

NextGen Eye Kit

V1.0

Dennistries Ltd

dennistries.com

“At bottom, robotics is about us. It is the discipline of emulating our lives, of wondering how we work.”

-Rod Grupen

Law 1

A robot must never harm a human, or through inaction, allow a human to come to harm.

Law 2

A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.

Law 3

A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Isaac Asimov, 1942

Welcome to the exciting world of Robotics!

Robotics is an exciting field that is growing in importance. Slowly, robots have been entering into our lives, whether by building our cars, serving us drinks or even a robot lawn mower, robots are now everywhere.

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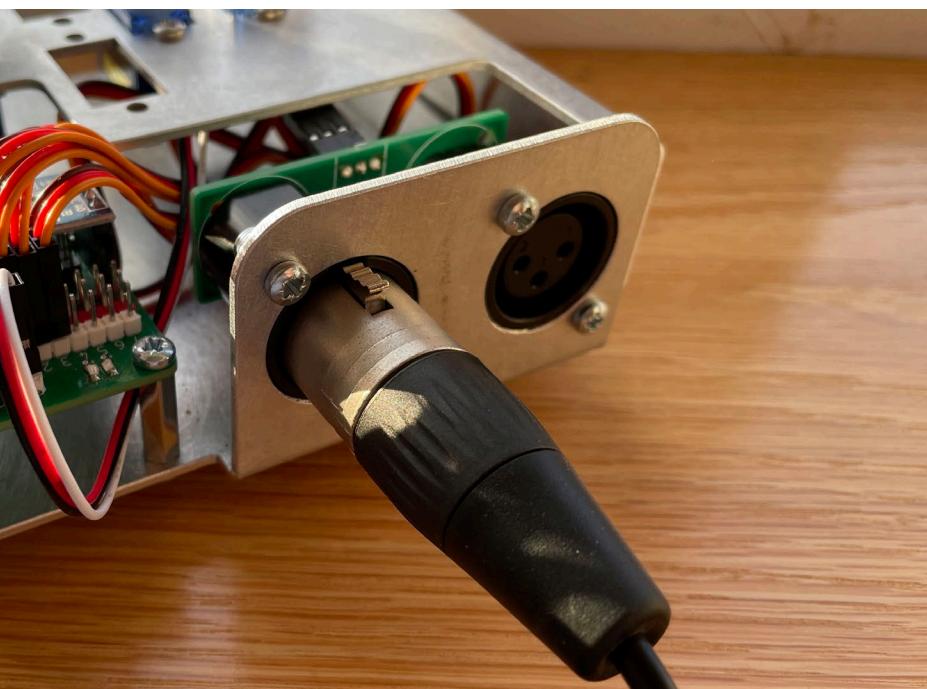
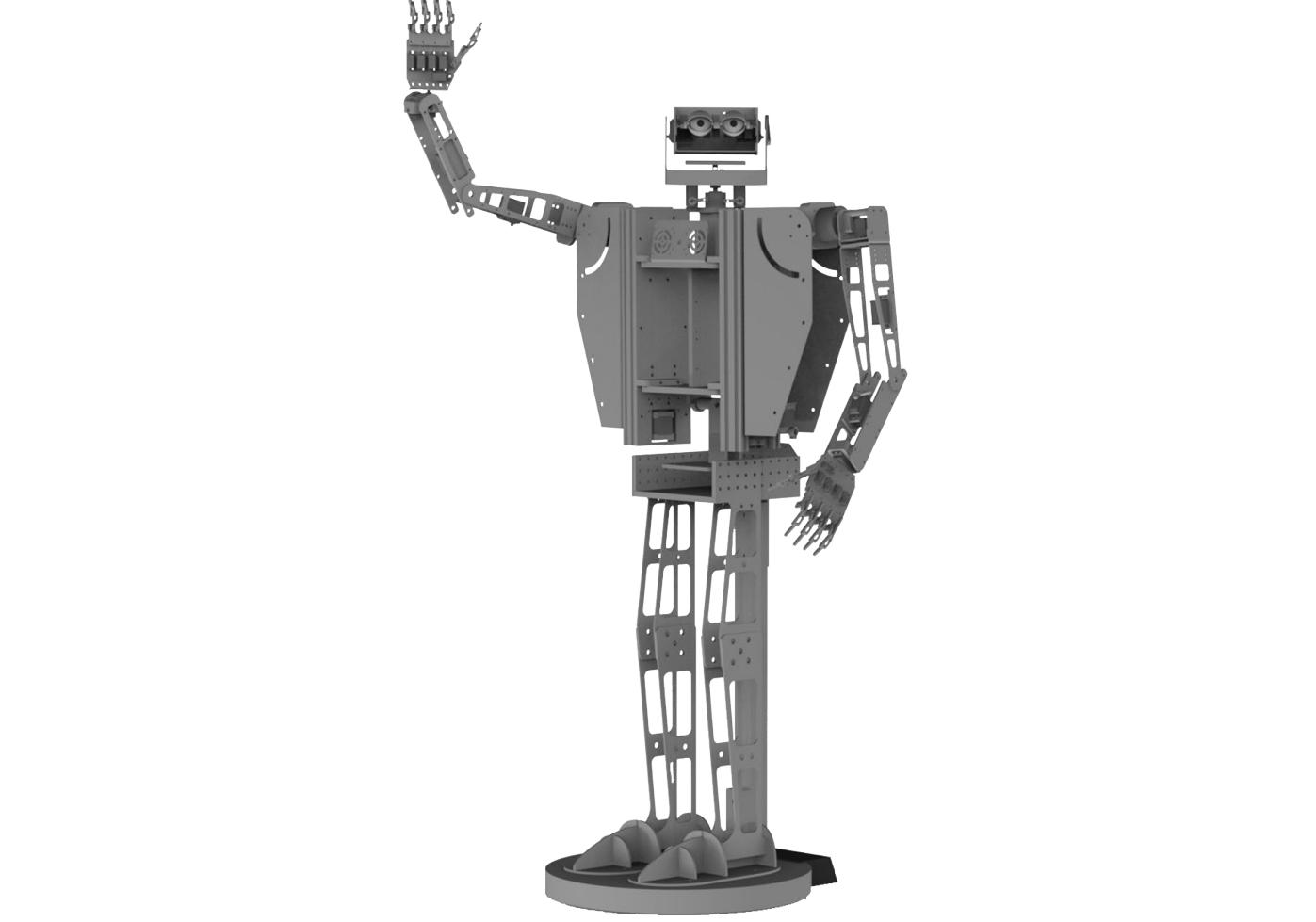
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NextGen Eye Kit

The NextGen Eye Kit brings the excitement of human like robotics to the table top in a small kit form. We have taken the eye module out of our world renowned GREG NextGen unit, put it together with a base, added some special electronics and turned it into a kit just for you, with no soldering or programming required.

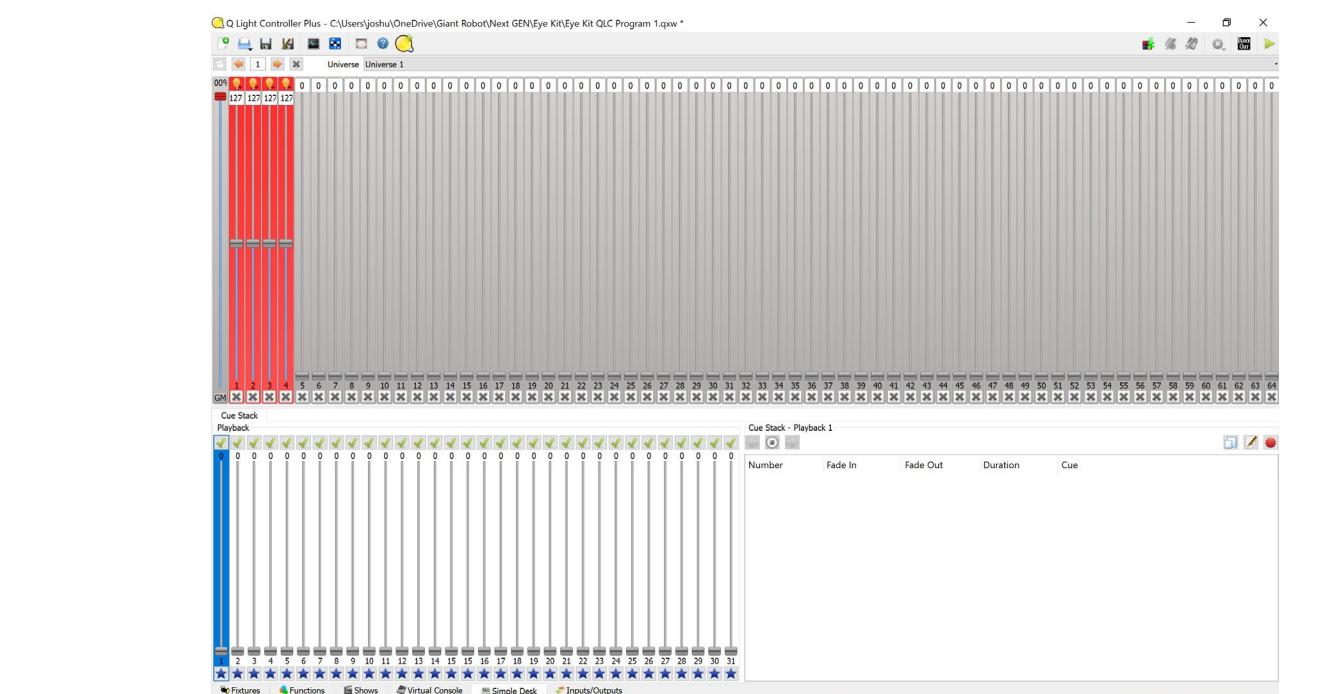
Throughout the construction of this kit you will begin to understand the basics of robotic mechanics, which is called 'mechatronics'. You will learn about how motors can move parts of a robot in a life like way, and then you will learn how to build shows using specialised show control software, just like Disney do with their Audio Animatronics.

Starting below, and continued on the next two pages, you will be introduced to the software protocol used to control this kit, DMX. You will then be introduced to some of the key parts of the kit. Following this we have the instructions to build this kit, and to control it, plus a section on how to take your projects further.



DMX

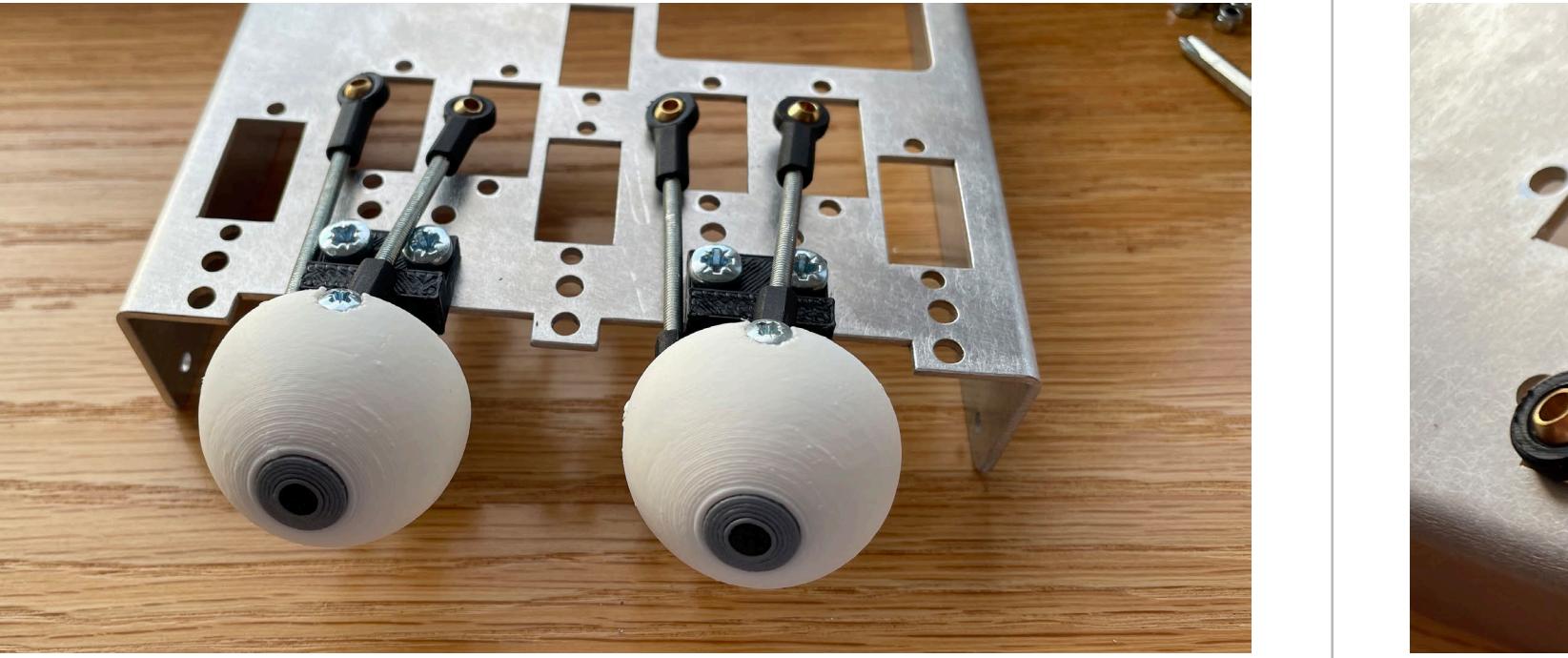
Digital Multiplex 512 (DMX 512, or just DMX) is a protocol based on RS485. The protocol, which can theoretically span a 1km long cable, is most commonly used for controlling disco equipment such as lighting. It sees a lot of use in the theatre industry for controlling lights, where in a single theatre the cable could loop around every light and not reach its maximum length. The '512' is because DMX can control up to 512 addresses in a single DMX 'universe', so an RGB light is three addresses, one for each colour. This can be a quick and easy way to control the unit, with the addresses mapped to the various motors. Each DMX receiving device will have two sockets, one for in, and one for out. Devices are then connected together in a long chain, with the controller at the start.





Servo Motors

Servo Motors are a special type of motor that allows for accurate positioning. Most motors have two cables, positive and negative. Servos have a third cable, a data cable. Servos can be set to a certain degree, as opposed to just spinning. Servos also come with 'Servo Horns' which enable parts to be screwed to the servo motor's shaft.



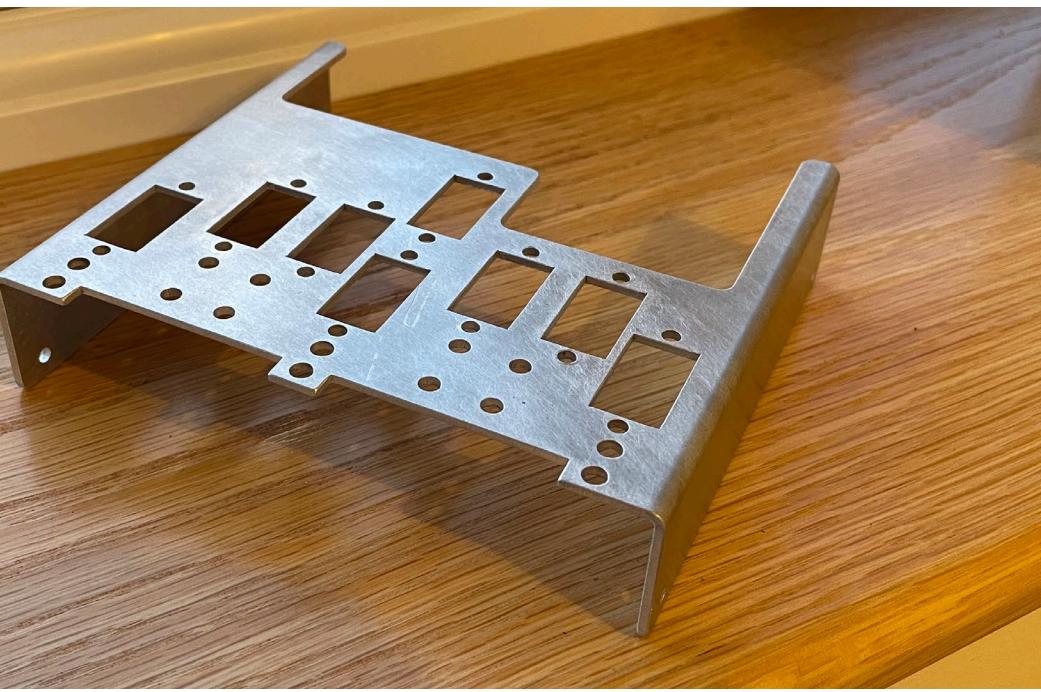
Eye Balls

The eyes for the unit are 3D printed in various colours to give the impression of an eye ball, an iris and a pupil. There are two mounting holes for pusher arms, one on the top, and one on the left (when looking at the eye from the front).



