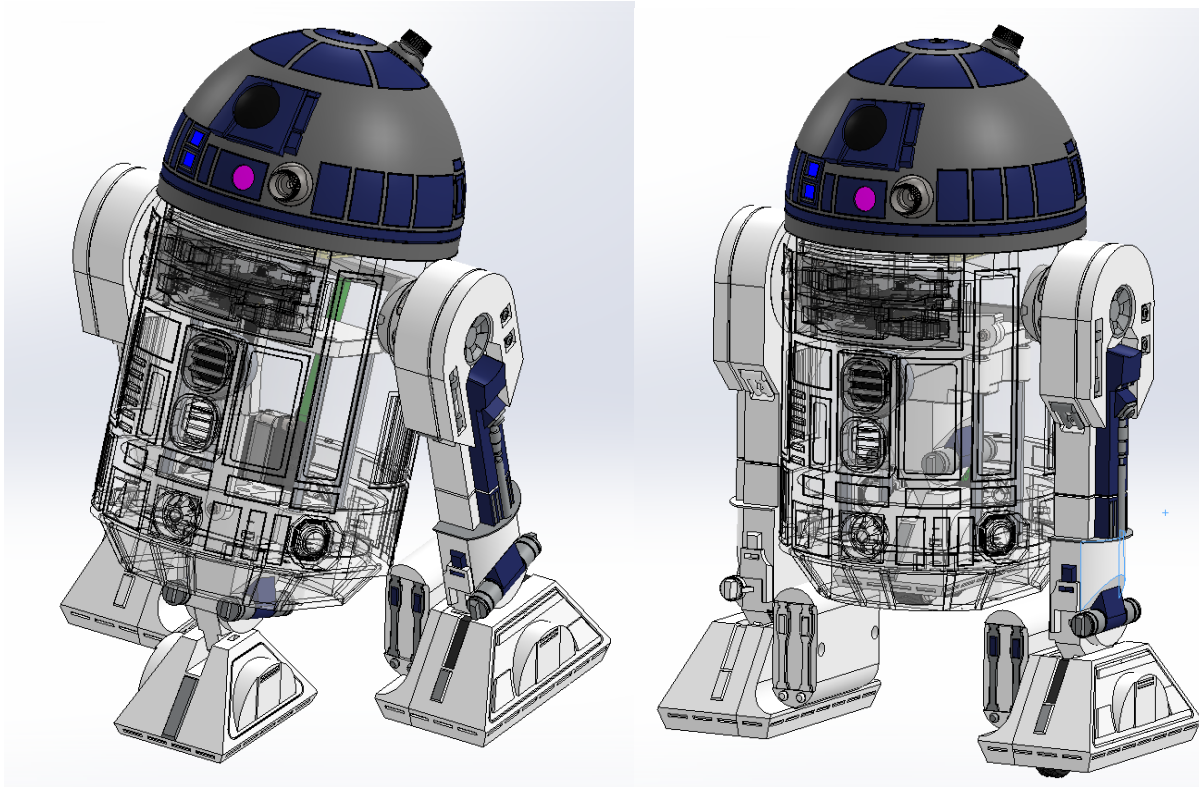# 2-3-2 Mini R2-D2 Guide by Matt Zwarts

This is the guide for printing and assembling a mini 2-3-2 R2-D2 that I designed, this allows for a fully functional 2-3-2 conversion on the legs, front arms open and close, drive and dome rotation all work independently. Thanks to Michael Baddeley for sharing the base model to work from, also thanks to all those people that have test printed and sounding boarded ideas along the way.

This is a complicated little build so please take your time and read the instructions and assembly documents before starting. I utilize the phone app I wrote on MIT App developer for Android to control all the features but a multi-channel RC transmitter could do the same. The phone app will hopefully be released on iOS as well, MIT App developer has recently updated, but the current trials I did failed in some areas... I'm an iOS man so I'll persevere.

Here is a link to an interview on the design overview Michael Baddeley did with me:

https://www.youtube.com/watch?v=BYv2sppbuP4&t=1008s

Review the parts and recommended settings for printing to keep weight and strength optimized before printing and post some pics of you build in the Facebook Group. Ask questions in the group as well for support as it is a great community.

https://www.facebook.com/groups/MrBaddeley/about/

Buy me a virtual coffee or some filament if you like to keep adding to my designs and builds that I enjoy sharing.

https://paypal.me/Matteous78?locale.x=en_AU

Happy Building,

Matthew Zwarts

Contents

Printer Settings

All the prints I did were with PLA + material, except the flex/ rubber tyre on the wheels, use your own print temperatures and machine based settings. The flex wheels I found were needed due to the extra weight in the mini 2-3-2 giving some traction issues, there is a non flex wheel option in the folder as well.

Anything noted with a _s in the file name requires supports to print, the remaining parts do not require supports and **Do Not** print the legs with any supports as there are cavities that are needed for the Leg Tie Rod to fit in to.

	Part Name	Qty	Supports	Overhang Value	Infill %	Notes
Body	Leg Tilt Servo Linkage.STL	1			40	Needs to be strong
	MZ R2_D2_Body_2-3-2.STL	1			15	
	MZ R2_D2_Body_2-3-2_Rear_Door.STL	1			15	
	Skirt.STL	1			15	
	Battery Mount.STL	1			15	
	Electronics Mount.STL	1			15	
	Front Vent.STL	1			15	
	Hub A.STL	1			30	Needs to be strong
	Hub B.STL	1			30	Needs to be strong
	Leg Tilt Main Cross Brace.STL	1			30	Needs to be strong
Centre Lift	Crank A Servo.STL	1			30	Needs to be strong
	Crank B Lift.STL	1			30	Needs to be strong
	Linear Rail 8mm Hex x4.STL	4			30	Needs to be strong
	R2-D2 Centre Ankle Cylinders x 2_s.STL	2	Yes	60%	15	
	Base.STL	1			30	Takes all the mechanism weight

Matthew Zwarts   Version 1.0

| Category	Part	Qty	Supports	Density	Value	Notes
	Centre Footshell.STL	1			15	
	Centre Leg Lift Top.STL	1			30	servo stress point
	Centre Leg Top.STL	1			15	
	Centre Leg.STL	1			15	
	Crank A Servo - Small servo horn.STL	1			30	Only if required for small servo horns
Wheels	Wheel.STL	2			30	
	Flex Tyre.STL	2			80	Print in flex or rubber filament
Front Arms	Utility Arm x2_s.STL	2	Yes	60%	15	
	R2_D2_Body_Front Arm Cutout Insert_s.STL	1	Yes	60%	15	Keep the support density down to 5-10% to be able to get the support material out easily
	Utility Arm Pin x2.STL	2			30	
Front Castor	R2 Front Castor Tyre x2.STL	2			40	
	Front Caster Axle MZ x2.STL	2			40	
	Front Castor Fork x2.STL	2			40	
Legs	R2 2-3-2 Right Foot_s.STL	1	Yes	60%	30	
	R2 2-3-2 Right Leg Inner.STL	1			15	
	R2 2-3-2 Right Leg.STL	1	NO		15	No Supports
	Leg Tie Rod x2.STL	1			60	
	R2 2-3-2 Left Battery Box.STL	1			15	
	R2 2-3-2 Left Foot_s.STL	1	Yes	60%	30	
	R2 2-3-2 Left Leg Inner.STL	1			15	
	R2 2-3-2 Left Leg.STL	1	NO		15	No Supports
	R2 2-3-2 Right Battery Box.STL	1			15	
Omniwheels	Omniwheel 50mm Part D.STL	2			30	
	Omniwheel 50mm Tyre.STL	16			30	
	Spacer.STL	4			30	
	5x45mm Axle.STL	2			30	
	Omniwheel 50mm Part A.STL	2			30	
	Omniwheel 50mm Part B.STL	2			30	
	Omniwheel 50mm Part C.STL	2			30	
Dome	R2 Dome Periscope.STL	1			15	No supports needed :)
	R2 Mini Periscope - Base_s v2.STL	1	Yes		15	Keep support to 5%, easy to remove
	R2 Mini Periscope - Top v2.STL	1			15	
	R2 Mini Periscope -Lid_s v2.STL	1	Yes		15	
	Dome Centre Spider_s.STL	1	Yes		15	
	Periscope Main Body.STL	1			15	
	Periscope Shaft v2.STL	1			15	

Print guide

The main body has built in supports in the front arm cavity and rear door cavity, these are removed after printing with a screwdriver and gentle persuasion

