the users use the SpeedyBee app on the go to set and limit parameters for functions of the drone. Such parameters can be set for ports, configurations, motors, battery, receiver, setup, modes, proportional integral derivative ‘PID,’ and on screen display ‘OSD.’ Setting and adjusting these parameters through the app, allows the user to efficiently operate the drone, FPV goggles, and main transmitter.

One of the most important functions of the drone is the ability to smoothly and easily control the drone’s movements. In order to adjust and fine tune the drone’s characteristics, the pilot must adjust the PID values. PID tuning is the process of getting the desired proportional gain and the rate of change, this allows the drone to react to oscillations to stabilize the drone. This is a very important part of the drone’s flying nature.

In order for the pilot to get information about the drone, the FPV goggle interface gives a live feed from the camera in conjunction with multiple drone readings. These readings include voltage, compass, altitude, signal strength, drone speed, and flight duration. Along with the FPV goggles the user uses the radio transmitter to communicate with the drone’s receiver. Through the input of the radio transmitter the drone will feel the experience of pitch, yaw, and roll which corresponds to the user's input. This is a critical process in order for the drone to fly properly.

Without BetaFlight these instructions from the user’s radio transmitter cannot be interpreted by the flight controller. BetaFlight uses the convenient SpeedyBee app to configure the drone’s components to systematically communicate with one another. In such, BetaFlight uses the ports tab in the app to structure the Universal Asynchronous Receiver/Transmitter ‘UART’ to identify the receiver as a component of the drone; the UART bridges the gap of communication between components and the flight controller. These are examples on how they can communicate with one another by BetaFlight to carry out the users input.

BetaFlight uses a gyroscope and a barometer to balance the drone. These components communicate to each other through thousands of miniscule commands by the flight controller to stabilize the drone. There are many modes that the pilot can choose from to change the appropriate stabilization. For example, angle mode is a system which compensates for human input and allows for the drone to remain in a stable hover while in neutral position. The stabilization system is integrated into the flight controller and once programmed, the software calculates and configures responses of the drone from these instruments without human input. Additionally, acro mode allows the user to completely have manual control and have no limits to the flying characteristics including no flight stabilization. Acro and angle are the most commonly used modes; angle being a beginner friendly mode and acro an advanced mode.

Secondary Circuit

The secondary circuit’s function is to separately power the mechanism servo and the laser. This secondary circuit is run on four AAA batteries that are mounted on the bottom back of the drone. In this challenge the team used resource skills and ingenuity by reusing a RC car transmitter and PPM receiver to fulfill the need of the gripper mechanism. Because of this the mechanism is able to be opened proportionally and can be tuned. The laser draws very modest current and therefore it was practical to put it on a separate power supply and also for the safety concerns of overcurrent. In conjunction these systems work seamlessly with one another.

	Bill of Materials 1 - UAV Drone			
	Part	Material	Quantity Total	Price
1	SpeedyBee F405 V3	Silicone	1	$34.99
2	SpeedyBee ESC	Silicone	1	$34.99
3	EMAX ECO II Motors	Metal	4	$63.96
4	TBS Source One Frame	Carbon Fiber	1	$39.59
5	JHEMCU VTX	Silicone	1	$18.99
6	Betaflight Receiver	Silicone	1	$8.99
7	Foxeer FPV Camera	Silicone	1	$19.89
8	HQ 5x3.1x3 Propellers	Plastic	4	$3.49
9	Uxcell MMCX Antenna	Copper	1	$6.99
10	FPV Drone 5.8ghz Stub	Brass	1	$13.99
11	Zeee 4S Lipo Battery	Lithium	4	$77.98
12	RadioMaster TX12 Transmitter	Plastic	1	$109.90
13	Emax Transporter FPV Goggles	Plastic	1	$98,99
14	800 mAH Lithium-ion Battery	Lithium	1	$9.99