Lock Nuts

Lock nuts are very similar to normal nuts, but are slightly longer, with a blue nylon ring. When the bolt cuts into the nylon, it becomes much harder to turn the screw. This ensures the screw is locked in place. You will need to hold the lock nut with pliers when tightening. Bolts come in either M3 (for 3mm holes) or M4 (for 4mm holes) in this kit.



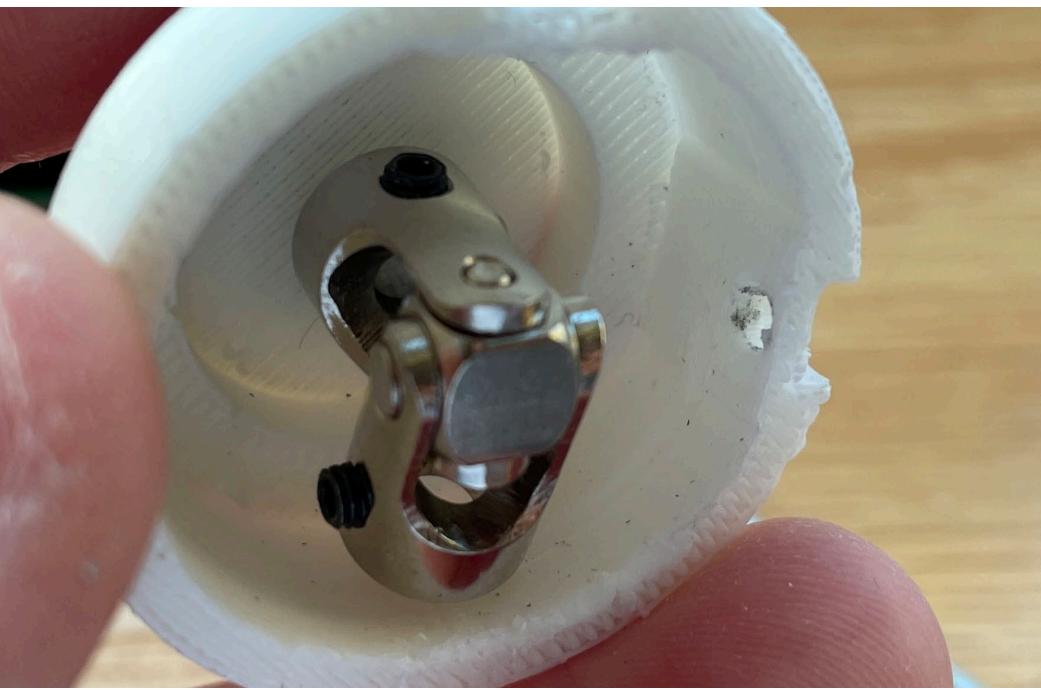
Main Assembly Top

The main assembly top is a folded aluminium component that allows for the mounting of the eye balls and the servo motors. It has cut outs at the back to allow for space for the circuit boards.



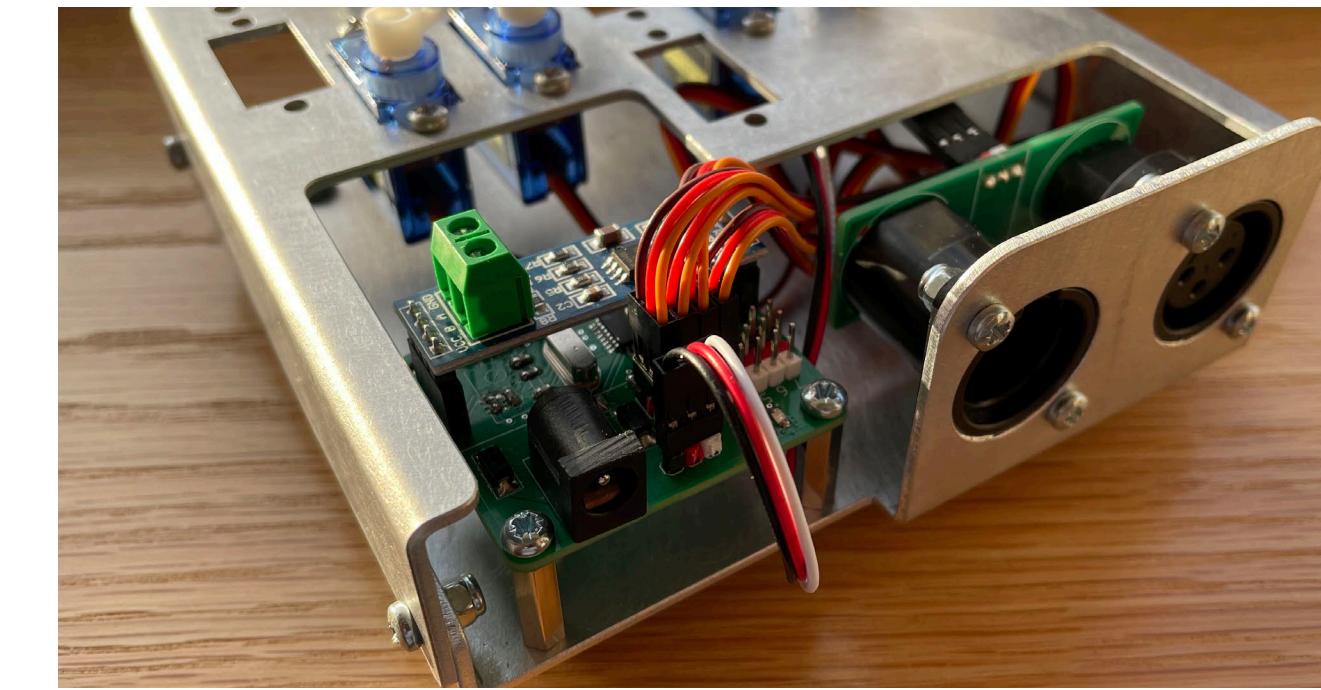
Main Assembly Base

The main assembly base has mounting holes for the main circuit board and the DMX interface, along with the rubber mounting feet.



Universal Joints

Universal Joints are mounts that allow parts to be moved in two axis of motion. These are used to allow the eyes to move up and down, and left and right, but do not enable forward and backward motion.



Circuit Boards

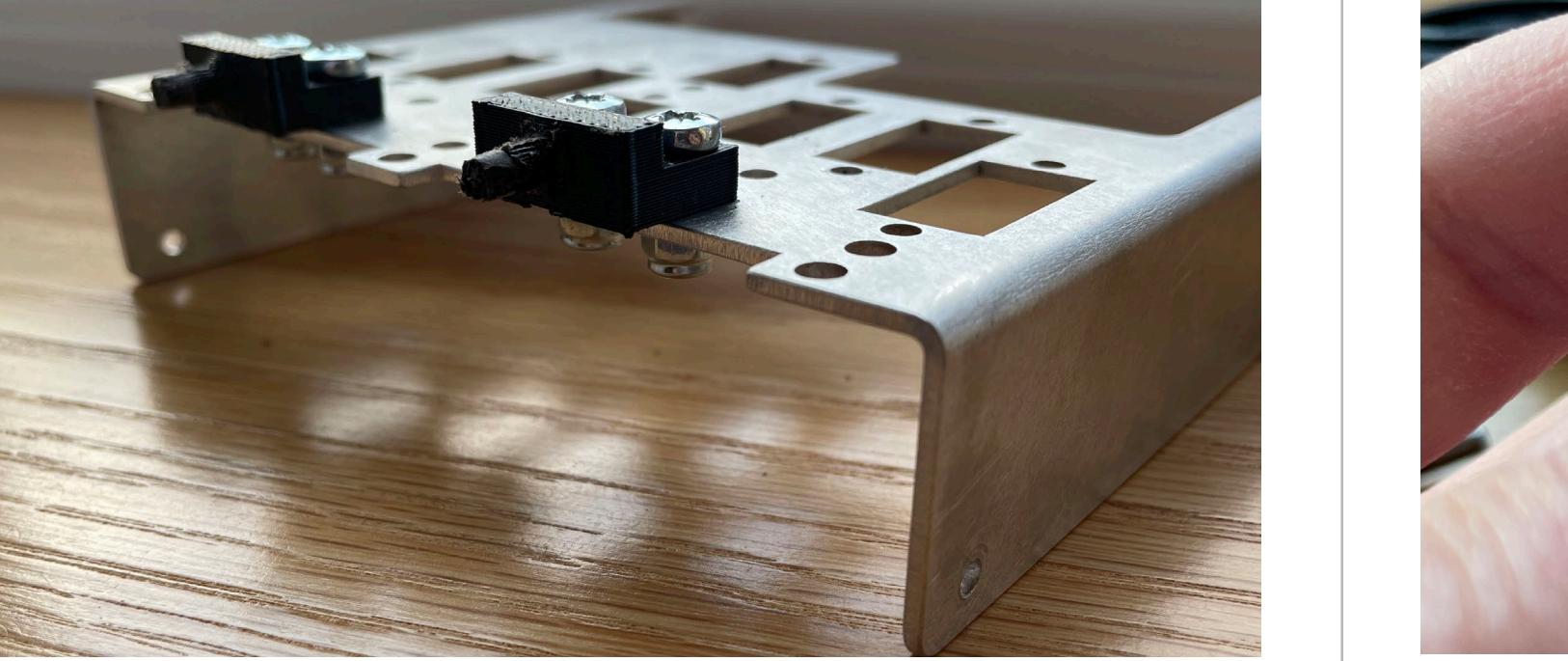
There are two circuit boards in this kit, the first is the Main Controller, which is mounted on three stand-offs, and the DMX interface, which is screwed into the folded aluminium part of the main assembly base.

It's time to build!

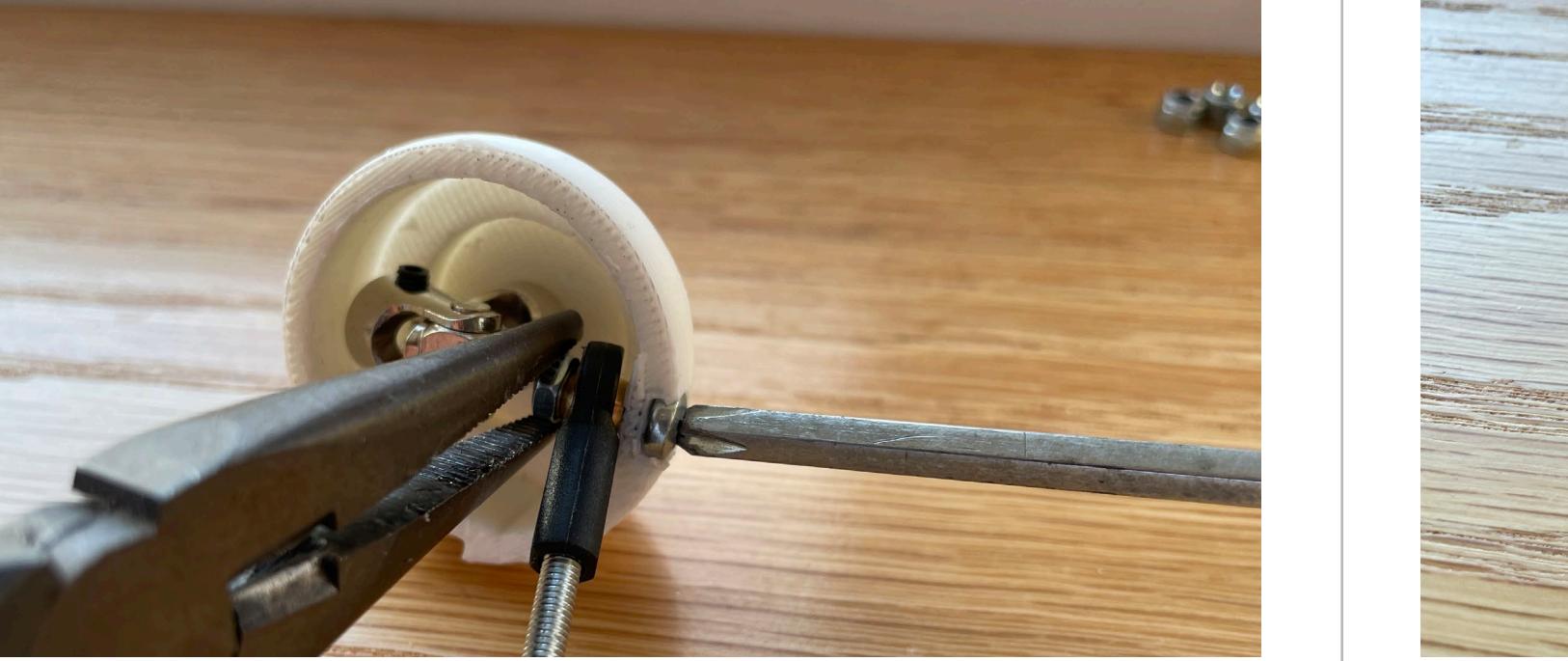
Clear a space where you can construct the product. The box contains numerous parts in bags. Be sure not to mix the parts, as some look similar to others.

x8 No4x6.5mm Self tapping screws	A x4 Servo Motor Sets	H
x6 M3x6mm Machine Screws	B x2 Eye Balls	G
x4 M3x8mm Machine Screws	C x2 Eye Mounts	F
x8 M3x10mm Machine Screws	D x1 Control Circuit	I
x4 M4x6mm Machine Screws	E x1 DMX Interface	J
x4 M4x12mm Machine Screws	F x1 Connector Cable	I
x3 M3x16mm Stand-offs	B x1 Main Assembly Base	IN BOX
x2 Universal Joints	E x1 Main Assembly Top	IN BOX
x4 M3 Nuts	D x1 Power Supply 5V 3A	IN BOX
x4 M3 Lock Nuts	C x1 DMX Cable	IN BOX
x4 M4 Lock Nuts	F x1 Screw Driver	IN BOX
x2 Eye Pusher Arms Horizontal	D x1 Pliers	IN BOX
x2 Eye Pusher Arms Vertical	A x1 Allen Key	G
x2 Rubber Feet	G x2 Zip-Ties	G