Supports built in

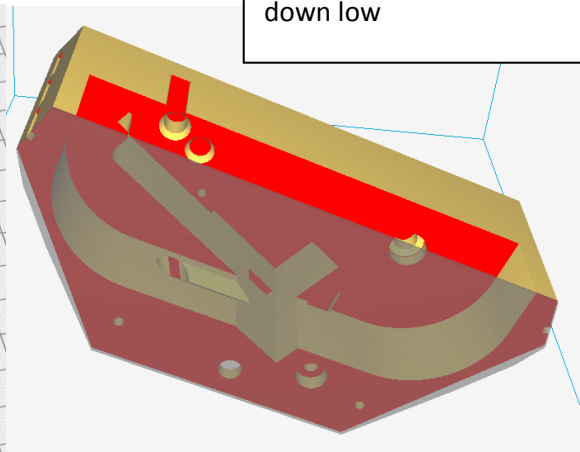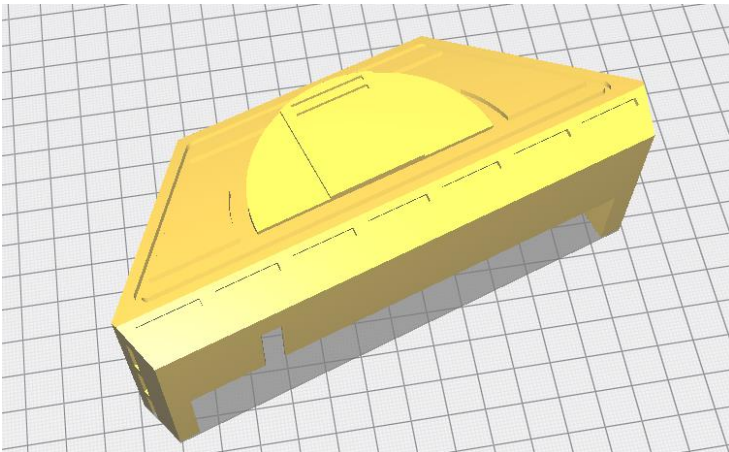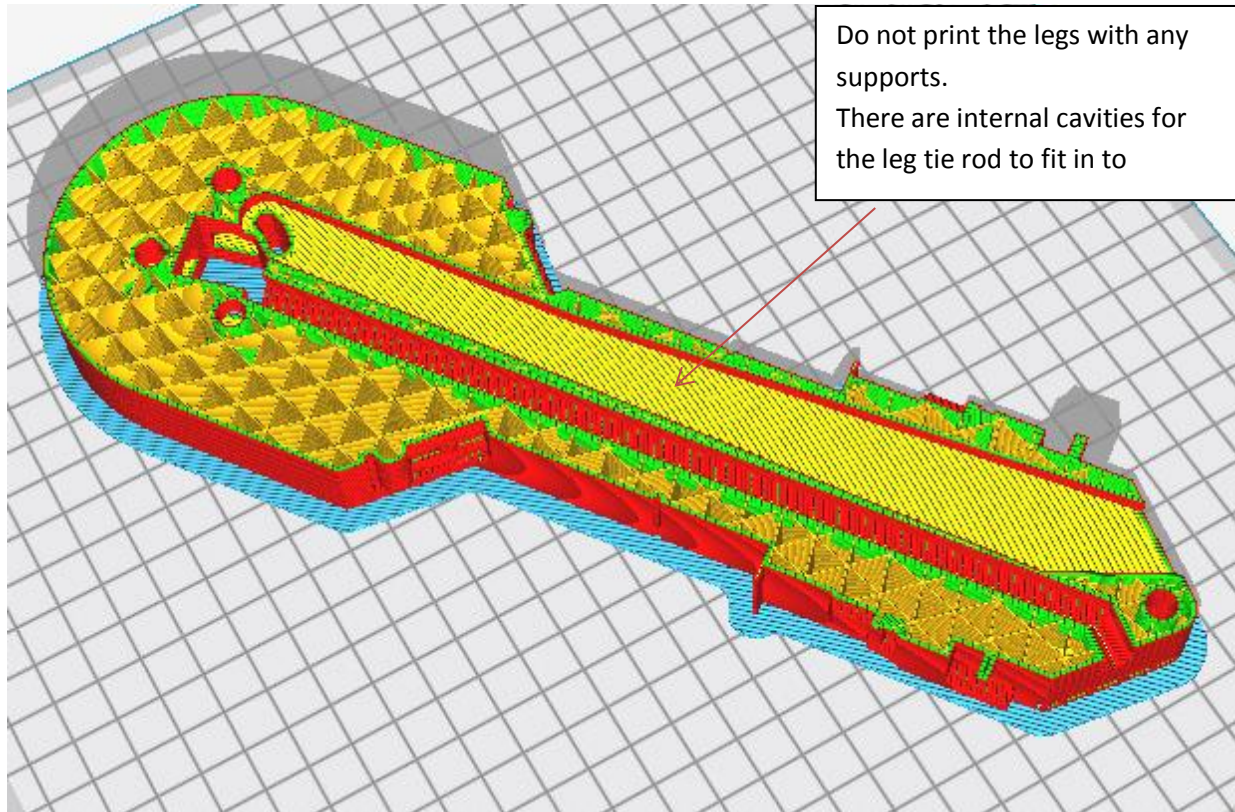Print linear rails lying flat, 4 required
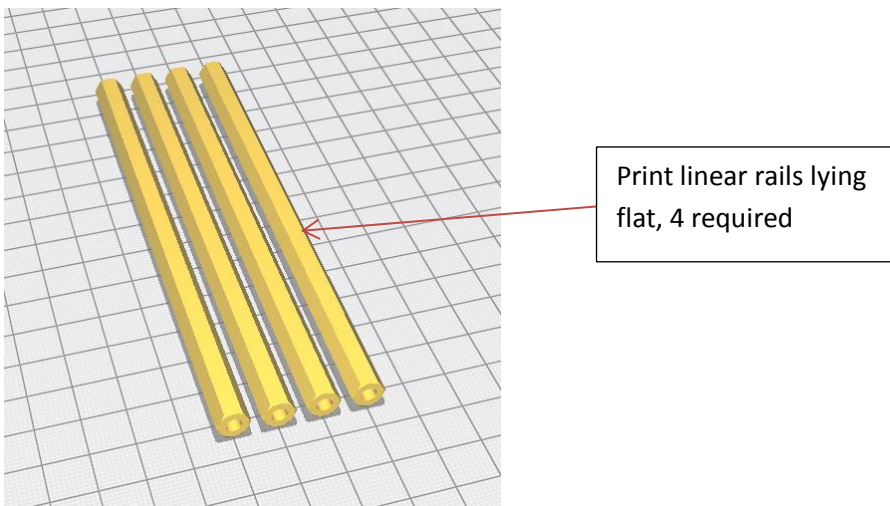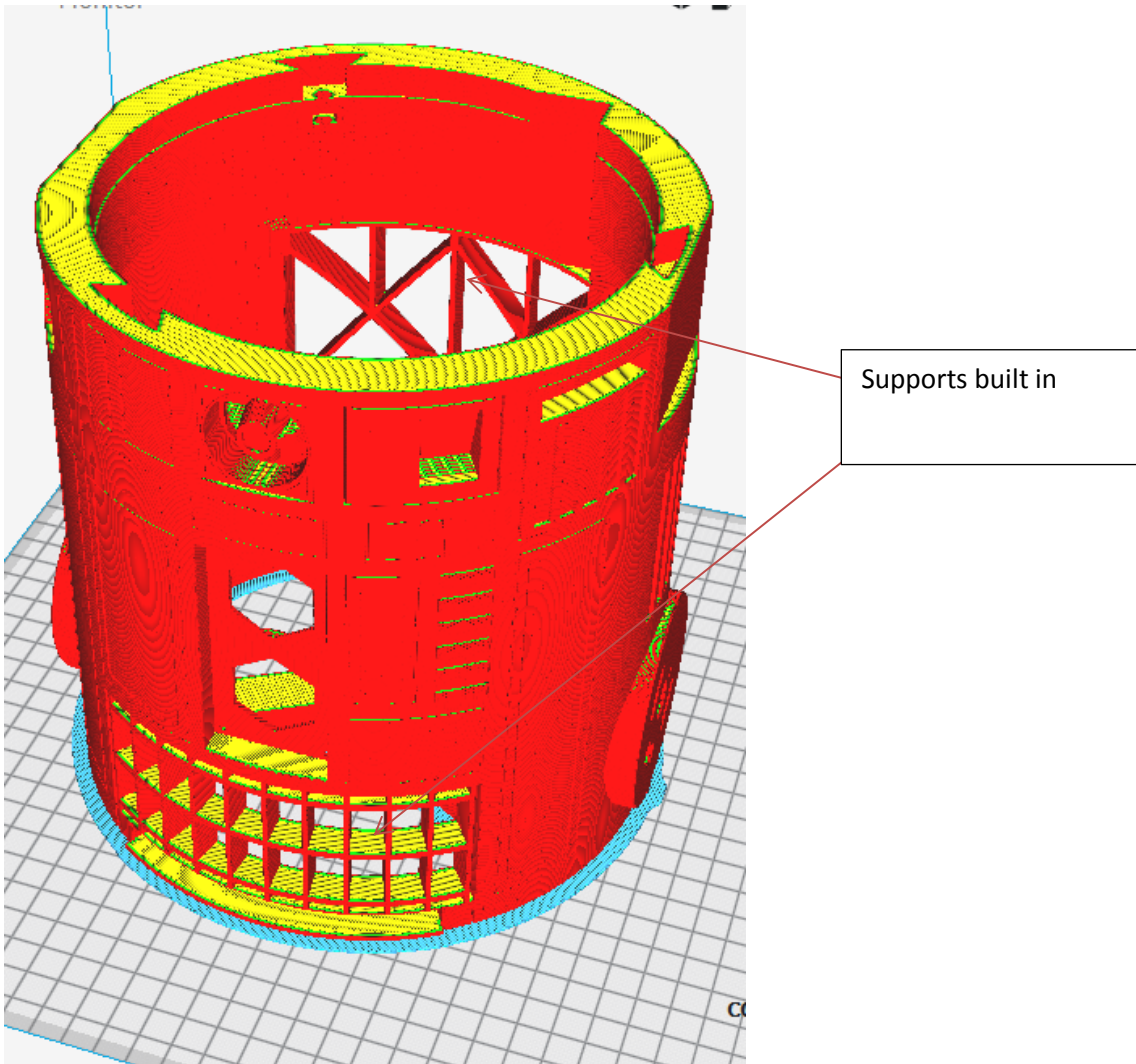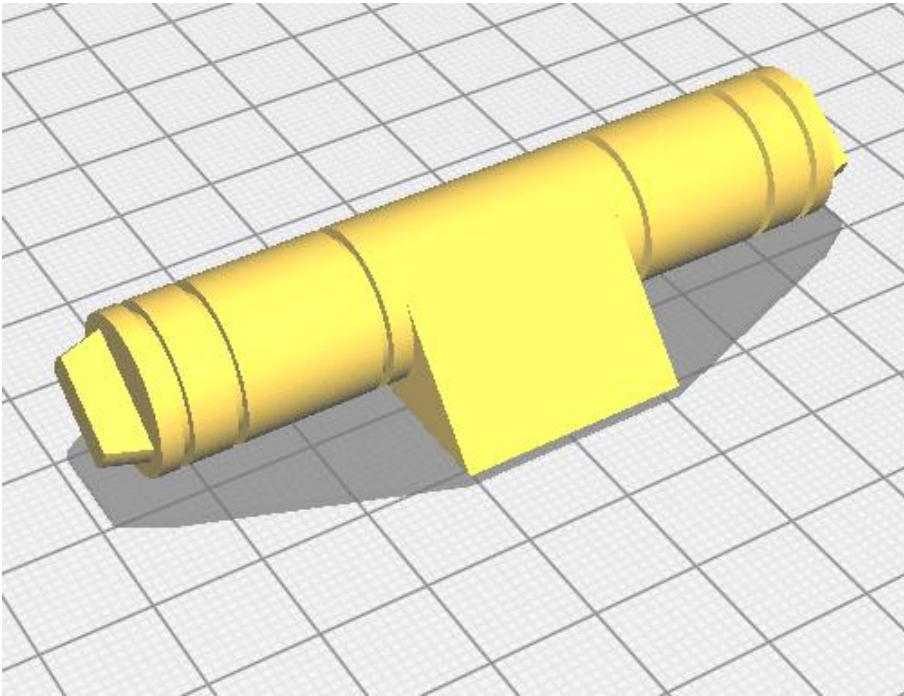
Ankle Cylinders will require a small amount of support underneath
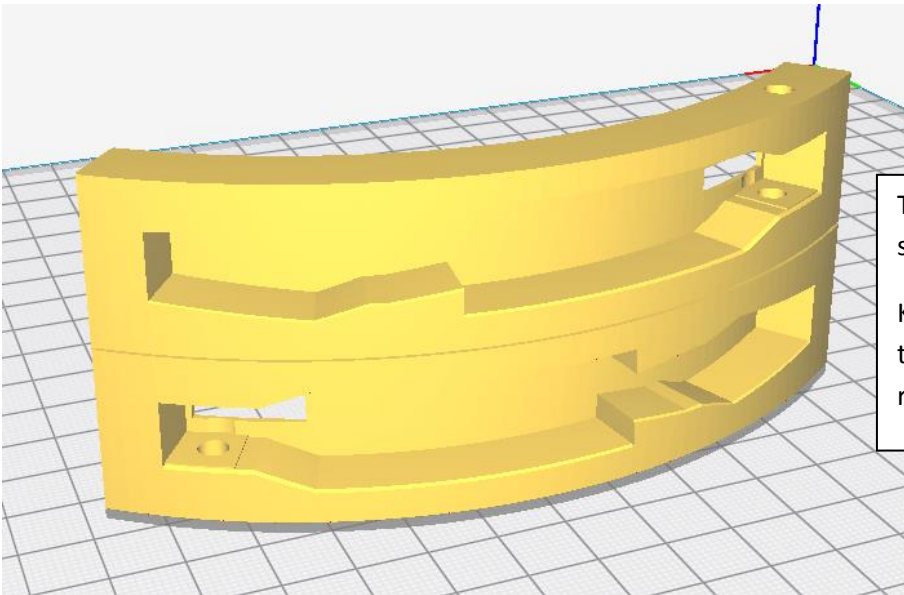
The front arm insert will require supports.