Bill of Materials 2 - Gripper Mechanism

	Part	Material	Quantity Total	Price
1	DumboRC Transmitter	Plastic	1	$35.99
2	DumboRC Receiver	Silicone	1	$15.99
3	MakerBot PLA	Plastic	1	$10.50
4	Laser Diode	Metal	1	$5.95
5	Miuzei 20KG Servo	Metal	1	$13.99
6	Tynulox ¼ Steel Rods	Metal	2	$5.59
7	Melsan Velcro	Plastic	2	$1.32
8	Screws	Plastic	2	$0.10
9	Energizer AAA Batteries	Alkaline	4	$13.76
10	Duracell AA Batteries	Alkaline	4	$4.09
11	Battery Holder	Plastic	1	$6.11
12	Ninoge Compression Spring	Metel	1	$0.05
13	Washers	Metal	4	$0.03
	Total of all Materials:			$656.19

Rules and Regulations

Safety

- Wear high visibility vest and safety glasses at all times with proper TSA attire.
- Only work on your drone within your designated pit area.
- Two (2) welding blankets are required to cover your table and floor in the pit area.
- All tools with combustible fuel are prohibited in the pit area.
- All batteries must be placed on welding mats while charging.
- Propellers must be removed from your drone whenever it's outside the competition area.
- Remove the battery from your drone whenever it's outside the competition area.
- Drones must fly within the designated competition area only when directed by officials.

Drone Specifications

- Competing drones must have four motors, four propeller blades, and a camera.
- Drones must be assembled from open-sourced parts (kits are allowed).
- No commercially available drones are allowed (e.g., Mavic Pro).
- Drone frames can be made from various materials including wood, plastic, 3D printed materials, resin, and metal combined plastic.
- Battery packs must be commercially available, open-sourced lithium-ion batteries.
- Propeller size: 4 inches to 8 inches overall length and should be removable.
- Diagonal motor size (excluding propellers): 6 inches to 14 inches.
- Propeller guards are optional, but must fit in an 18" x 18" inspection box.
- Drones must incorporate magnets or grippers related to the competition year's theme.
- Landing gear should be adaptable to accommodate various missions and payloads.

Portfolio - USB PDF

- Title page with the name of the event, event title, conference city and state, year, and team identification number (1 page).
- Table of Contents (1 page).
- Photo log of major steps in drone production and assembly (with captions): motors, frame, ESC, video transmitter, flight controllers, cameras, etc. (pages as needed).
- Wiring schematic drawings of drone components (modules) with associated component-to-component wiring. Identified voltages are a plus (pages as needed).
- Explanation of programming software for flight function and stabilization (e.g., Q-Ground Control, Betaflight). Include any additional software and hardware used for mission function (software, microcontroller, Raspberry Pi, etc.) (pages as needed).
- Engineered drawings of assembled UAV with appropriate scale (max 4 pages).
- Bill of materials of all parts and components of the open-source UAV Drone (2 pages).
- Research on drone flight rules and regulations for the national conference location (local, regional, and federal) (2 pages).
- Resources (pages as needed).
- Plan of Work Log (pages as needed).
- Student Copyright Checklist.

United States Drone Laws - FAA

- Fly below 400 ft & keep the drone in visual line of sight (no screens).
- Register if 0.55-55 lbs (FAA.gov) & avoid restricted airspace (airports, military).
- The Recreational UAS Safety Test (TRUST).