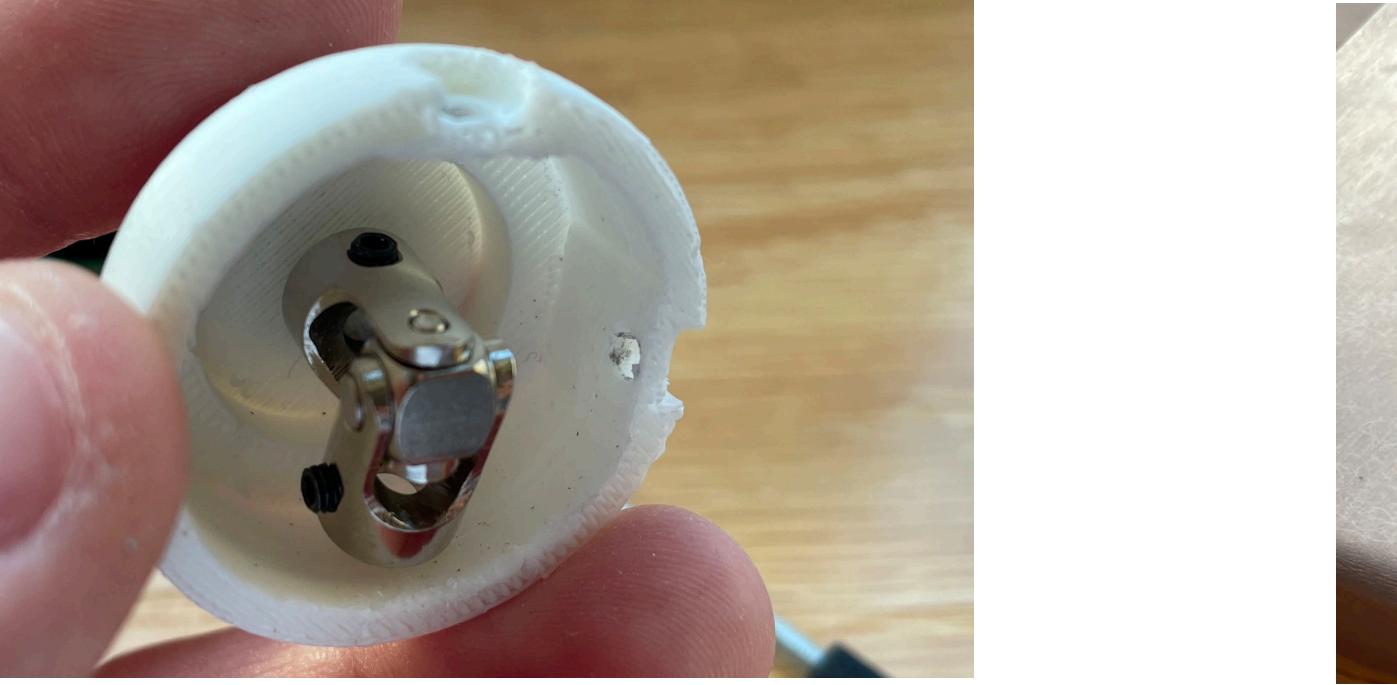




Firstly, fit the eye mounts onto the Main Assembly Top, making sure to have these the correct way around. To fix into place, place four M4x12mm Machine Screws through the Eye Mount holes, through the corresponding holes on the Main Assembly Top, and then secure into place using four M4 Lock Nuts. You will require both the pliers and the screw driver for this step.



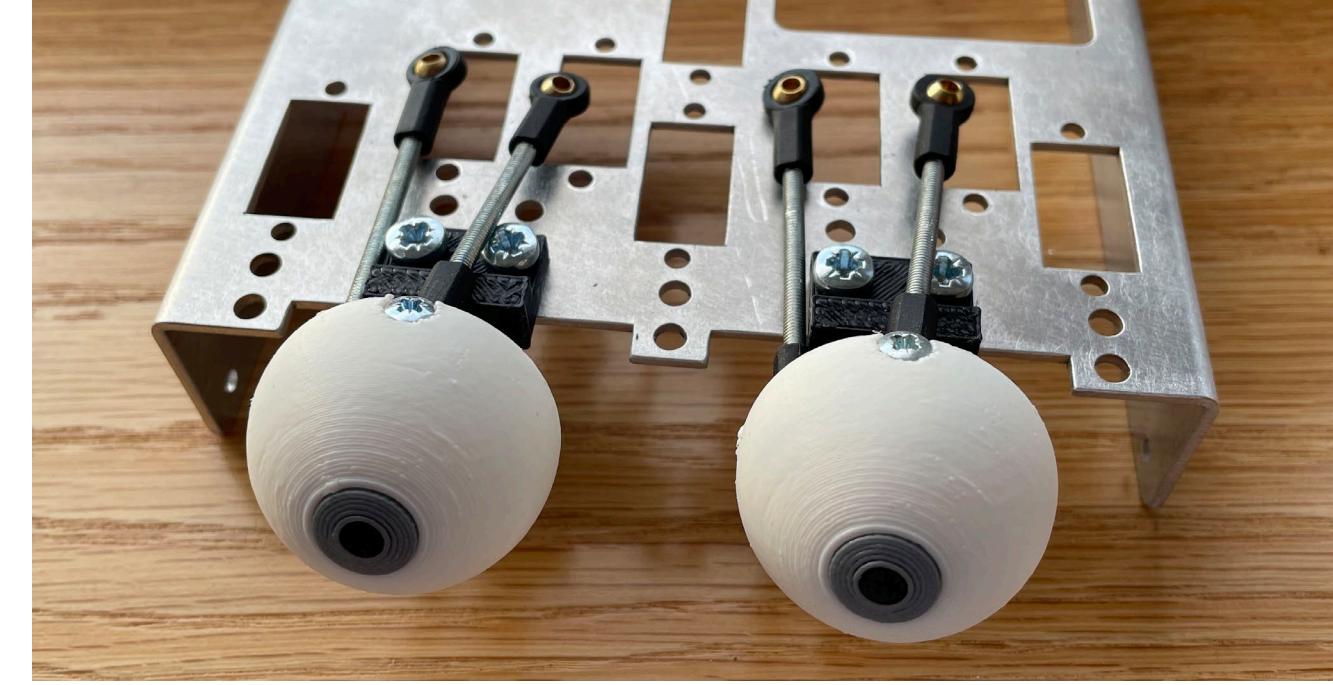
Once this is completed, carefully screw a M3x10mm Machine Screw through the top hole in the Eye Ball, and insert one Eye Pusher Arm Vertical onto the screw. As you turn the screw and it advances down, place a M3 Nut on the end. Hold this in place using the pliers, and finish tightening with the screw driver. Be careful not to tighten the screw too much or turn it too fast as you could damage the eye.



Next, take one Eye Ball and one Universal Joint. Carefully insert one end of the Universal Joint into the Eye Ball, and secure it in place using the Allen Key.



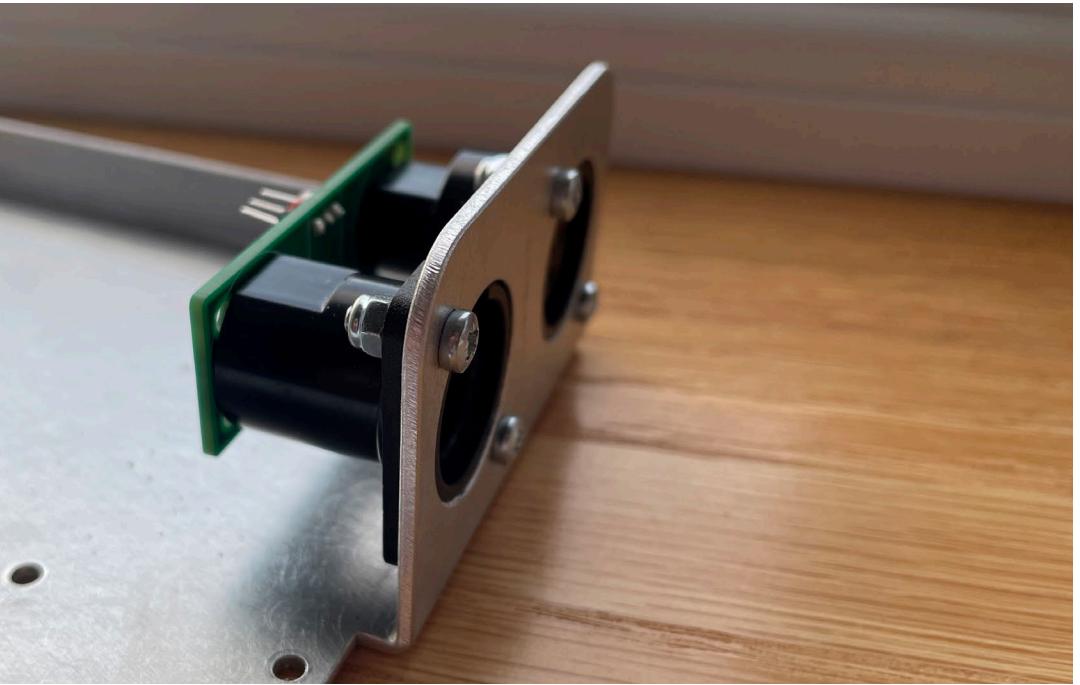
Carefully insert the other end of the Universal Joint onto one of the Eye Mounts you previously fixed to the Main Assembly top part. Once in place, tighten the grub screw in the Universal Joint using the Allen Key.



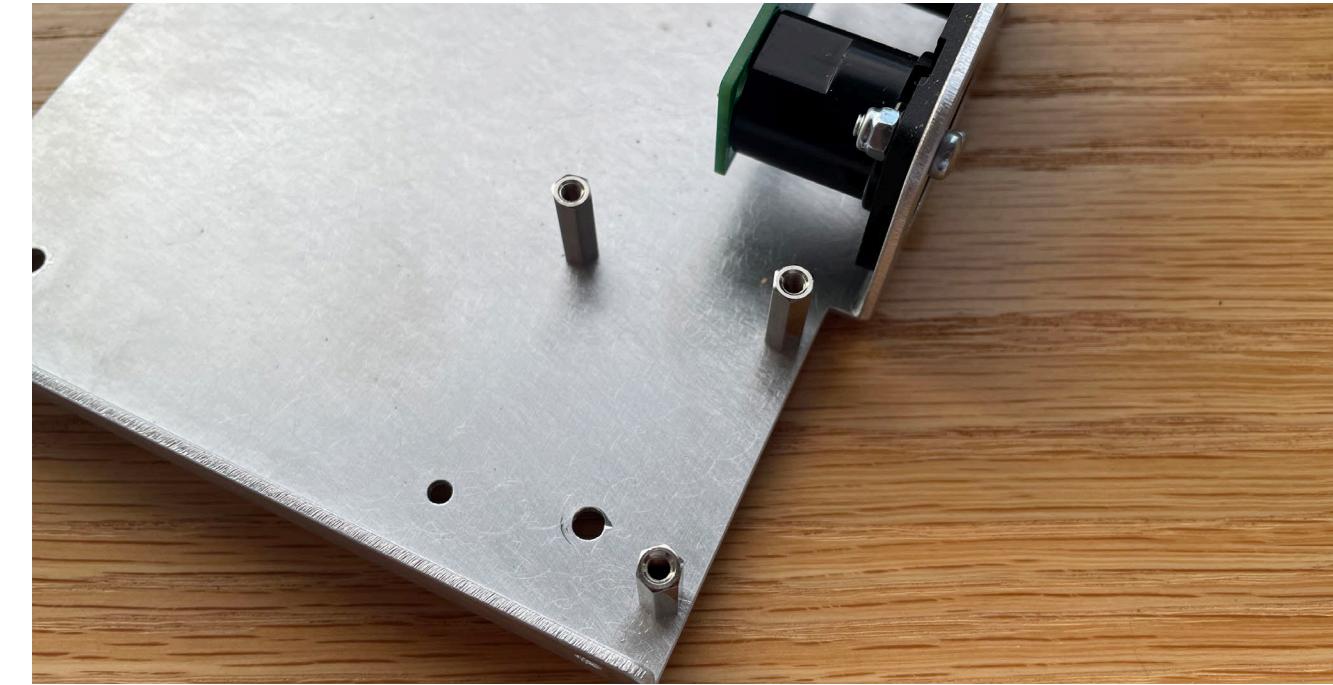
Repeat the last four stages with the other Eye Ball.



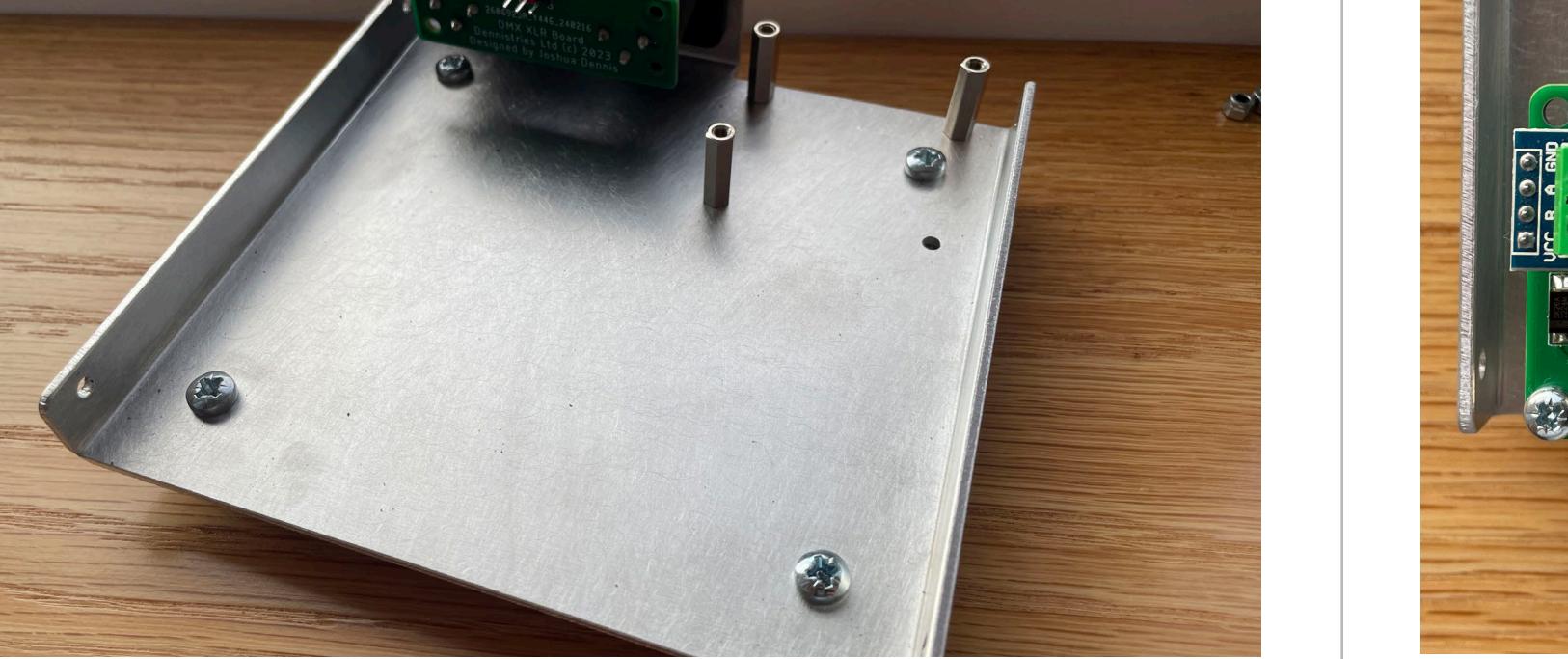
Repeat the last step with on the side hole on the same Eye Ball using one Eye Pusher Arm Horizontal.