Keep the support density down to 5-10% to help make it easy to remove

The feet will need supports, again keep the support infill down low

Do not print the legs with any supports.
There are internal cavities for the leg tie rod to fit in to

Bill Of Materials (BOM)

Electronics

Electronics can be sourced from anywhere Banggoods, Local electronics stores, online, here is a BOM for the parts used. The assumption is you have basics, soldering iron, solder, jst connectors, and so on, small wire for running through the legs and also for joining the HC-05 connections and switch for example.

This can be the challenging part of the build but do it slowly, get the power to the Arduino with a switch, test it.

Then add the HC-05 module with resistors, test it, connect it to the computer in the Arduino IDE and run the sketch serial monitor, check the phone app/ Bluetooth app connects, test it.

Then connect the motor driver and measure the voltage coming out before connecting to the motors, up to this stage can all be set up on a desk before installing into the body to make it easy to test.

Part Name	Qty	Source	Link	Comments
HC-05 Bluetooth Module	1	Banggoods	https://www.banggood.com/HC-05-Wireless-Bluetooth-Serial-Transceiver-Module-Slave-And-Master-p-908621.html?rmmds=search&cur_warehouse=CN	
Arduino Nano	1	Banggoods	https://www.banggood.com/NANO-IO-Shield-Expansion-Board-Nano-V3-Improved-Version-No-Cable-For-Arduino-p-1010994.html?rmmds=search&cur_warehouse=CN	Arduino Clone will be fine

Toggle switch (on - off)	1	Any	https://www.banggood.com/Red-3-Pin-ON-ON-SPDT-Mini-Toggle-Switch-AC-6A125V-3A250V-p-967014.html?rmmds=search&cur_warehouse=CN	Any toggle switch for on/ off
MX 1508 Motor Driver Board	2	Banggoods	5pcs Dual Channel L298N DC Motor Driver Board PWM Speed Dual H Bridge Stepper Module Module Board from Electronic Components & Supplies on banggood.com https://banggood.app.link/WfcEpe8eJ81167075.html?rmmds=search&cur_warehouse=CN	NOTE: This link is for a 5 pack
DC 3V-6V DC 1:120 Gear Motor	3	Banggoods	https://www.banggood.com/5Pcs-DC-3V-6V-Gear-Reducer-Motor-For-Arduino-DIY-Smart-Car-Robot-p-1260258.html?cur_warehouse=CN&rmmds=search	NOTE: this link is for a pack of 5 motors
7.4v Lipo Battery 850Mah or similar	1	Banggoods	https://www.banggood.com/Red-7_4V-500mah-or-850mAh-2S-25C-JST-Plug-Lipo-Battery-RC-Car-Models-Spare-Parts-p-1650549.html?cur_warehouse=CN&ID=6287712&rmmds=search	Larger battery will be fine so long as it fits, just 7.4 volt
Wire	-	Any		Various wire for connecting everything
Res	1	any		used to connect

Matthew Zwarts   Version 1.0

ist or 1K Oh m				the HC-05 and arduino
Res ist or 2K Oh m	1	any		used to connect the HC-05 and arduino
PC A9 68 5 Ser vo Mo tor bo ard	2	Banggo ods	https://www.banggood.com/3Pcs-PCA9685-16-Channel-12-bit-PWM-Servo-Motor-Driver-I2C-Module-p-1188110.html?rmmds=detail-topright-recommendation&cur_warehouse=CN	This link is for 3 boards
M G9 95 ser vo wit h ser vo hor ns	2	Banggo ods	https://www.banggood.com/2PCS-Racerstar-MG995-13KG-Metal-Gear-Large-Torque-Analog-Servo-For-1-8-1-10-RC-Car-Robot-Helicopter-Airplane-p-1512855.html?cur_warehouse=CN&rmmds=search	This link is for 2 servos
SG 90 ser vos	2 min imu m	Banggo ods	https://www.banggood.com/4PCS-SG90-Mini-Gear-Micro-Servo-9g-For-RC-Airplane-Helicopter-p-1010676.html?cur_warehouse=CN&rmmds=search	2 servos will animate the front arms, more are required for the dome holo projectors and periscope lift This link is for a pack of 4 servos The standard sg90 servos can be modified for continuous rotation for the holo projectors
Sli pri ng	1	online various sources	https://www.amazon.com/dp/B07YKXWFR8/ref=cm_sw_r_cp_apa_glt_fabc_W9YPHP54BJ7N8PD3HT4K?_encoding=UTF8&psc=1&fbclid=IwAR0RbDY1V ET0EnNr3FTskvEwtNUiaNaY2Dzz0MqpH7xrpqbPuF0KDHeUIEk	Slipring to run power and signal from the body to the dome