References

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https://www.speedybee.com/

https://www.racedayquads.com/

https://tsaweb.org/

TECHNOLOGY STUDENT ASSOCIATION WORK LOG 1				
Date	**Task**	**Time Involved**	**Team Member Responsible** (Students Initial)	**Comments**
12/18/2023	Meeting	90 Minutes	PP & CQ	Drone Challenge (UAV) project started.
1/11/2024	Identifying Problem	60 Minutes	PP & CQ	Drone problem was identified and the replacement flight controller was ordered. *Note*. Drone was built last year.
1/23/2024	Replacement of Part	90 Minutes	PP	Flight controller arrived and replaced it for the drone to function correctly.
2/6/2024	Brainstorming	60 Minutes	PP & CQ	Brainstorm different ideas of a gripper mechanism and choose the best option.
2/20/2024	Designing	60 Minutes	CQ	Started designing a prototype of a gripper in Autodesk Inventor.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG 2				
Date	**Task**	**Time Involved**	**Team Member Responsible** (Students Initial)	**Comments**
3/5/2024	Designing	60 Minutes	CQ	Finalized the prototype the gripper on Autodesk Inventor
3/19/2024	Designing	60 Minutes	PP & CQ	Redesigned the gripper on Autodesk Inventor to accommodate the ring object.
4/8/2024	3D Printing	60 Minutes	PP & CQ	Finalized the gripper design and started 3D printing.
4/9/2024	Secondary Circuit	60 Minutes	PP	Building the secondary circuit for the gripper.
4/10/2024	3D Printing	60 Minutes	PP & CQ	Gripper Pieces finished printing.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG 3				
Date	**Task**	**Time Involved**	**Team Member Responsible** (Students Initial)	**Comments**
4/11/2024	Assembly	60 Minutes	PP & CQ	Gripper assembly starts.
4/16/2024	Assembly	60 Minutes	PP & CQ	Gripper mechanism was attached to the drone.
4/17/2024	Assembly	60 Minutes	PP & CQ	Laser mount and the camera mount were attached to the drone.
4/23/2024	Testing	90 Minutes	PP & CQ	Drone testing was conducted.
4/25/2024	Portfolio	60 Minutes	PP & CQ	Final touches on the portfolio were made.

TECHNOLOGY STUDENT ASSOCIATION WORK LOG 4				
Date	**Task**	**Time Involved**	**Team Member Responsible** (Students Initial)	**Comments**
4/29/2024	Assembly	60 Minutes	PP & CQ	Drone and Gripper final touches.
5/2/2024	Departure	90 Minutes	PP & CQ	Departure for TSA Technosphere States.
5/16/2024	Improvements	60 Minutes	PP & CQ	Worked on gripper improvements by adding a spring.
6/15/2024	Finalize	60 Minutes	PP & CQ	Finalized the portfolio, drone, and gripper.
6/26/2024	Departure	90 Minutes	PP & CQ	Departure for TSA Nationals.

STUDENT COPYRIGHT CHECKLIST

(for students to complete and advisors to verify)

1) **Does your solution to the competitive event integrate any music?** ☐ YES ◉ NO

   If NO, go to question 2.

   If YES, is the music copyrighted? ☐ YES ◯ NO

   If YES, move to question 1A. If NO, move to question 1B.

   1A) Have you asked for author permission to use the music in your solution and included that permission (letter/form) in your documentation? If YES, move to question 2. If NO, ask for permission (OR use royalty free/your own original music) and if permission is granted, include the permission in your documentation.

   1B) Is the music royalty free, or did you create the music yourself? If YES, cite the royalty free music OR your original music properly in your documentation.

CHAPTER ADVISOR: Sign below if your student has integrated any music into his/her competitive event solution.

I, Lyndsay Almarode (chapter advisor), have checked my student's solution and confirm that the use of music is done so with proper permission and is cited correctly in the student's documentation.

2) Does your solution to the competitive event integrate any graphics? ☒ YES ◯ NO

   If NO, go to question 3.

   If YES, is the graphic copyrighted, registered and/or trademarked? ☐ YES ◉ NO

   If YES, move to question 2A. If NO, move to question 2B.

   2A) Have you asked for author permission to use the graphic in your solution and included that permission (letter/form) in your documentation? If YES, move to question 3. If NO, ask for permission (OR use royalty free/your own original graphic) and if permission is granted, include the permission in your documentation.

   2B) Is the graphic royalty free, or did you create your own graphic? If YES, cite the royalty free graphic OR your own original graphic properly in your documentation.

CHAPTER ADVISOR: Sign below if your student has integrated any graphics into his/her competitive event solution.

I, Lyndsay Almarode (chapter advisor), have checked my student's solution and confirm that the use of graphics is done so with proper permission and is cited correctly in the student's documentation.

3) Does your solution to the competitive event use another's thoughts or research? ☐ YES ◉ NO

   If NO, this is the end of the checklist.

   If YES, have you properly cited other's thoughts or research in your documentation? If YES, this is the end of the checklist.

   If NO, properly cite the thoughts/research of others in your documentation.

CHAPTER ADVISOR: Sign below if your student has integrated any thoughts/research of others into his/her competitive event solution.

I, Lyndsay Almarode (chapter advisor), have checked my student's solution and confirm that the use of the thoughts/research of others is done so with proper permission and is cited correctly in the student's documentation.