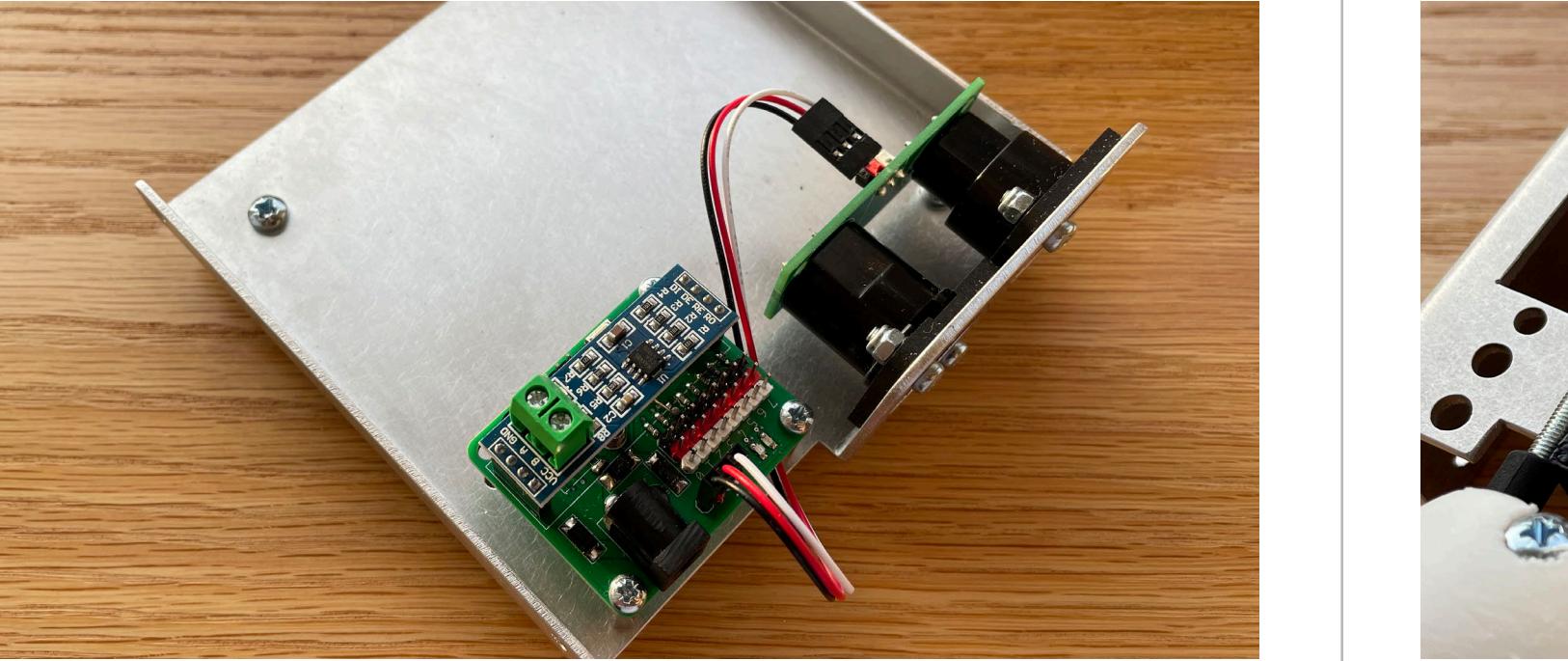
Place the Main Assembly Top to the side for the moment and pick up the Main Assembly Bottom and the DMX Interface Board. Using four M3x10mm Machine Screws, four M3 Lock Nuts, the pliers and screw driver, secure the DMX Interface Board into the back of the Main Assemble Bottom.



Next, take three M3x6mm Machine Screws and three M3x16mm Stand-offs and fix these into three smaller holes next to the DMX Interface mount. These can be fix on using just the screw driver, as they only need to be finger tight.



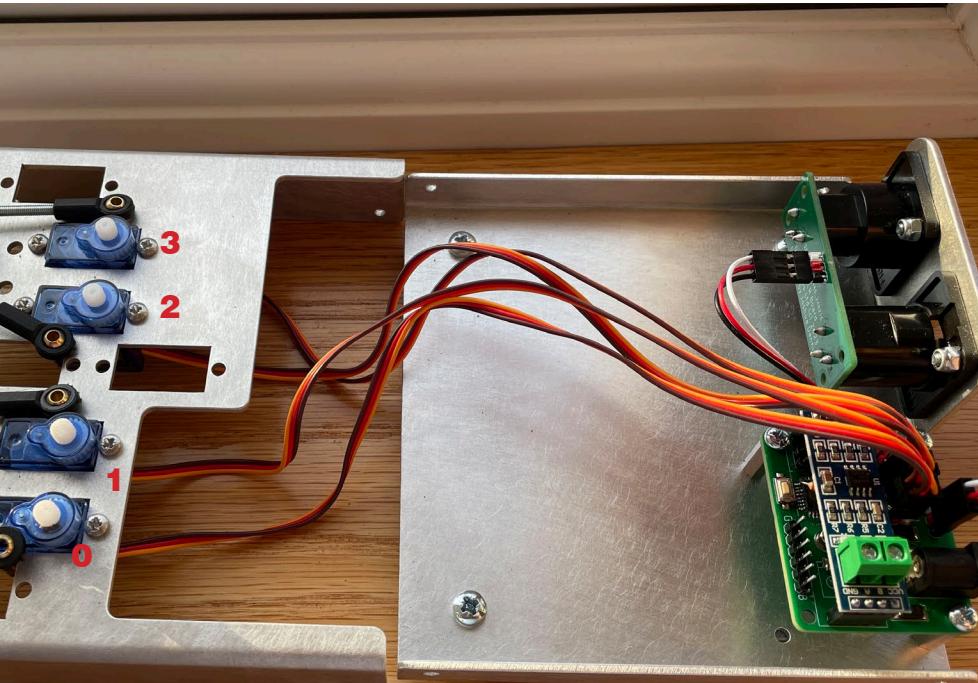
Using four M4x6mm Machine Screws, fix the rubber feet to the Main Assembly Base. To fit these correctly, screw each part in loosely first, and then tighten all four screws to ensure a correct fit.



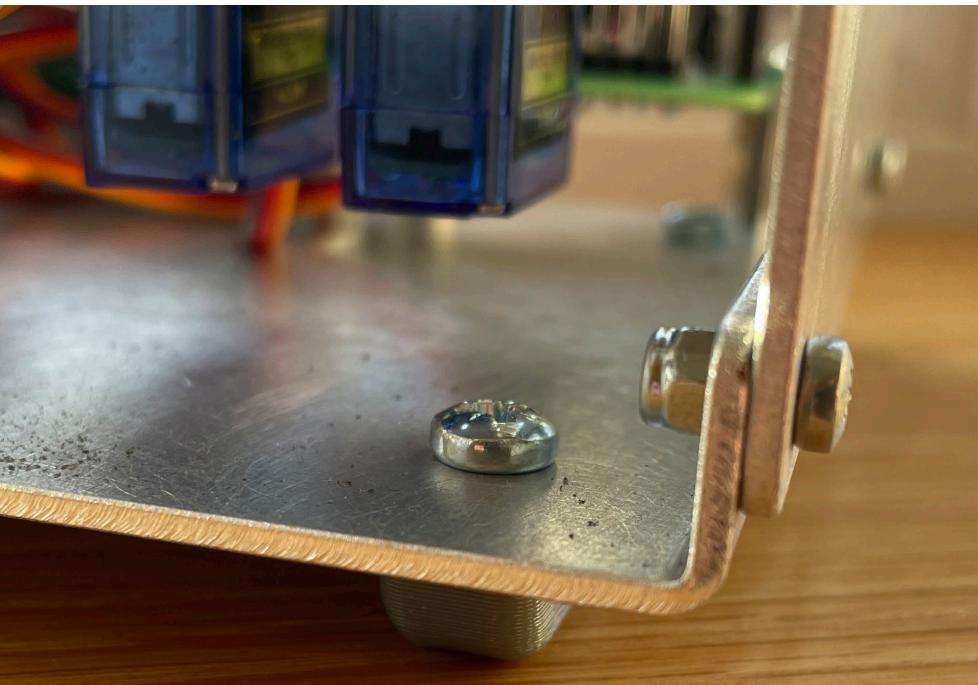
It is now time to connect the two circuit boards together. For ease, connectors have been colour coded. There is a single three pin, Black, Red, White connector on the Control Circuit, next to the power socket. Connect one end of the connector cable into this connector, ensuring the colours line up. Thread the cable under the Control Circuit, and then connect it to the matching connector on the DMX Interface Circuit.



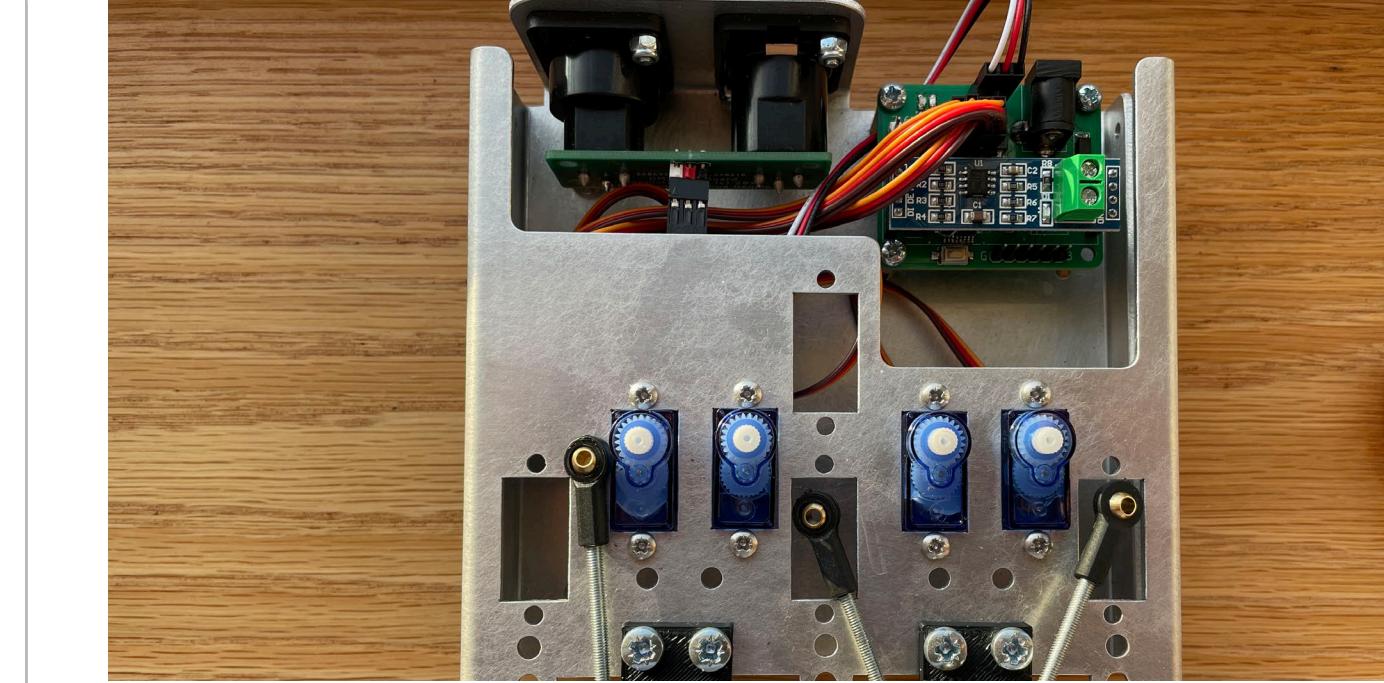
Using the remaining three M3x6mm, secure the Control Circuit to the top of the M3x16mm Stand-offs, ensuring the power socket is facing out of the Assembly.



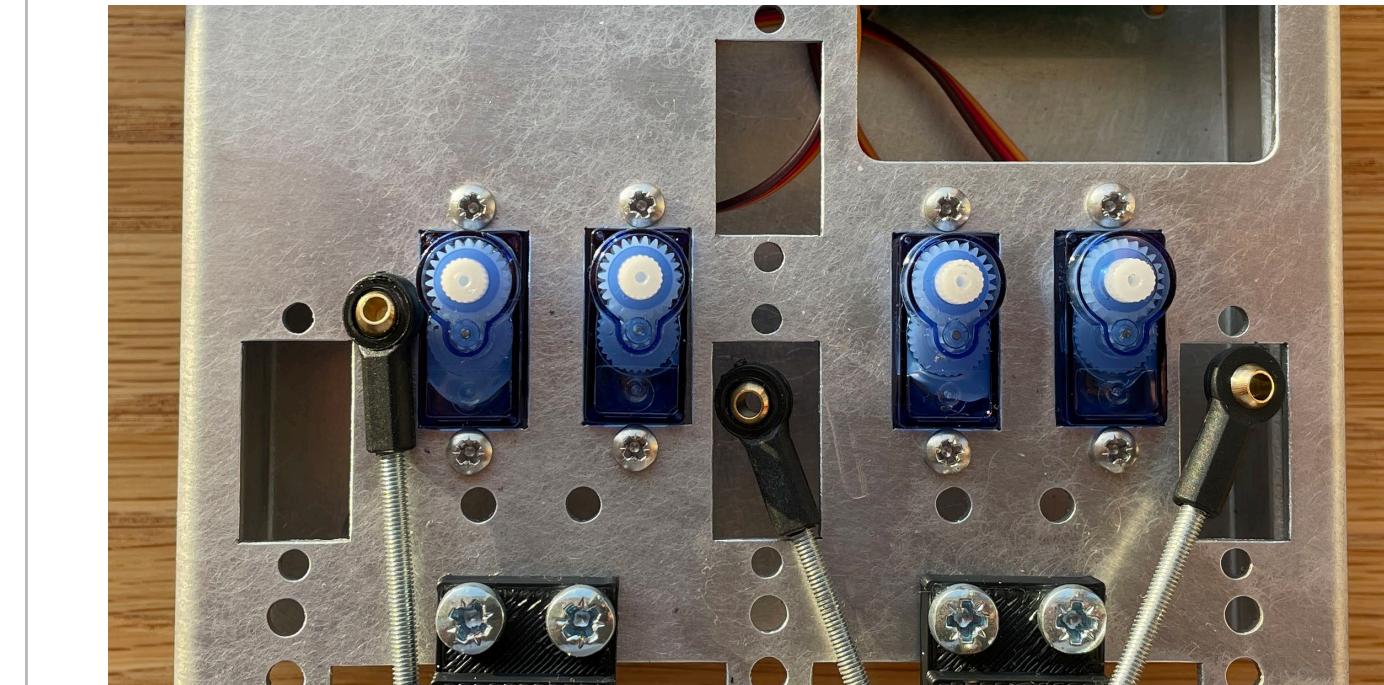
It is almost time to connect the two halves of the kit together. Firstly, we must connect the servos to the Control Circuit. There is a line of Black, Red, White connectors on the Control Circuit, labelled 0-7. Connect the servos to this circuit in the order shown above. The brown servo wire connects to the black pin off the connectors on the Control Circuit.



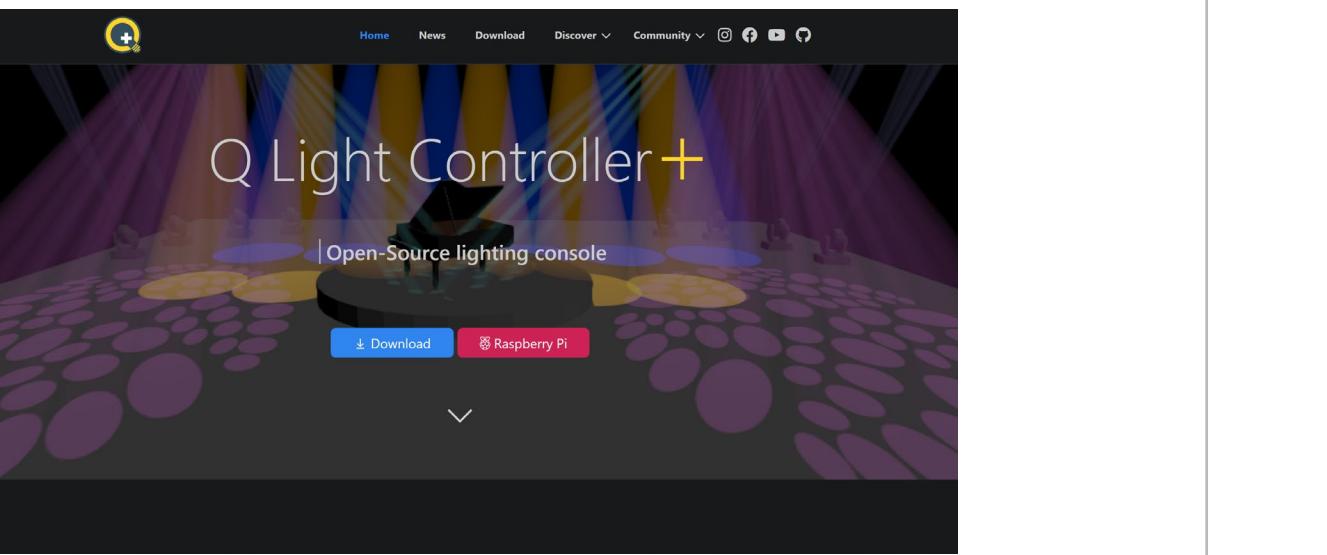
Using four M3x8mm Machine Screws and four M3 Lock Nuts, secure the two parts of the assembly together with the holes in each corner.