Fasteners

These fasteners can be sourced anywhere, online or local hardware store. Buy packets to make it cheaper overall and maybe buy a few spares just in case.
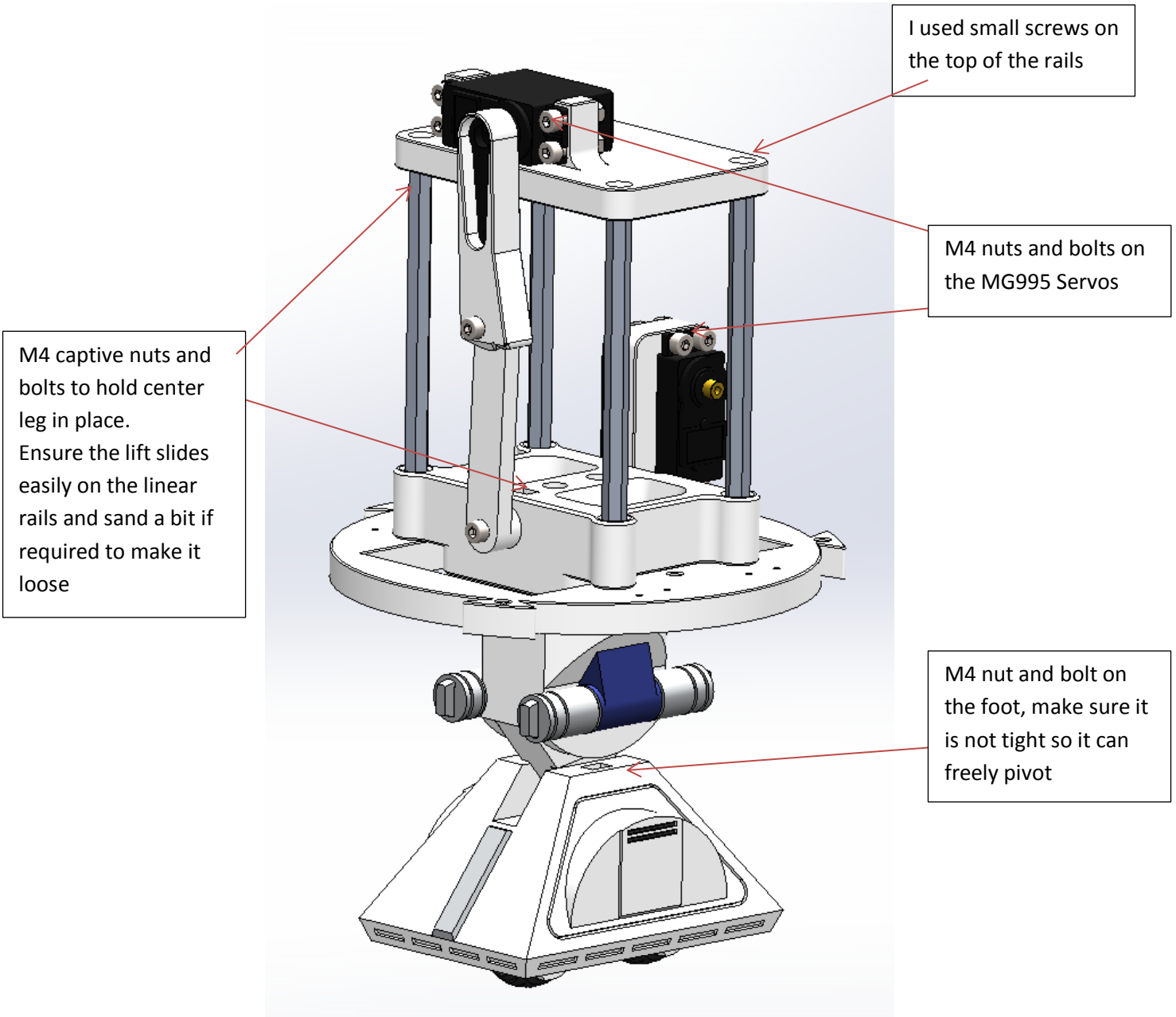
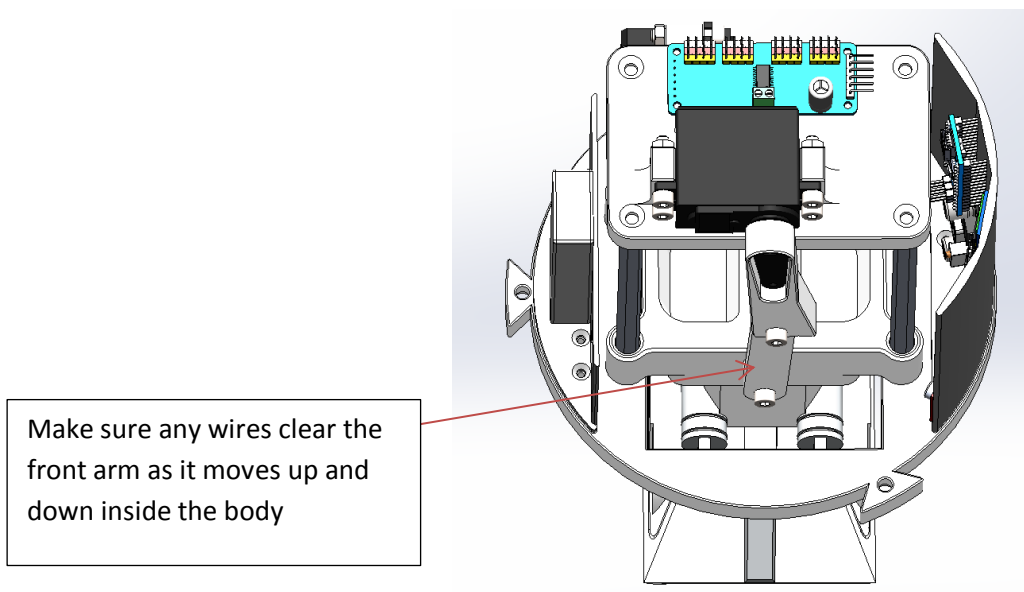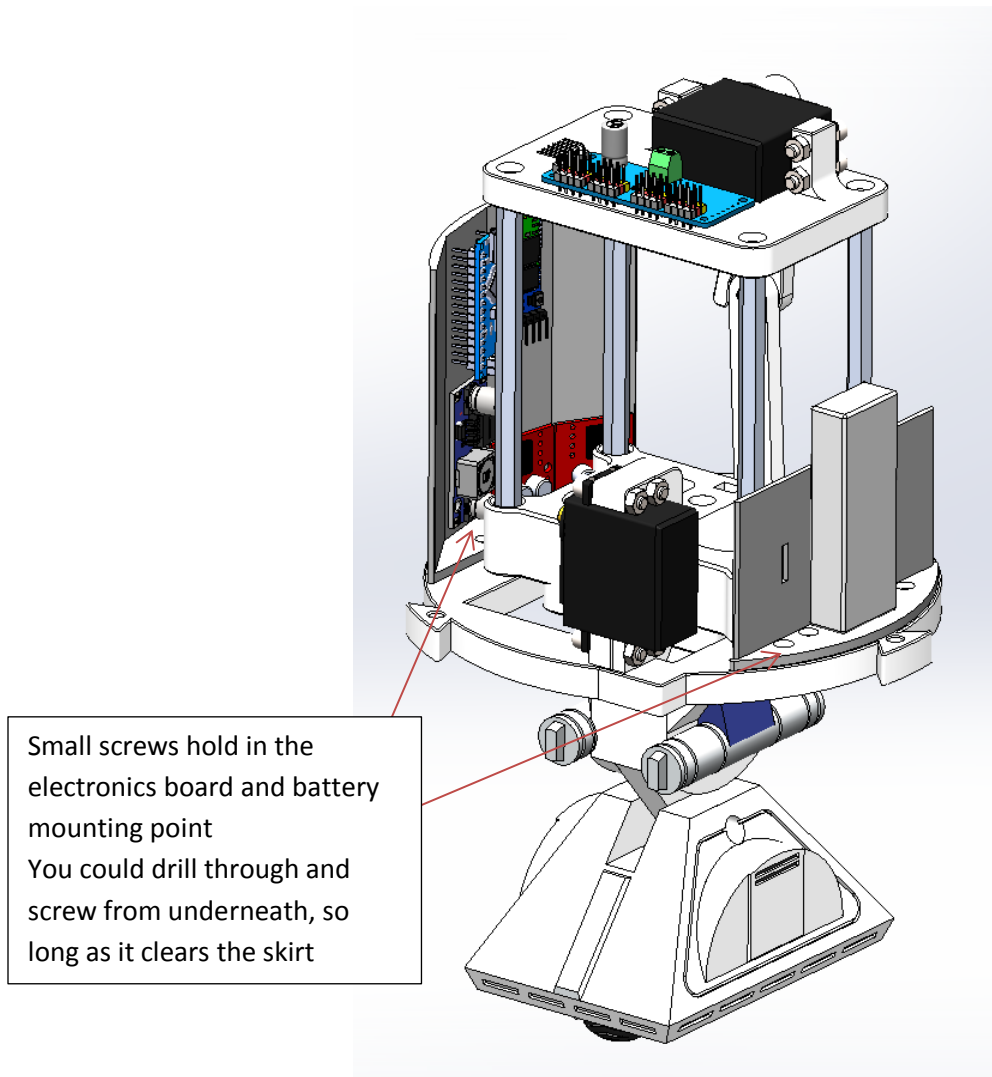| Description	Quantity	Source	Comment
M6 x 25 Long SHCS	6	Hardware store	I got my bolts from used filament spools, Esun PLA+, recycled!
M6 x 35 Long SHCS	2	Hardware store	Bottom pivot on the ankles
M6 nuts	8	Hardware store	Can be Nylock or lock nuts for the legs
Bearings 22mm OD x 8mm ID x 7mm	2	Hardware store	For the front castor wheels
Various wood screws	4	Hardware store	The ones I used were 8G x 20mm long, this holds the footshells on to legs
Small wood screws	-	Hardware store	Hold on the motor for the dome rotation, could be just hot glued
M4 grub screw 10mm long	1	Hardware store	Retain the dome gear onto the motor
M4 x 12 mm SHCS	5	Hardware store	SHCS (Socket Head Cap Screw) allen key bolts
M4 x 20 mm SHCS	20	Hardware store	SHCS (Socket Head Cap Screw) allen key bolts
M4 x 35mm SHCS	2	Hardware store	These are for the top of the leg tie rod
M4 nut	28	Hardware store	Some can be exchanged for Nylocks if desired
Bearings 10mm OD x 5mm ID x 4mm	4	Online	For the omniwheel to feet bearings, this can be replaced with a printed spacer
1.6mm diameter wire	500mm		Cut into lengths per the omniwheel instructions

Assembly Tips

Assembly can be tricky as there is a lot to fit in a little droid, refer to the images below to aid in the fitting together, as always test fit everything before applying glue if required or squashing something together with too much force.

Refer to the PDF assembly drawings to cover most of the specific details.

Centre Lift

I used small screws on the top of the rails

M4 nuts and bolts on the MG995 Servos

M4 captive nuts and bolts to hold center leg in place.
Ensure the lift slides easily on the linear rails and sand a bit if required to make it loose

M4 nut and bolt on the foot, make sure it is not tight so it can freely pivot

Matthew Zwarts   Version 1.0

With the electronics boards and battery installed

Small screws hold in the electronics board and battery mounting point
You could drill through and screw from underneath, so long as it clears the skirt

Make sure any wires clear the front arm as it moves up and down inside the body

Matthew Zwarts   Version 1.0
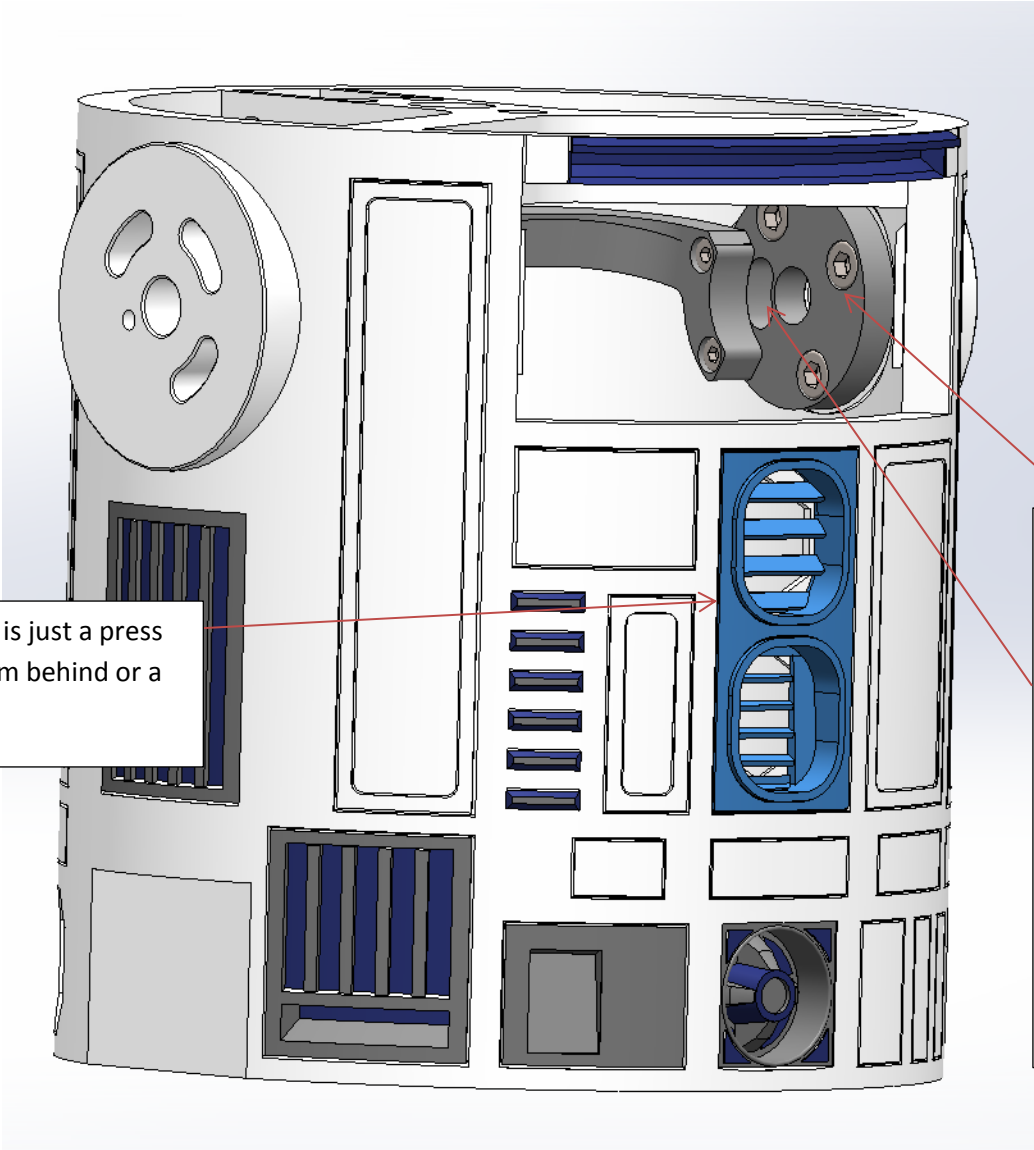
Body and Legs

Assemble the Main Cross Brace with the M4 x 12 nuts and bolts, this will then be forced into the body cavity and then screw onto the legs with the M6 bolts
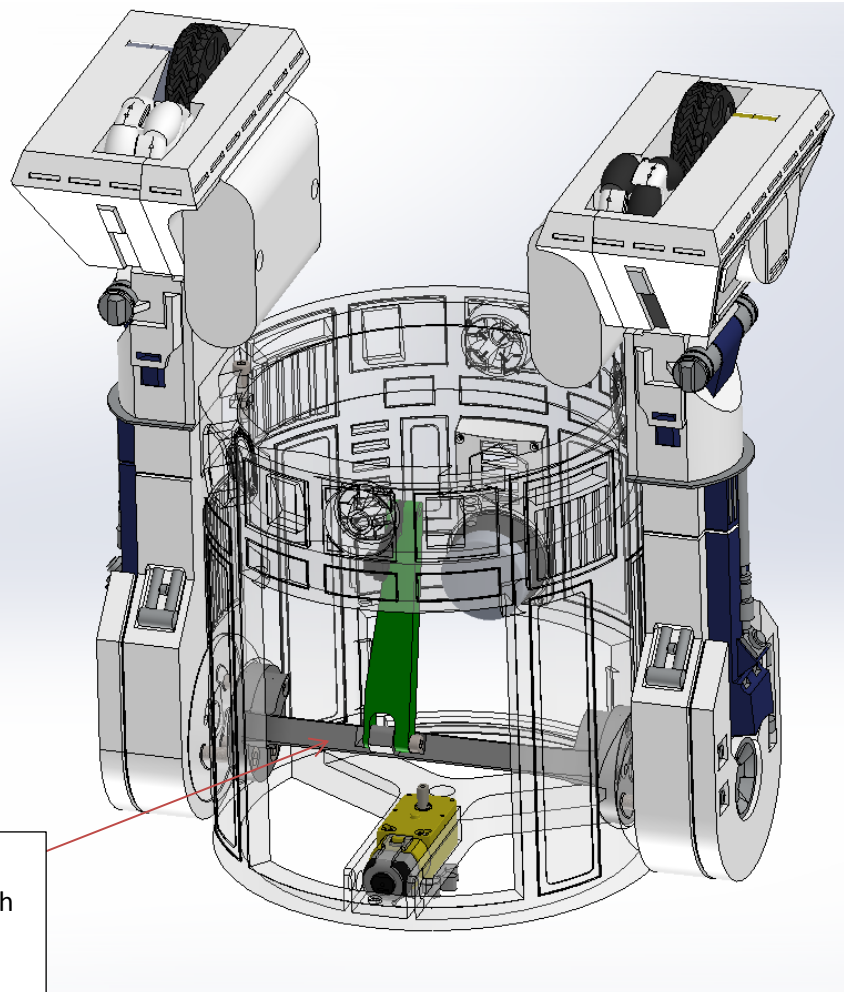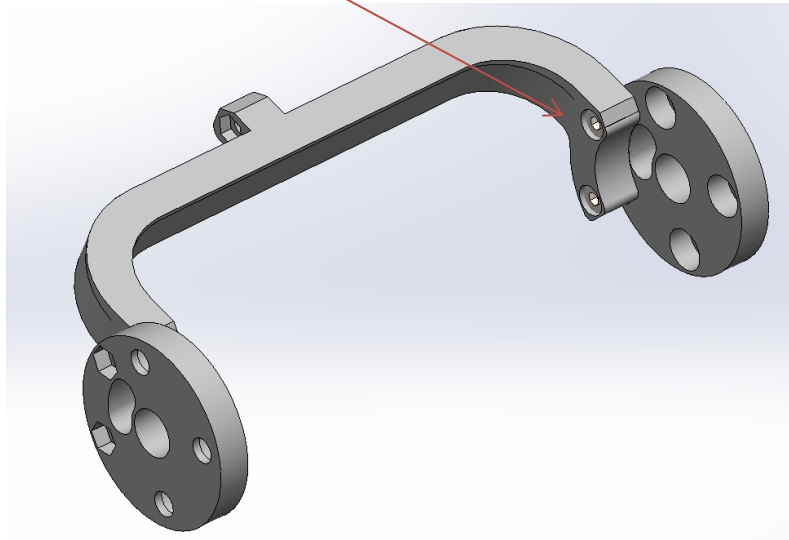
Centre Cross brace inserted and legs bolted into body with the M6 bolts