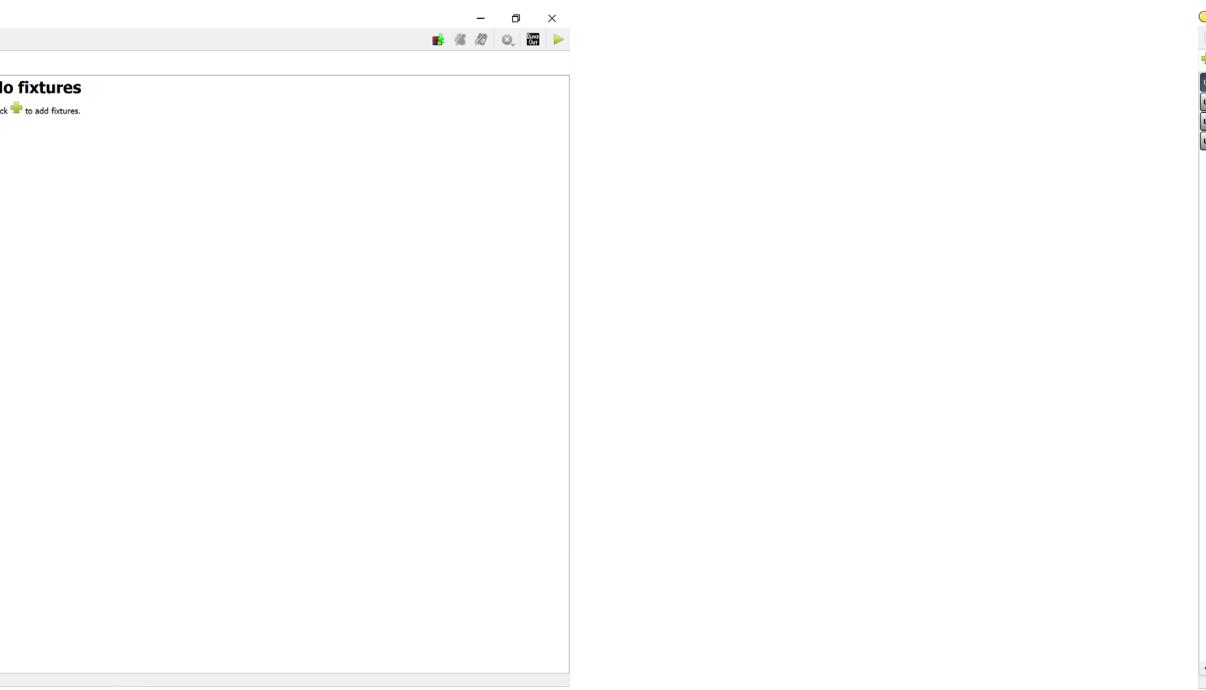
Once all the servo cables have been connected, bundle them together and use a zip-tie to hold them in place. Push the cables to the side, behind the DMX Interface, and slide the Main Assembly Top over the Main Assembly Base.



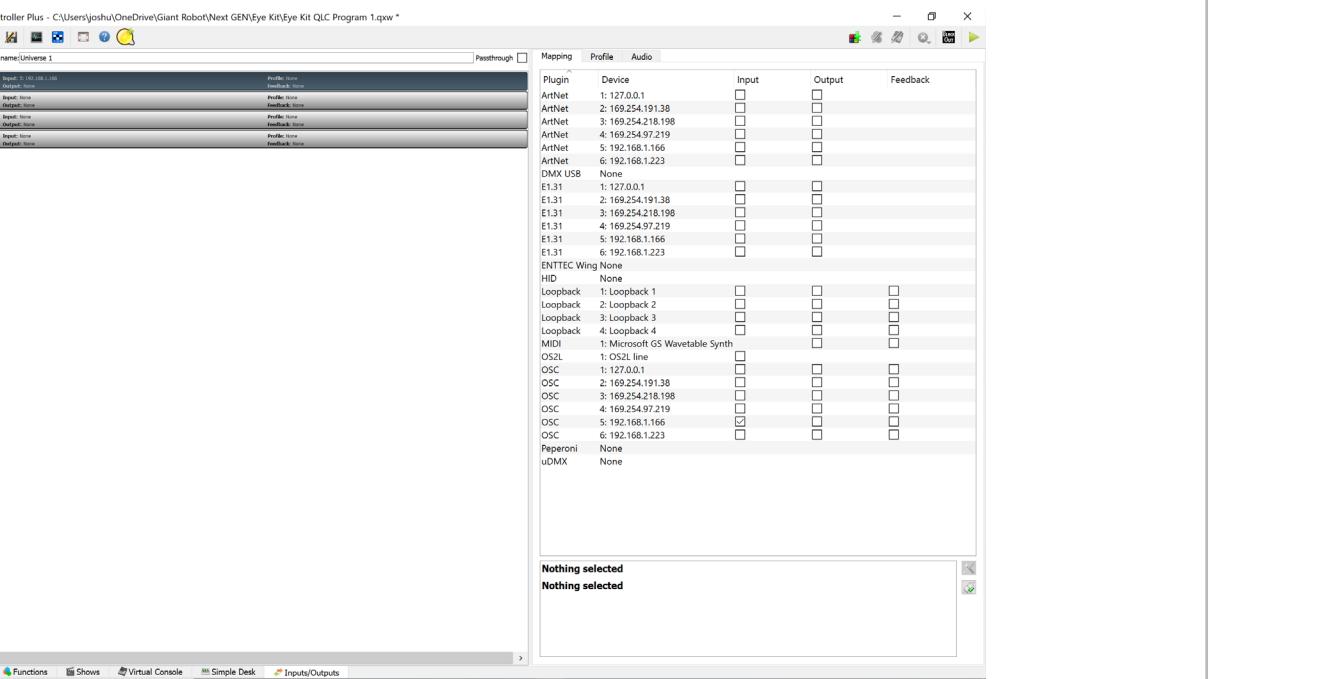
You have now nearly completed the assembly. The next stage will be to connect the eyes to the servo motors. To do this we need the motors to be in the correct position, and we will do this using the control software. The next steps will guide you through downloading the software 'Q Light Controller Plus' (QLC+).



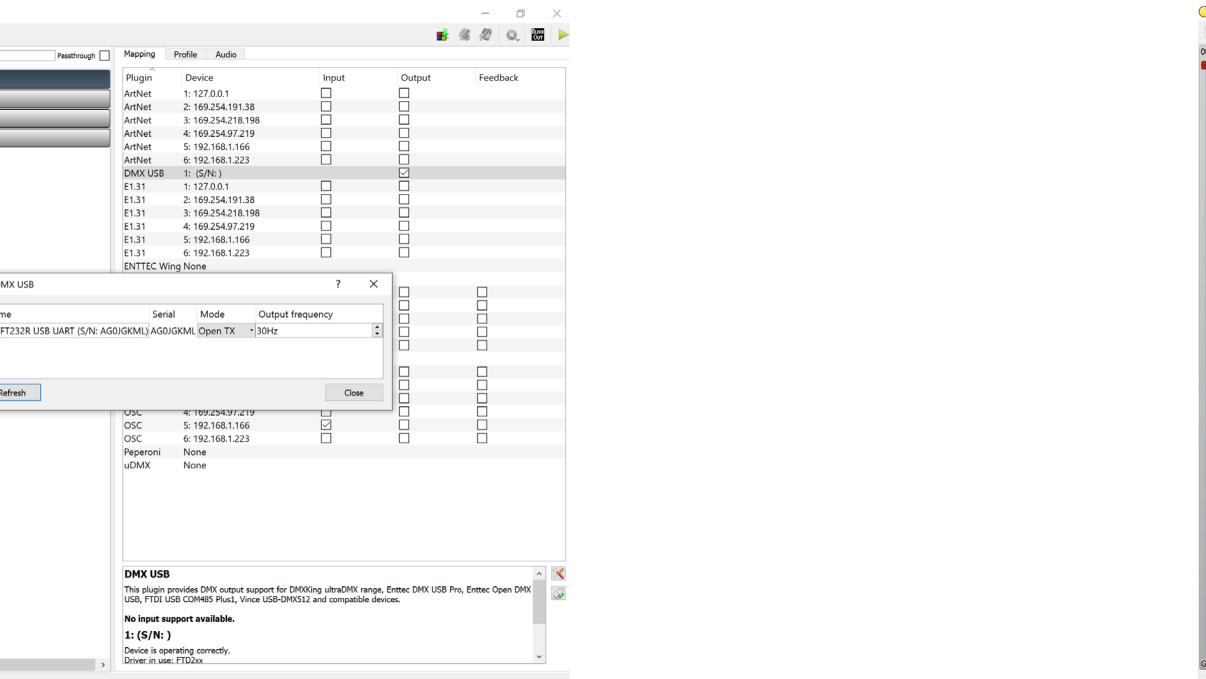
Go to the website <https://qlcplus.org/> and follow the download steps, including the download wizard. If you are constructing this as part of a school or university project, speak to your teacher regarding the downloading of the software.



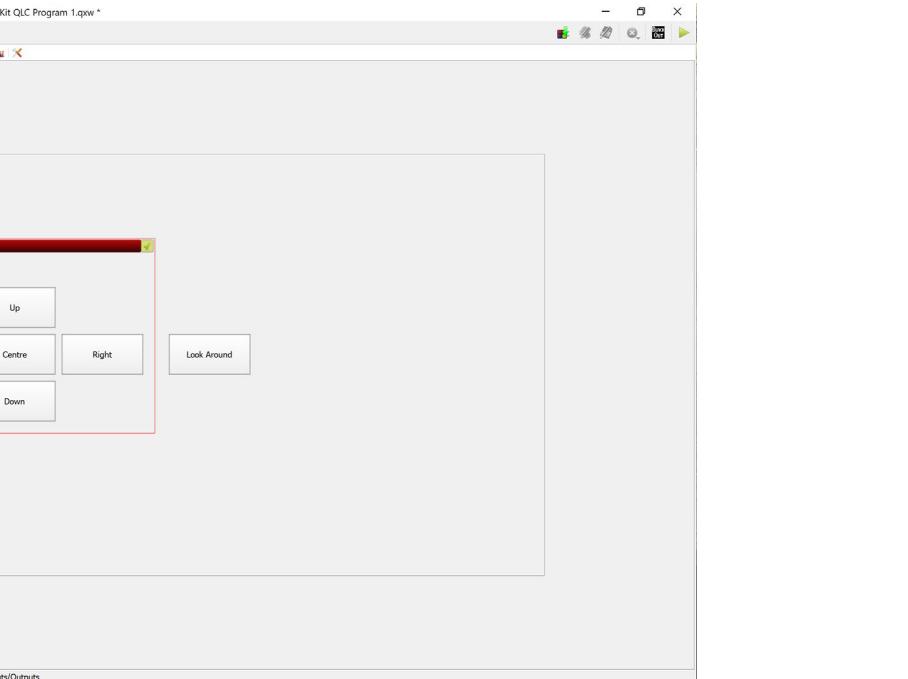
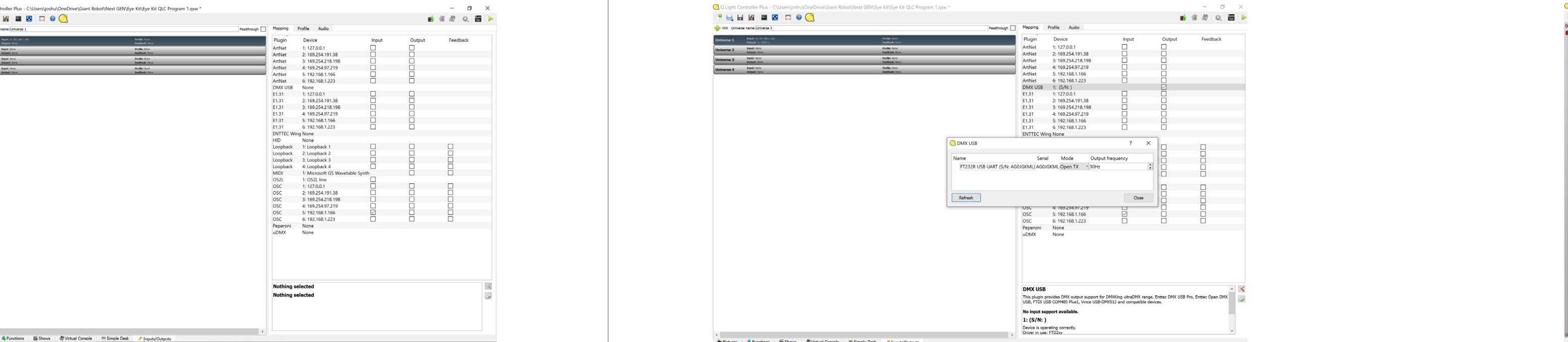
When you open QLC+, you will be greeted by this page. Click the 'open' button and open the program you would have downloaded with this manual. If you are constructing this as part of a school or university project, speak to your teacher as to where to find this program.



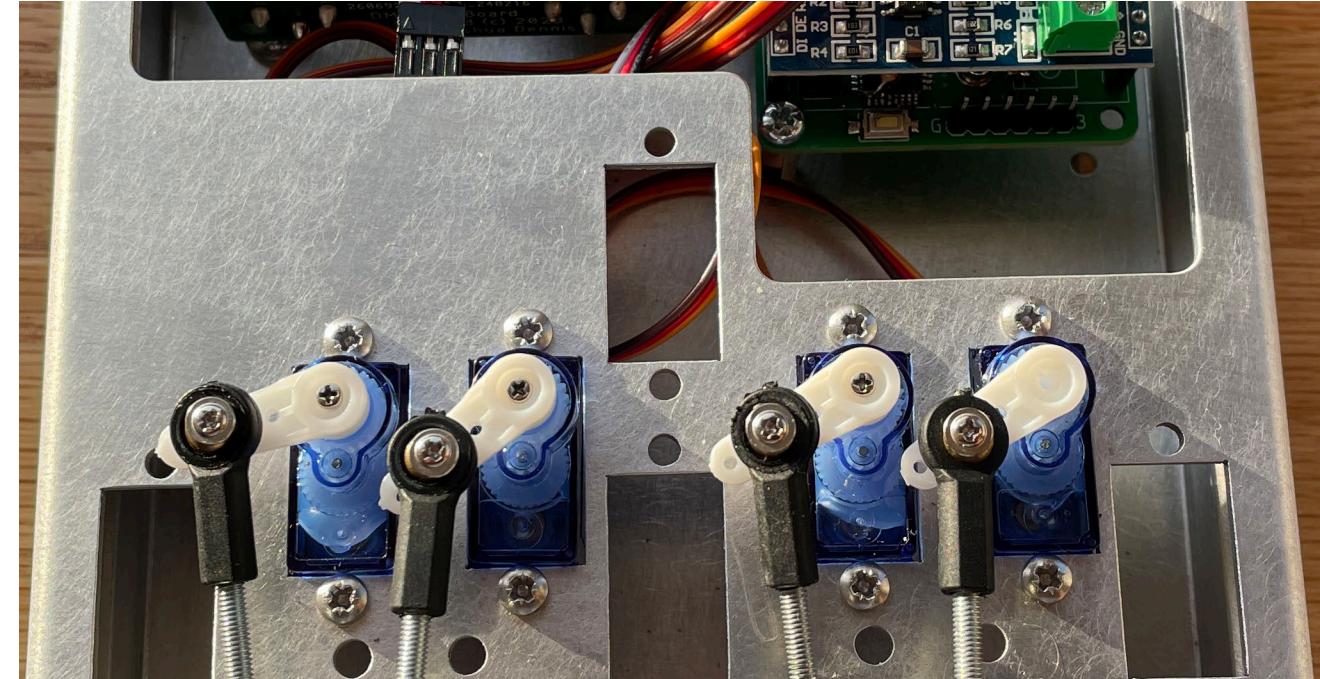
At the bottom of the window, click on the Inputs/Outputs button which will bring up this window. Next, connect the DMX Cable into a USB port on your computer. Double click on the 'DMX USB' line on the 'Mapping' section