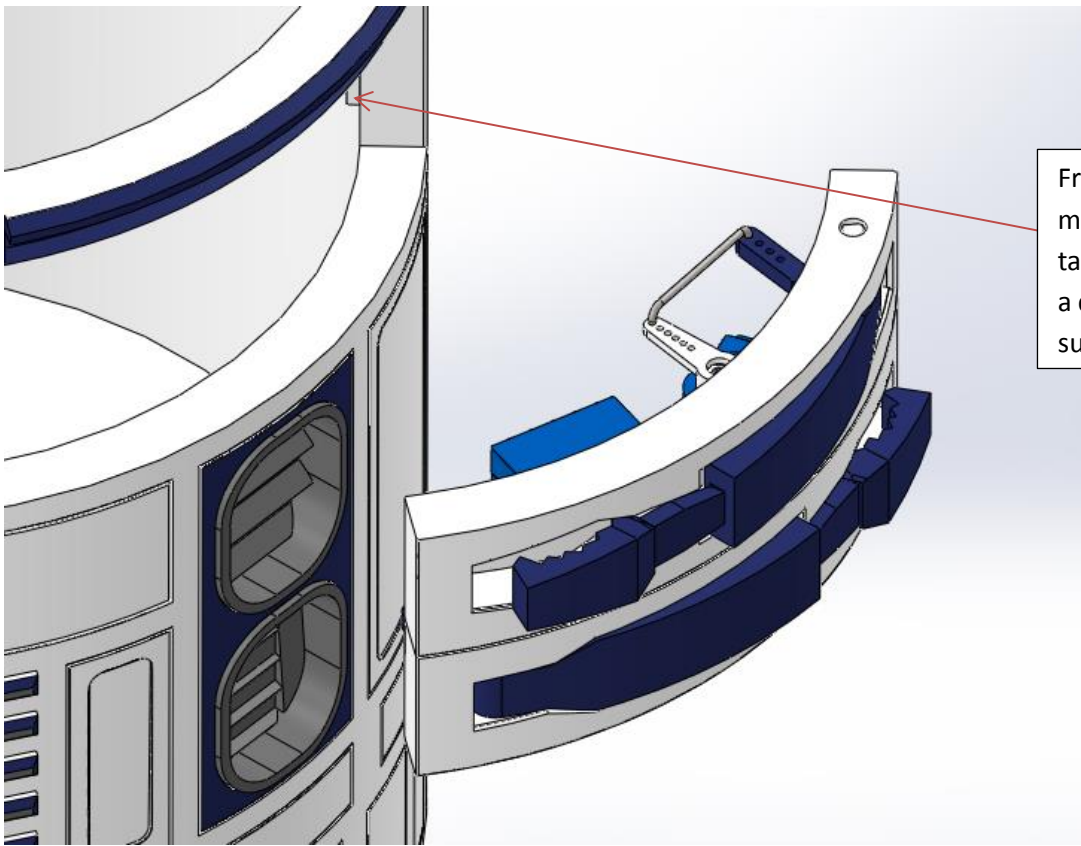Matthew Zwarts   Version 1.0

The center vent is just a press fit or screws from behind or a drop of glue
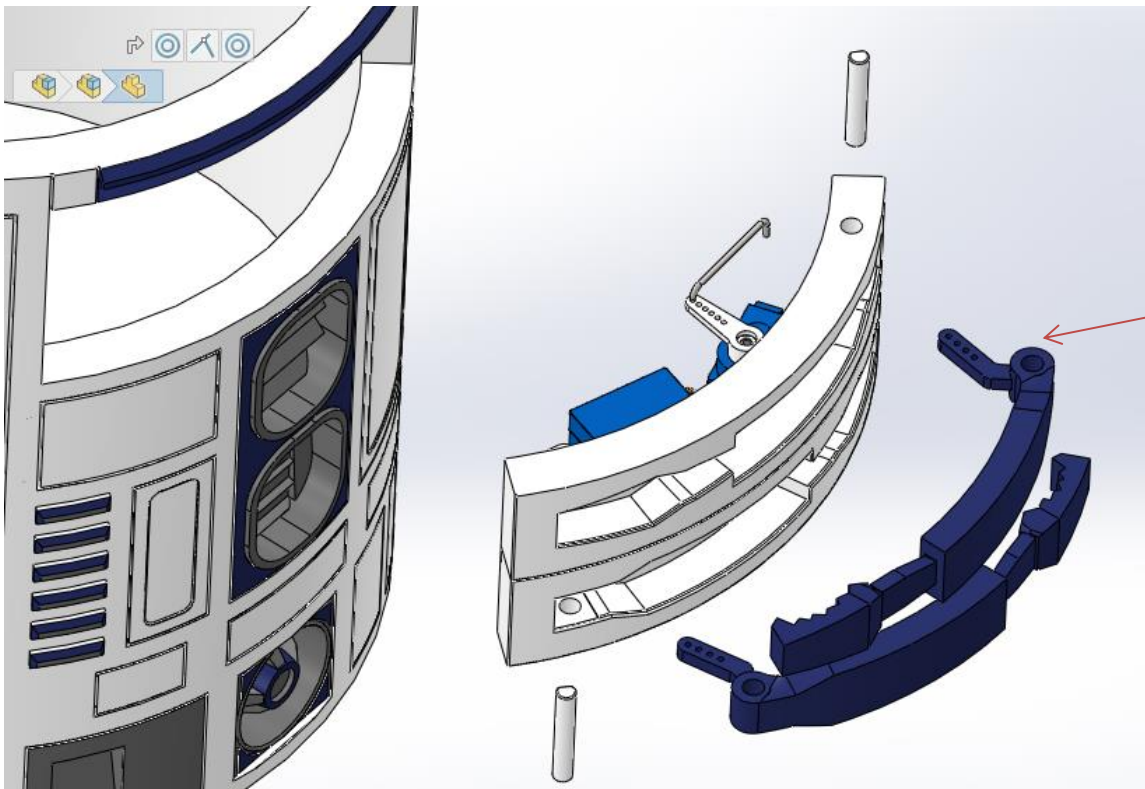
M6 x 25 bolts 3 off into the leg captive nuts.

The M4 x 35mm bolt screws in from the inside of the body through and into the top of the leg tie rod to anchor the ankle and stop the body tipping over in 2 leg mode

Matthew Zwarts   Version 1.0
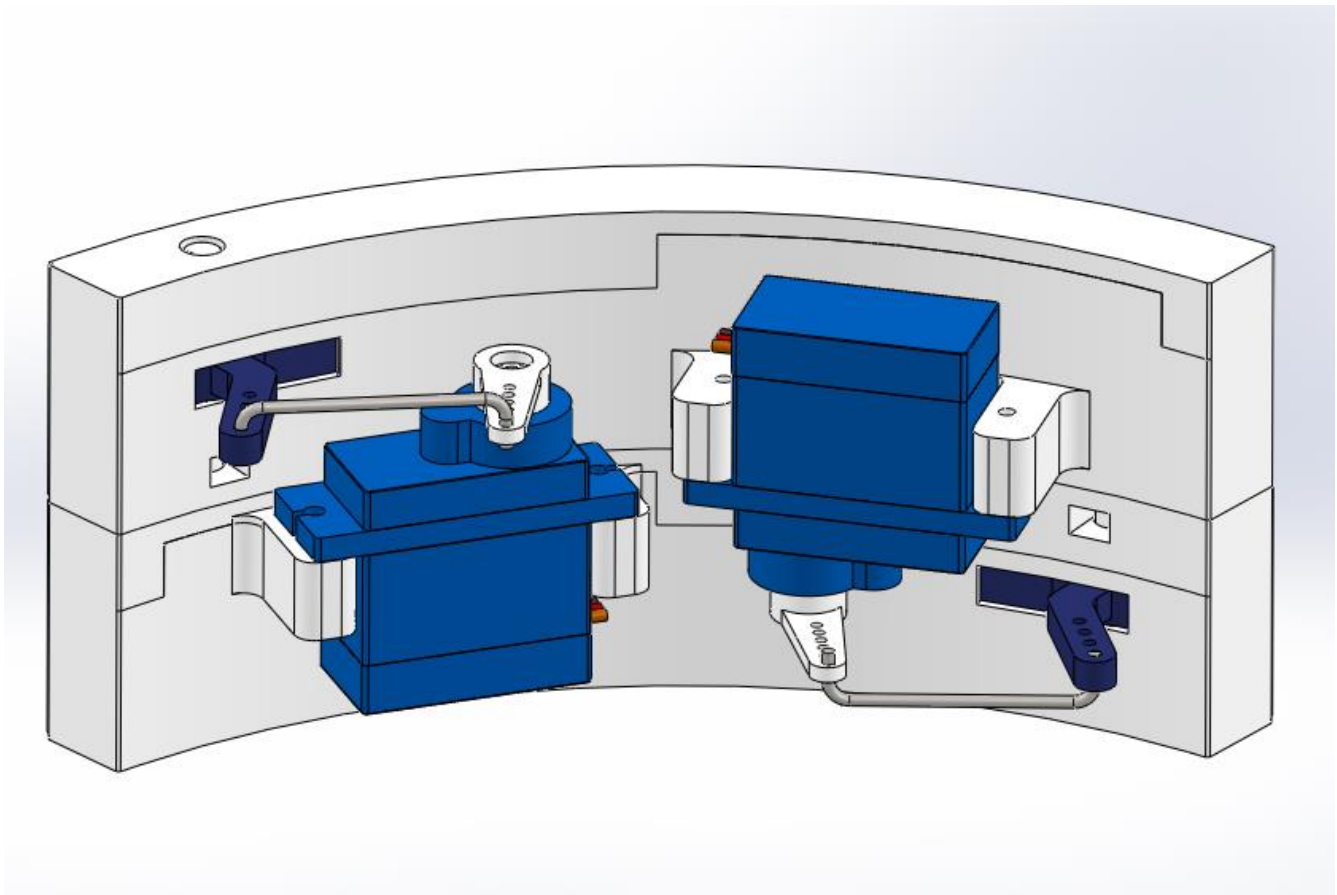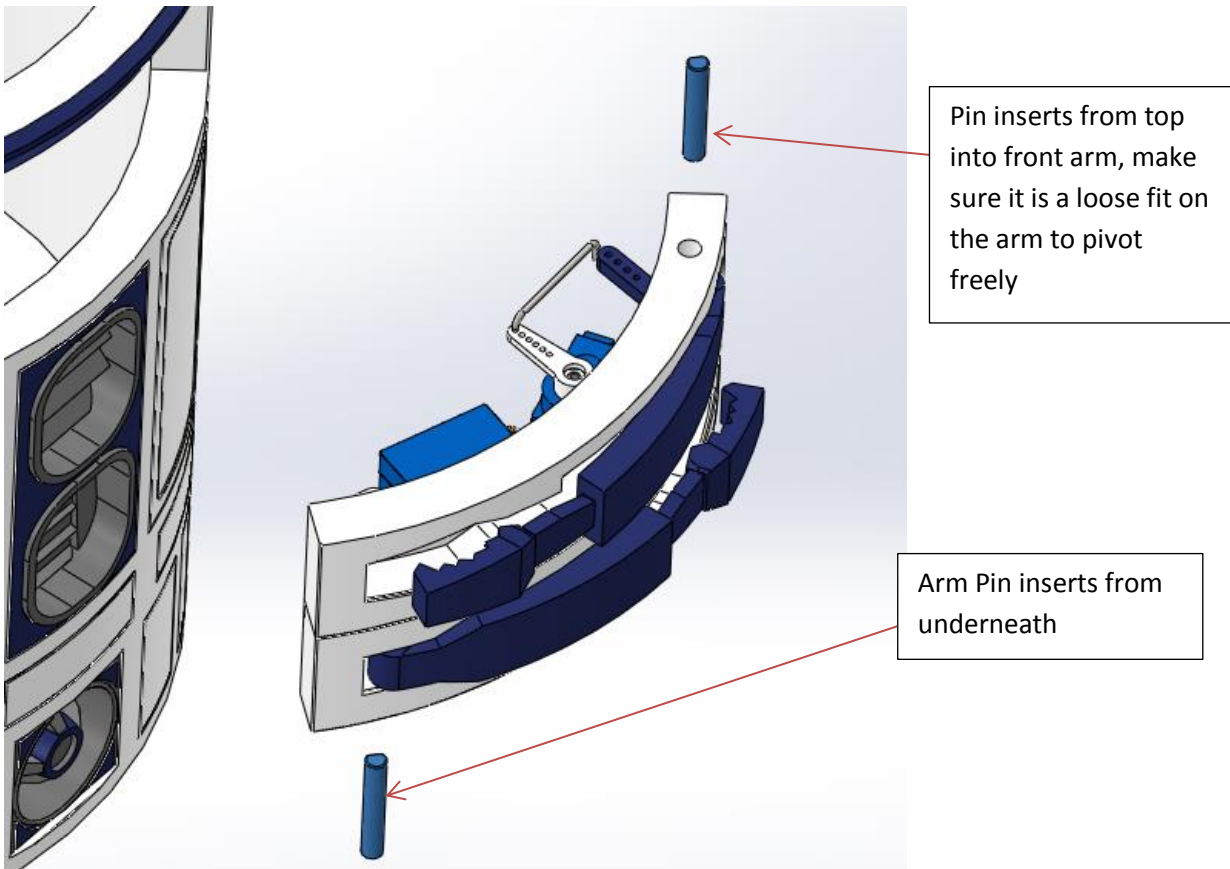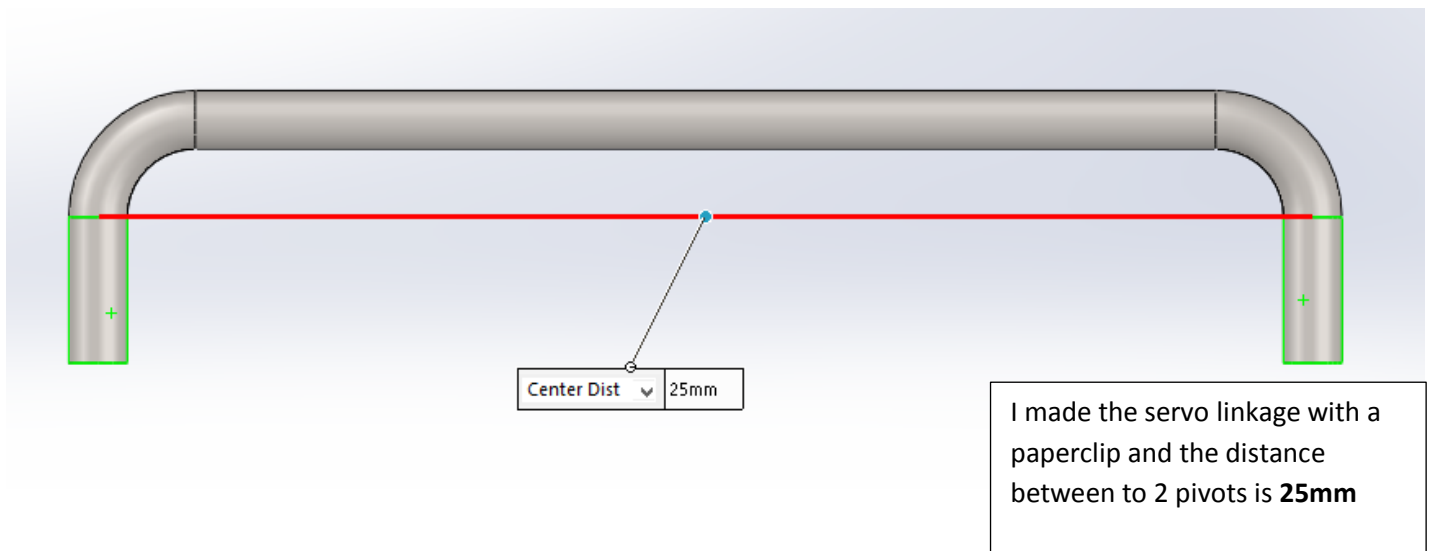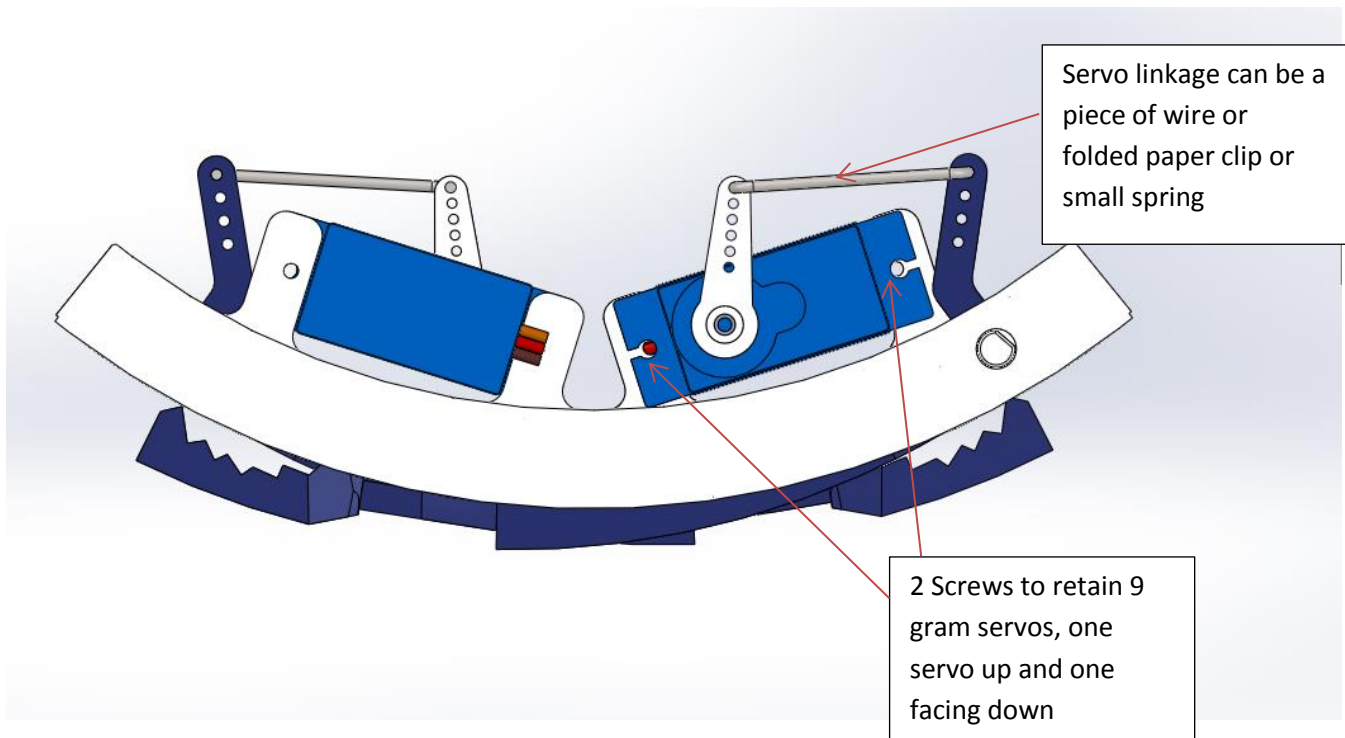
Front Arms