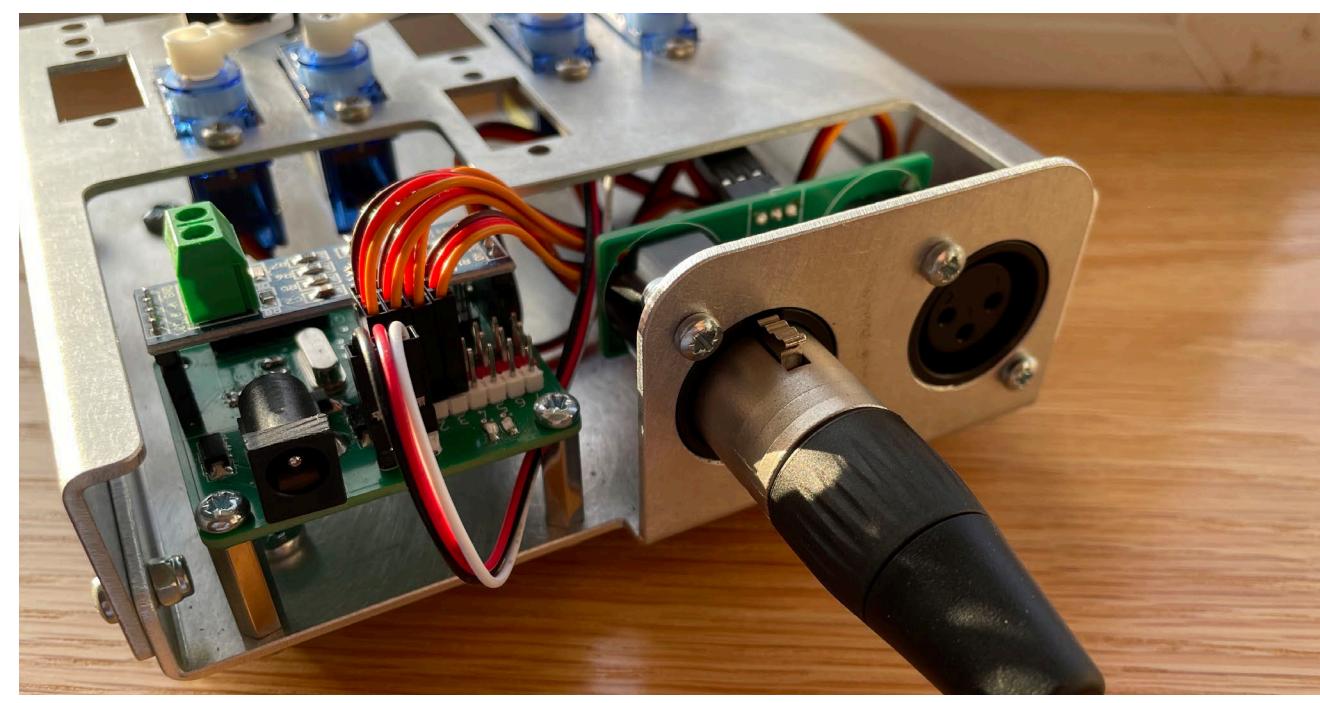
This dialog box will appear. If it is empty, like the one shown, click refresh until your DMX Cable appears, then click close.



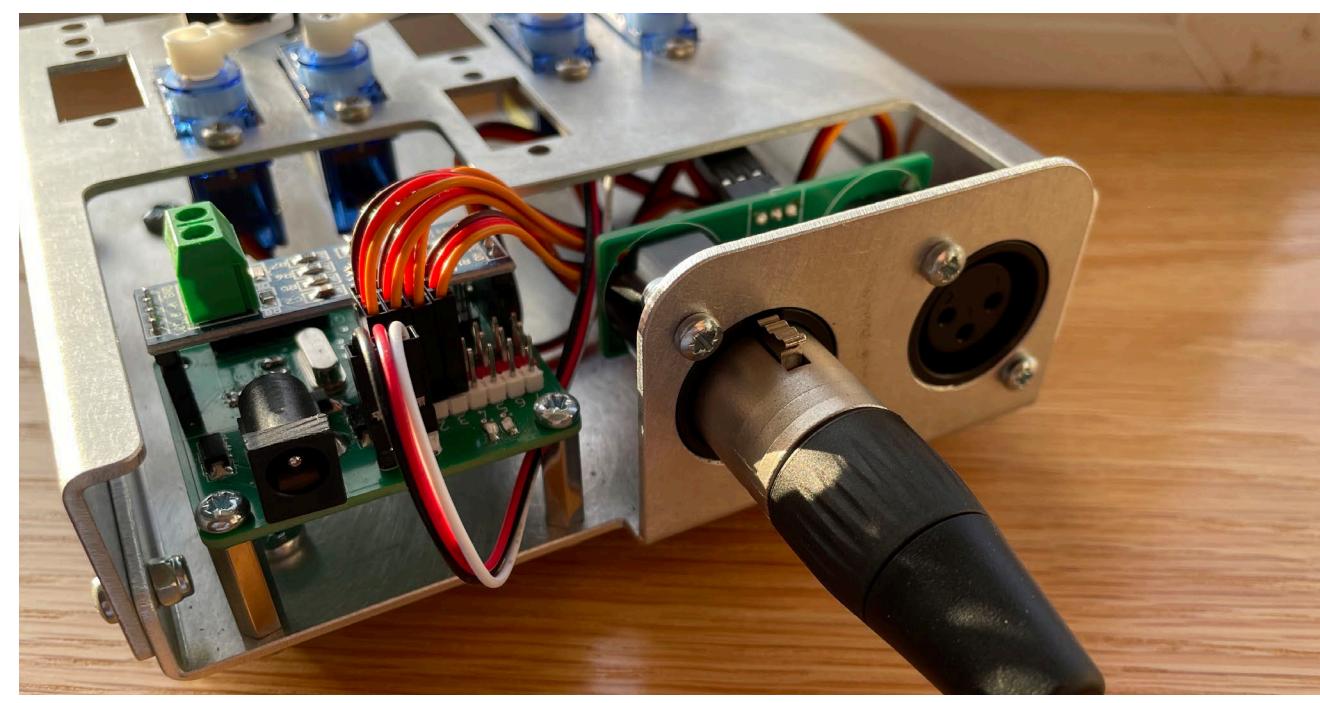
Back in QLC+, click on the 'Virtual Console' at the bottom of the window. This will bring up the above page. In the top right corner there is a green 'play' button. Click this. It will be replaced with a red 'stop' button. Next, click the button in the middle of the page labelled 'Centre'. You should hear and see the Servo Motors move.

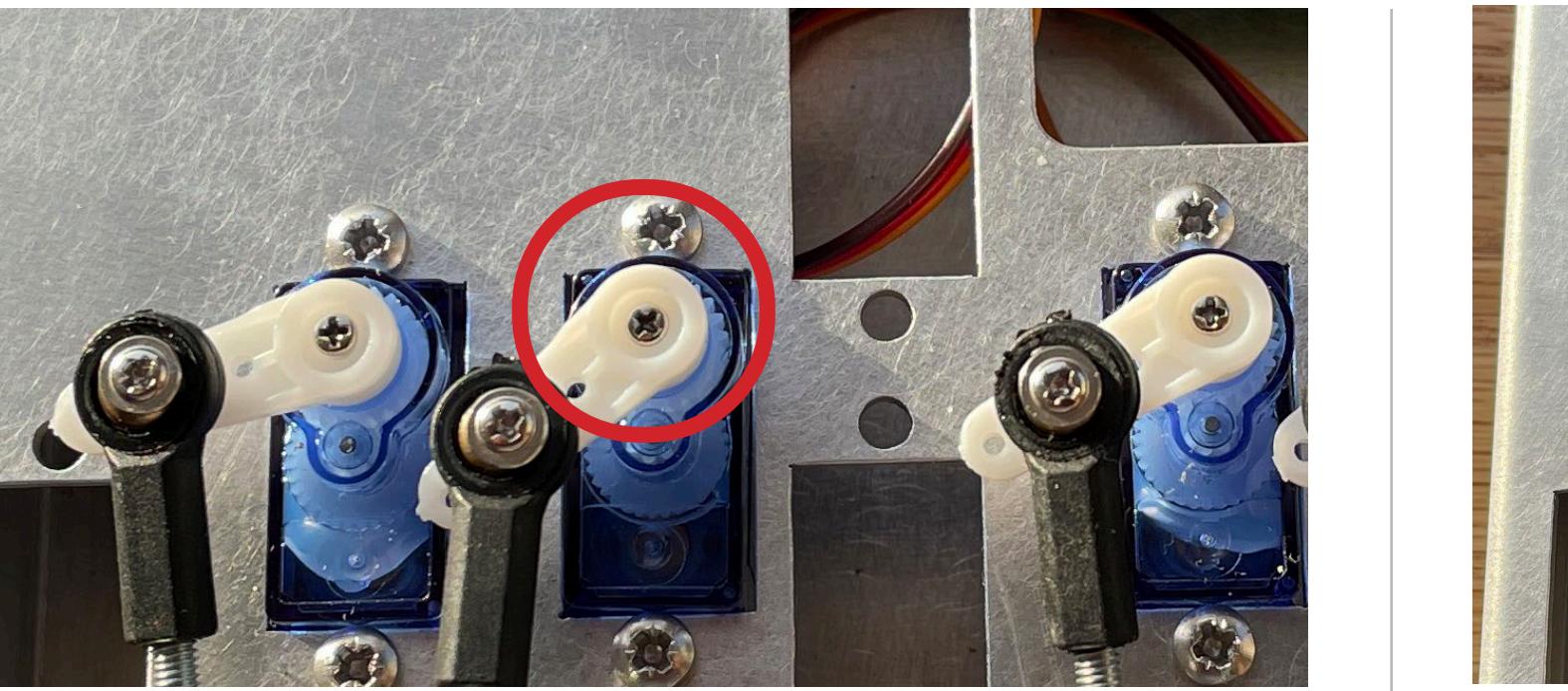


The Servo Motors have been moved into the 'centre' position, as if the eyes are looking straight ahead. It is now time to connect them. Take the servo horns that came in the packet with your servos and place each one onto the servos in the above configuration.

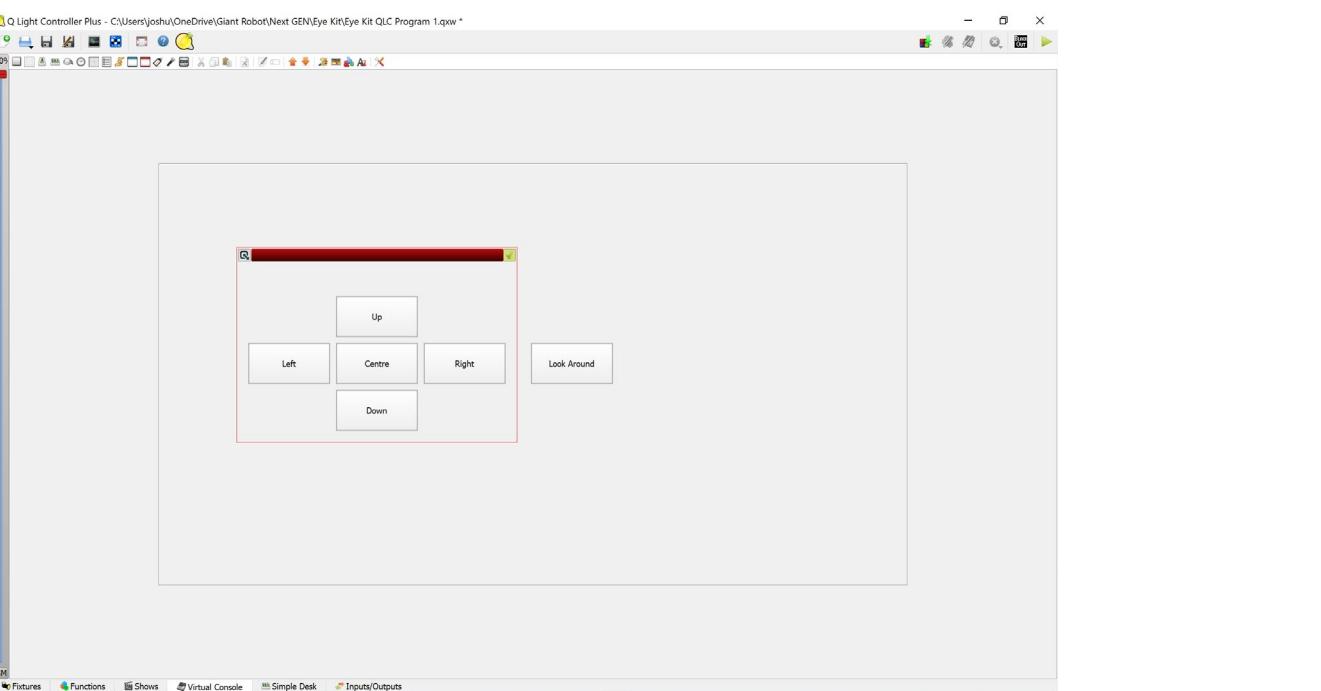


Connect the Power Supply into the Control Circuit. A blue light should turn on. If it does not, immediately unplug your cable and check you have connected the Servo Motors correctly. Then reconnect. Next, connect the DMX Cable into the DMX Interface. It will only fit in one of the two sockets.

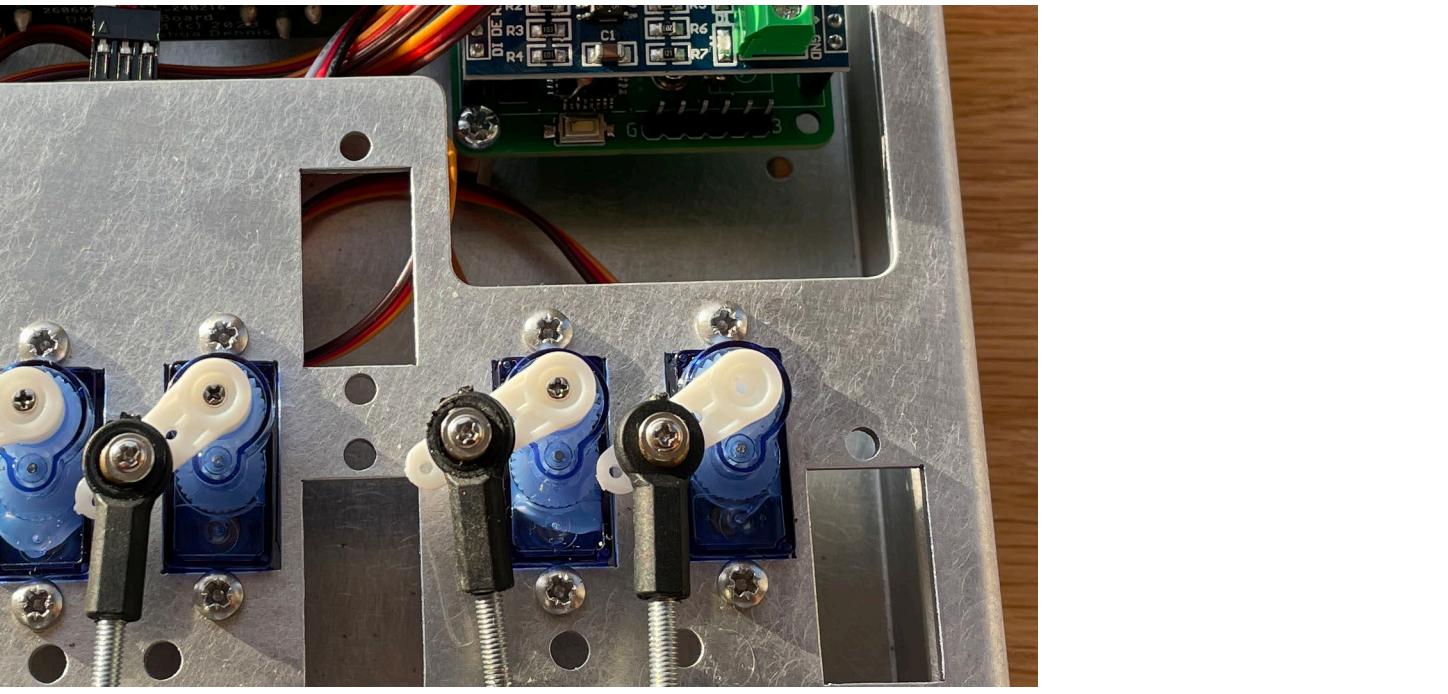




Using the smallest screws in the servo horn pack, secure the servo horns into the servos.