Front insert pushes into the main body up to 2 location tabs, I didn't use any glue. But a drop of hot glue would suffice.

Arms slot into front arm insert

Pin inserts from top into front arm, make sure it is a loose fit on the arm to pivot freely

Arm Pin inserts from underneath

Servo linkage can be a piece of wire or folded paper clip or small spring

2 Screws to retain 9 gram servos, one servo up and one facing down

Center Dist ⌄ 25mm

I made the servo linkage with a paperclip and the distance between to 2 pivots is **25mm**

Dome and Periscope

Small LED can be added and triggered from the PCA9685 board. Wires run up the periscope shaft
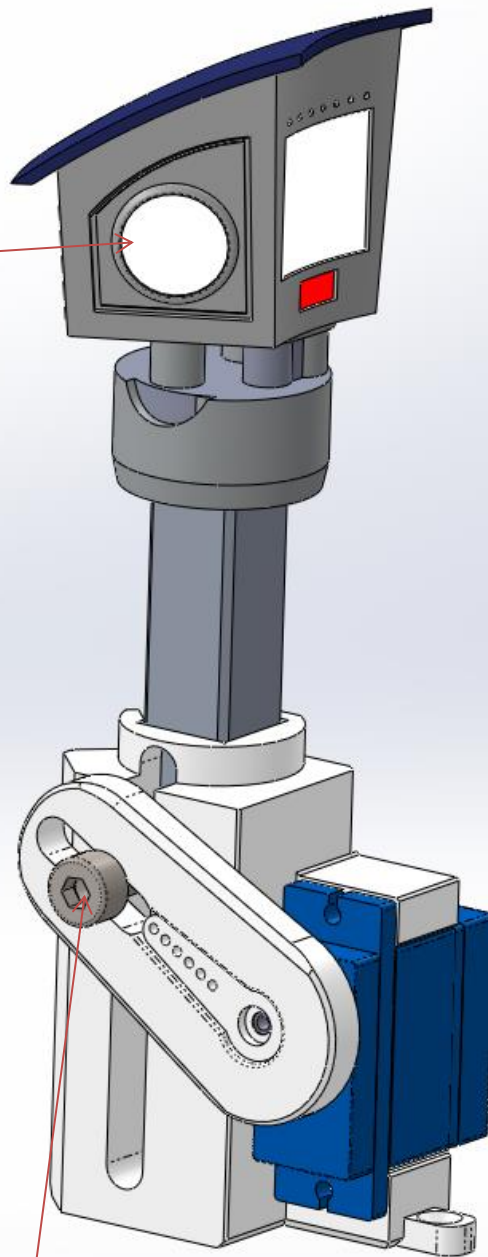
SG90 servo and servo horn attached to adaptor

M4 bolt into periscope shaft
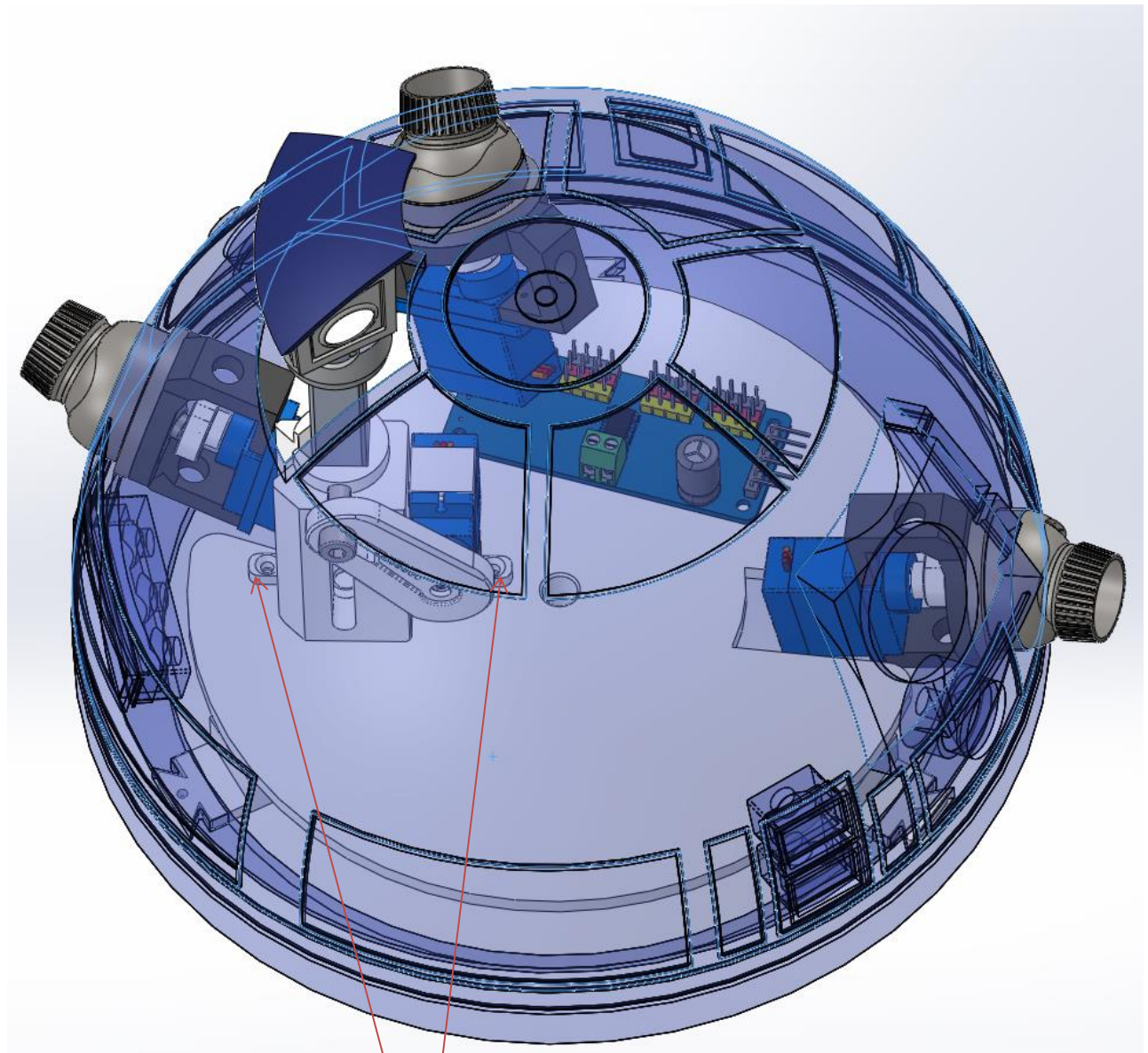
2 small screw holes locate the periscope in the correct position on the Dome Centre Spider, the PCA9685 can be located where shown for all the connections to servos and LED's