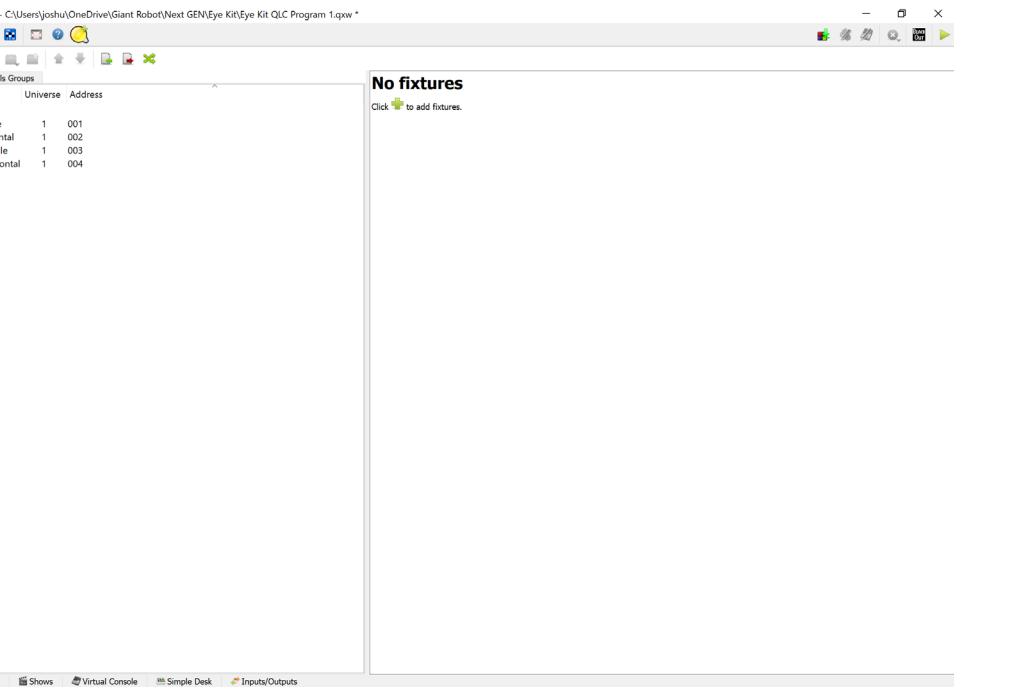
Returning to QLC+, each button in the red box will move the eyes to a corresponding position. The red box is 'exclusive', meaning only one button in the box can function at a time. Try pressing the buttons to see where the eyes look. There is another button labelled 'Look Around'. This button will run the eyes in a sequence where they look around the room.



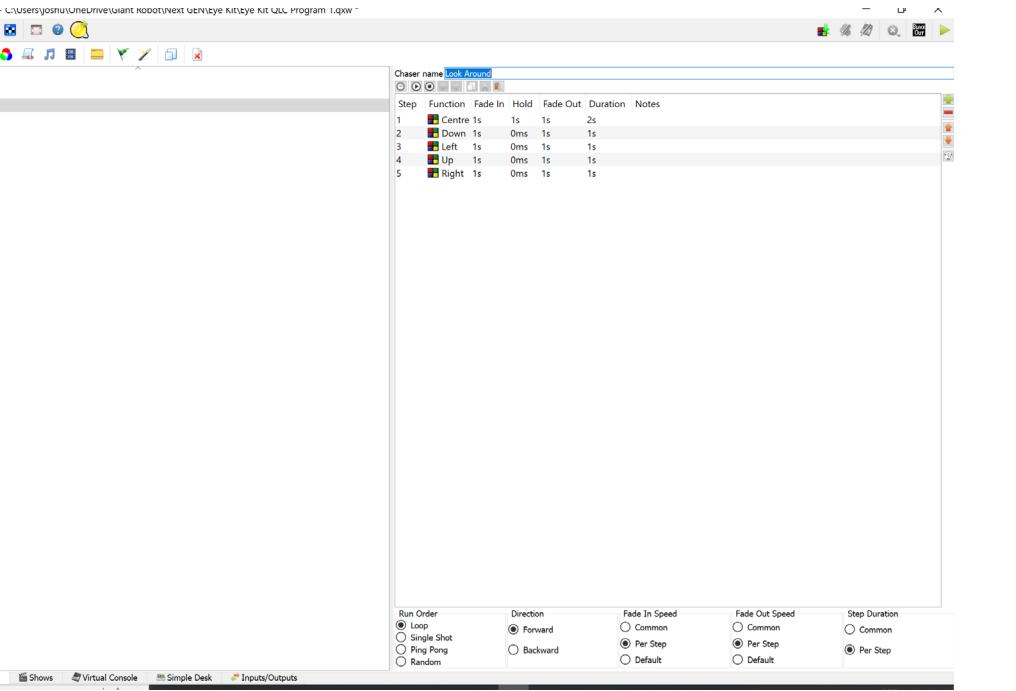
Using the self tapping screws in the servo horn packs, fix the Eye Pusher Arms into their corresponding servo horns. These should be secured into the third hole from the end on each horn, as shown above. This completes the mechanical assembly.



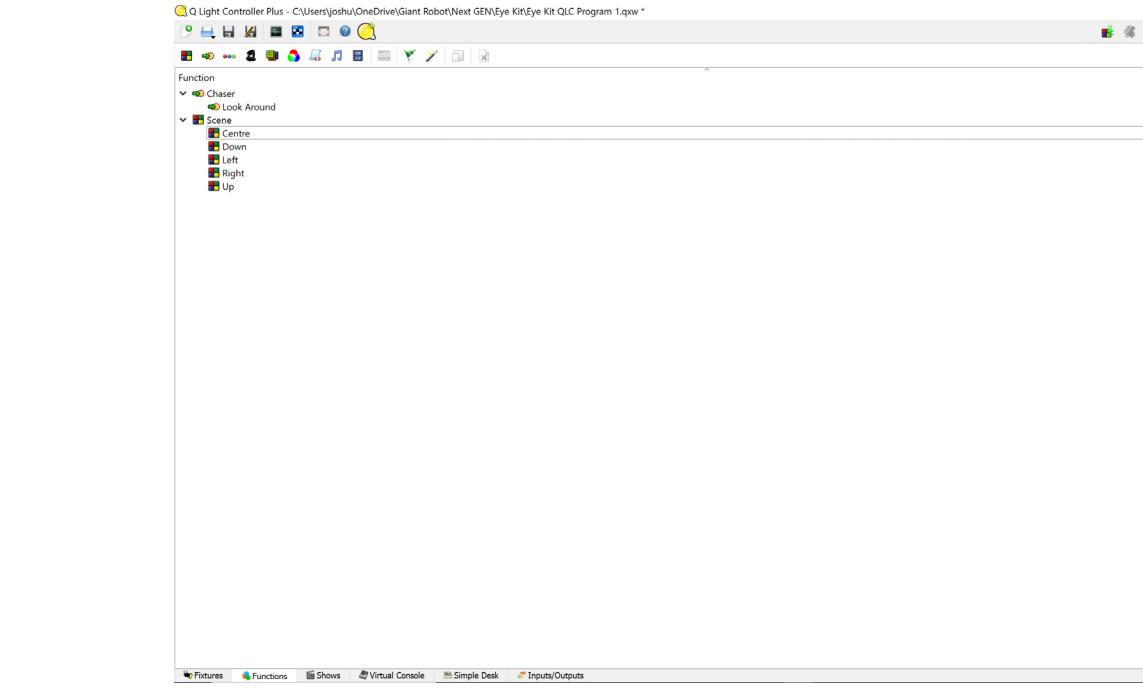
The following steps will take you through the pages of QLC+, enabling you to create your own functions for the eyes.



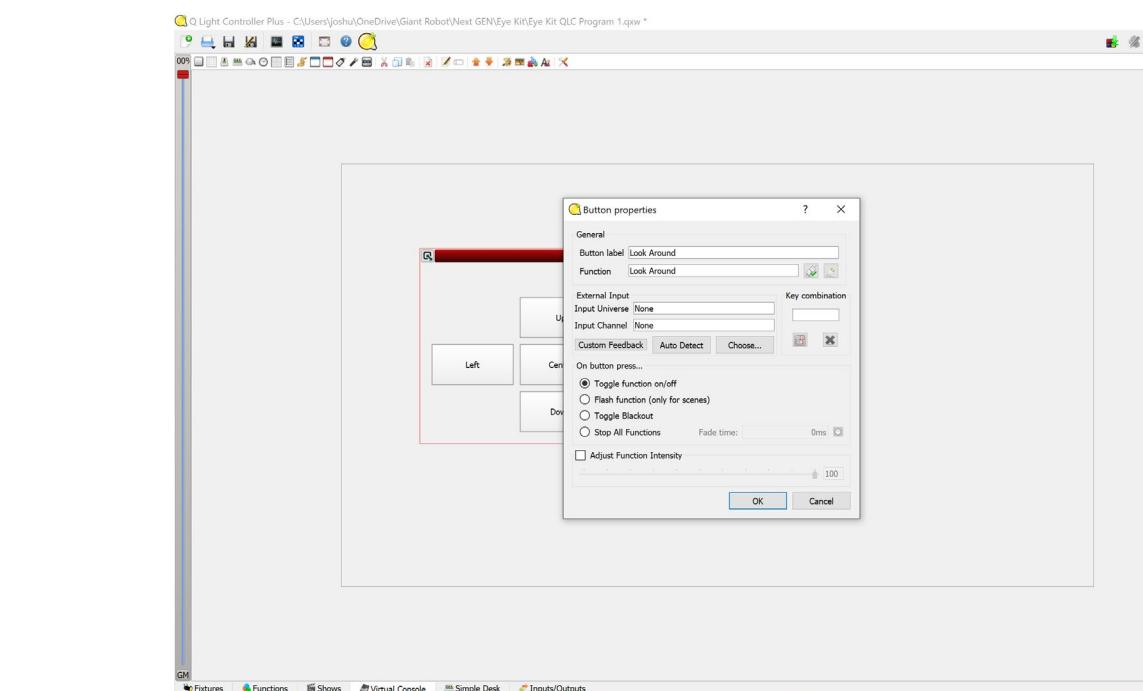
The 'Fixtures' page shows the individual fixtures registered in the program. You can see there are four (one for each servo), linked in addresses 001-004. You can have up to 512 fixtures in each DMX 'universe'. If you wanted to add more fixtures (if you had multiple kits connected together with the eyes on different addresses for example), you click the green '+' symbol.



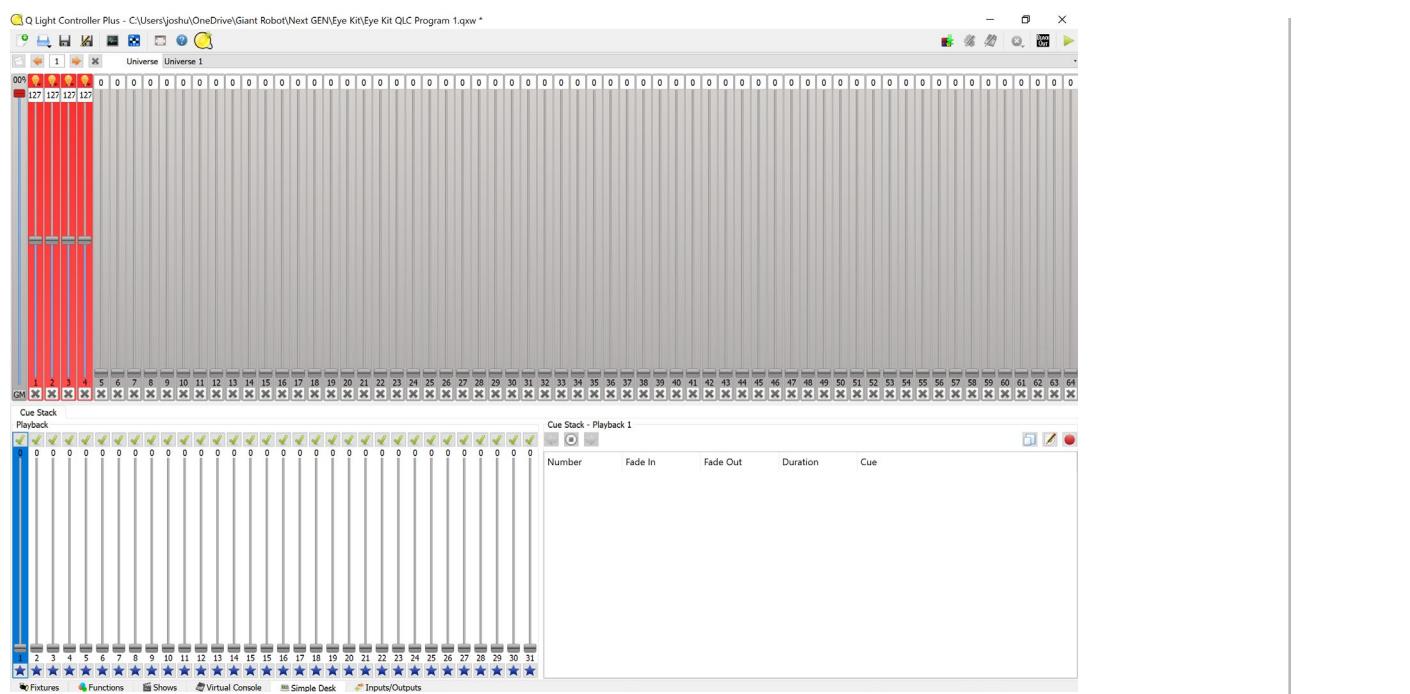
There has also been one chaser created. Chasers allow you to group scenes together into a full motion. Think of scenes like the pages in a flip book, and chasers as the book itself. When you run through a chaser, you are flicking the animation book!



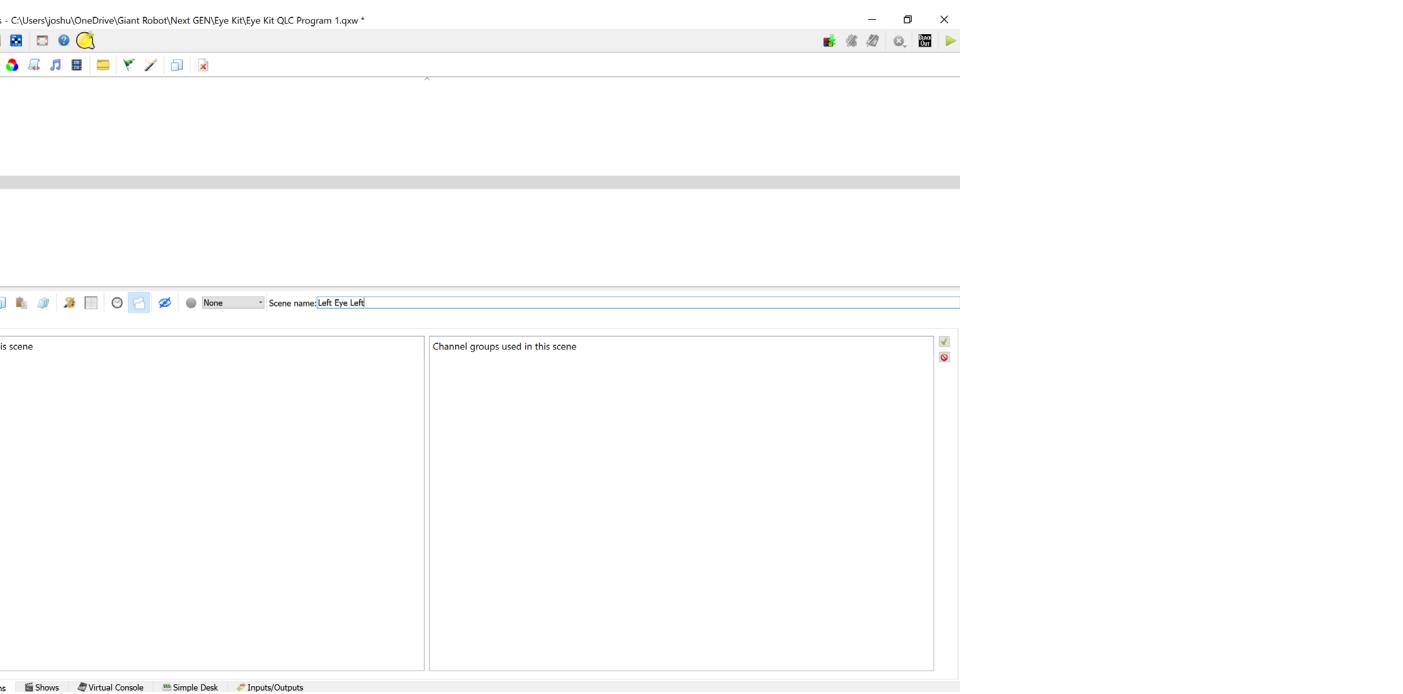
The next page is the 'Functions' page. Here you can see five scenes have been created. If you click on a scene, a separate box will appear, and there are sliders for each fixture.



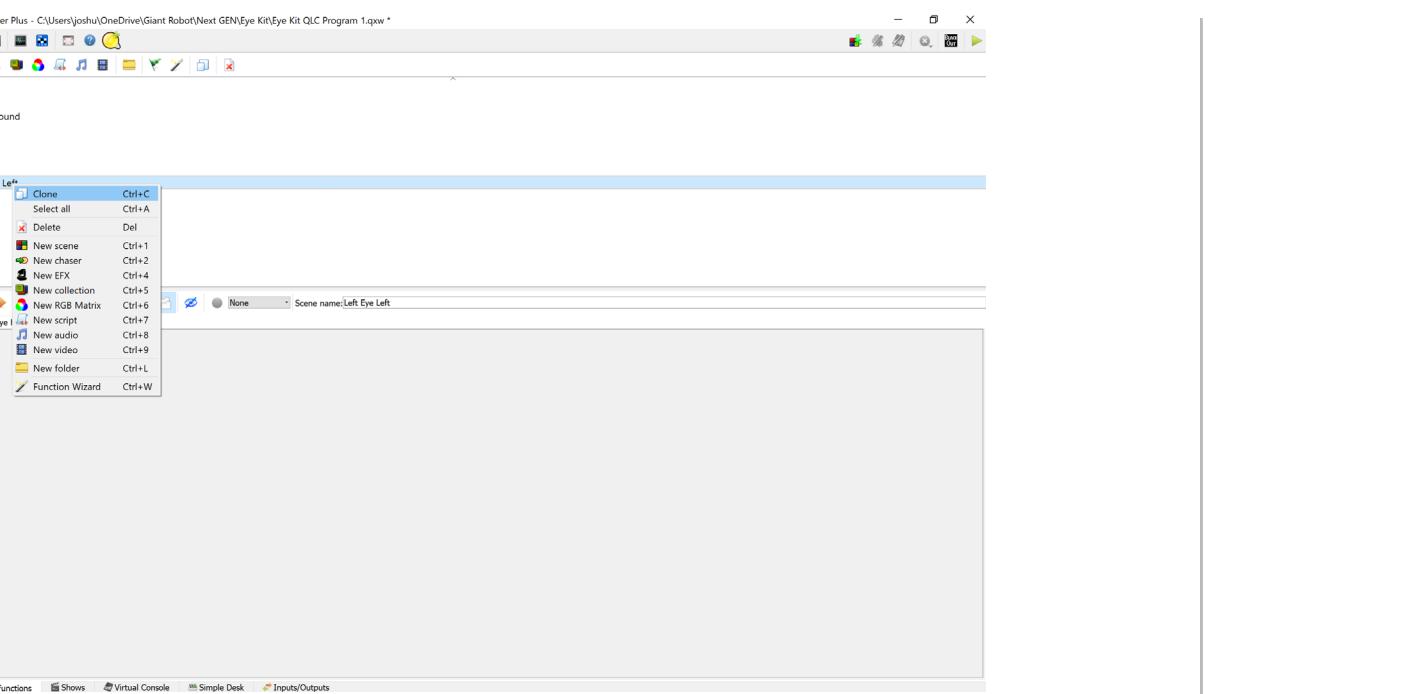
Head back to the Virtual Console page. Ensure the show is not running by clicking the 'stop' button in the top corner (if a 'play' button is there instead of stop, the show is not running). Double tap on one of the buttons, a dialog box will appear. Here you can see the settings for that button, including what chaser or scene it is linked to (under the 'Function' label).



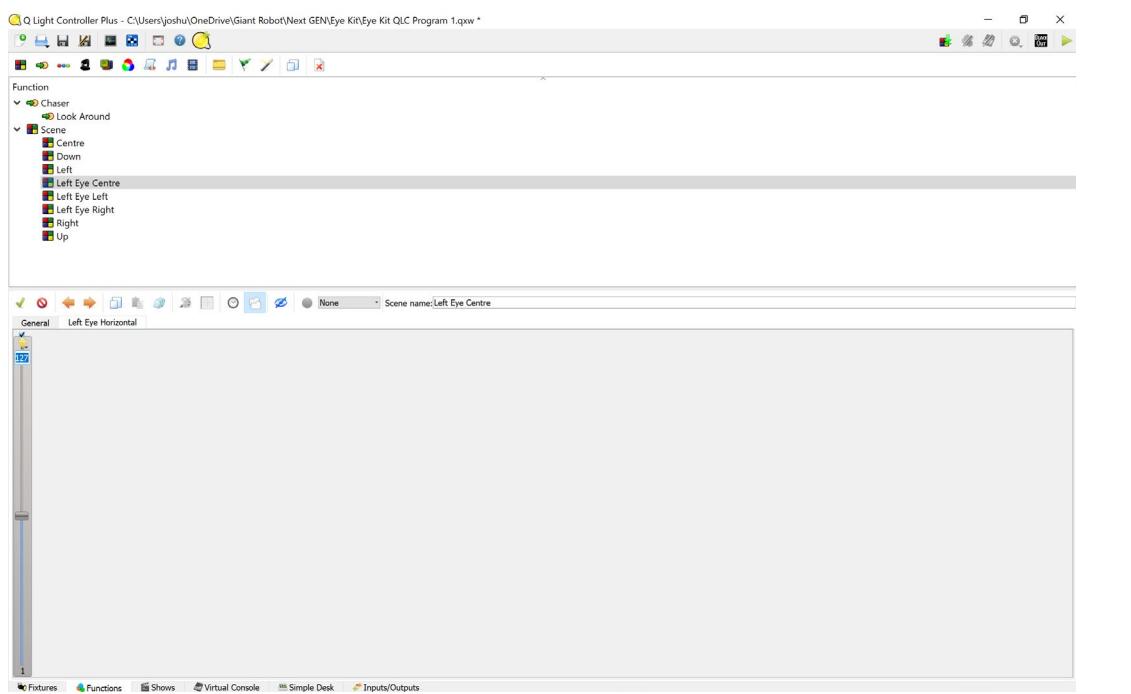
Finally, we arrive at the ‘Simple Desk’ page, where we see a series of sliders. Here you can manually adjust the values for all 512 fixtures that can exist in the DMX universe, but as we only have registered, only sliders 1-4 have a light bulb symbol, showing they are connected to functions. Try moving one of the sliders and see the eyes move!



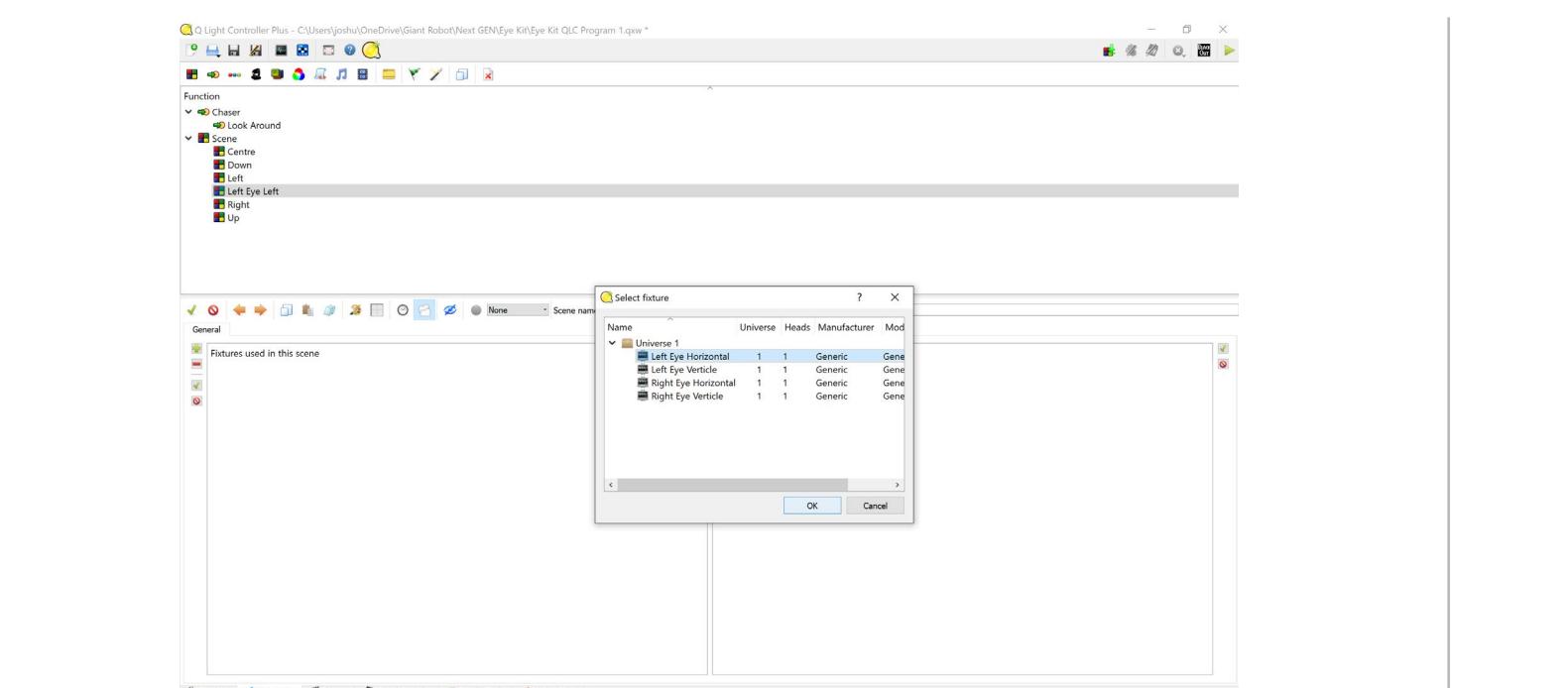
The final part of this manual will be showing you how to build a series of sliders. Here you can manually adjust the values for all 512 fixtures that can exist in the DMX universe, but as we only have registered, only sliders 1-4 have a light bulb symbol, showing they are connected to functions. Try moving one of the sliders and see the eyes move!



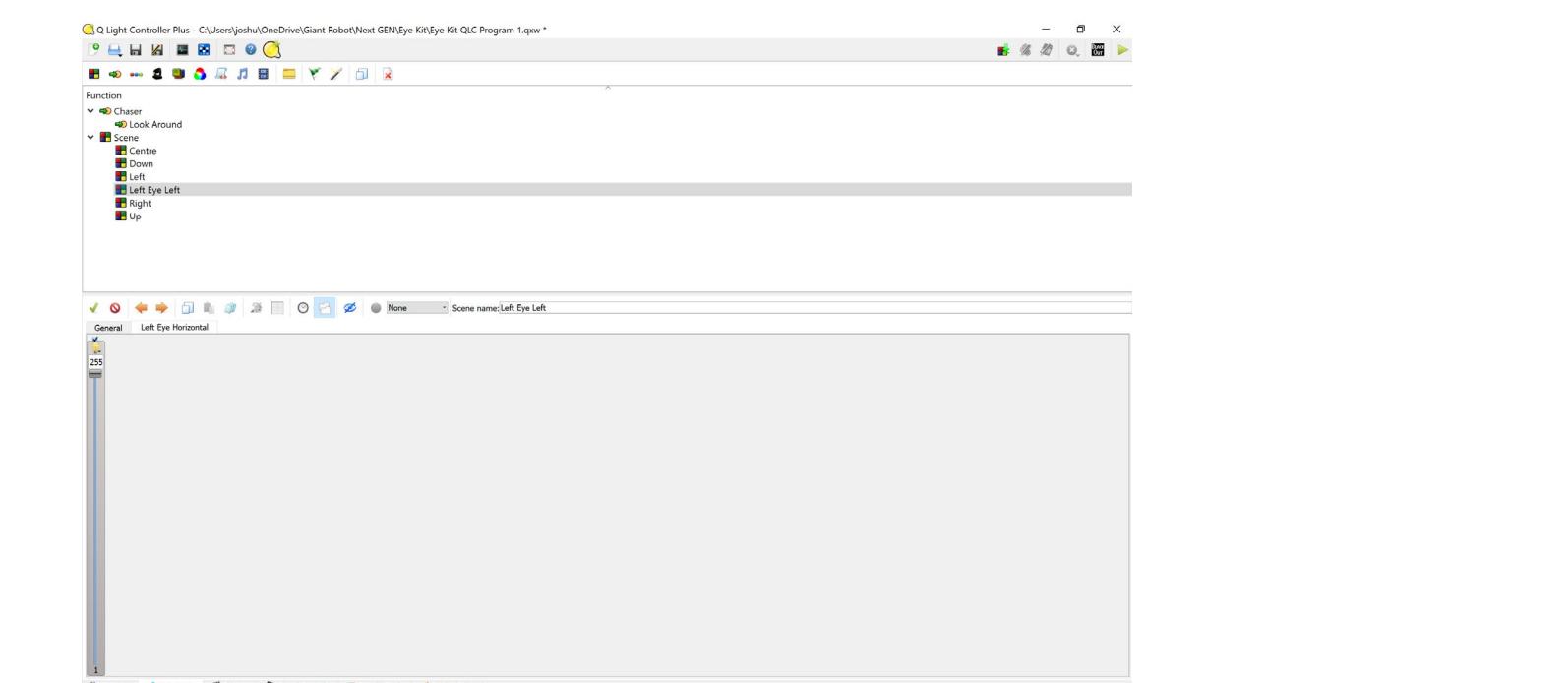
To save time with creating another scene, we can right click on the scene in the main window and select ‘Clone’. This will produce a copy. Rename this copy ‘Left Eye Right’ and adjust the slider to a value of 0, or all the way to the bottom.



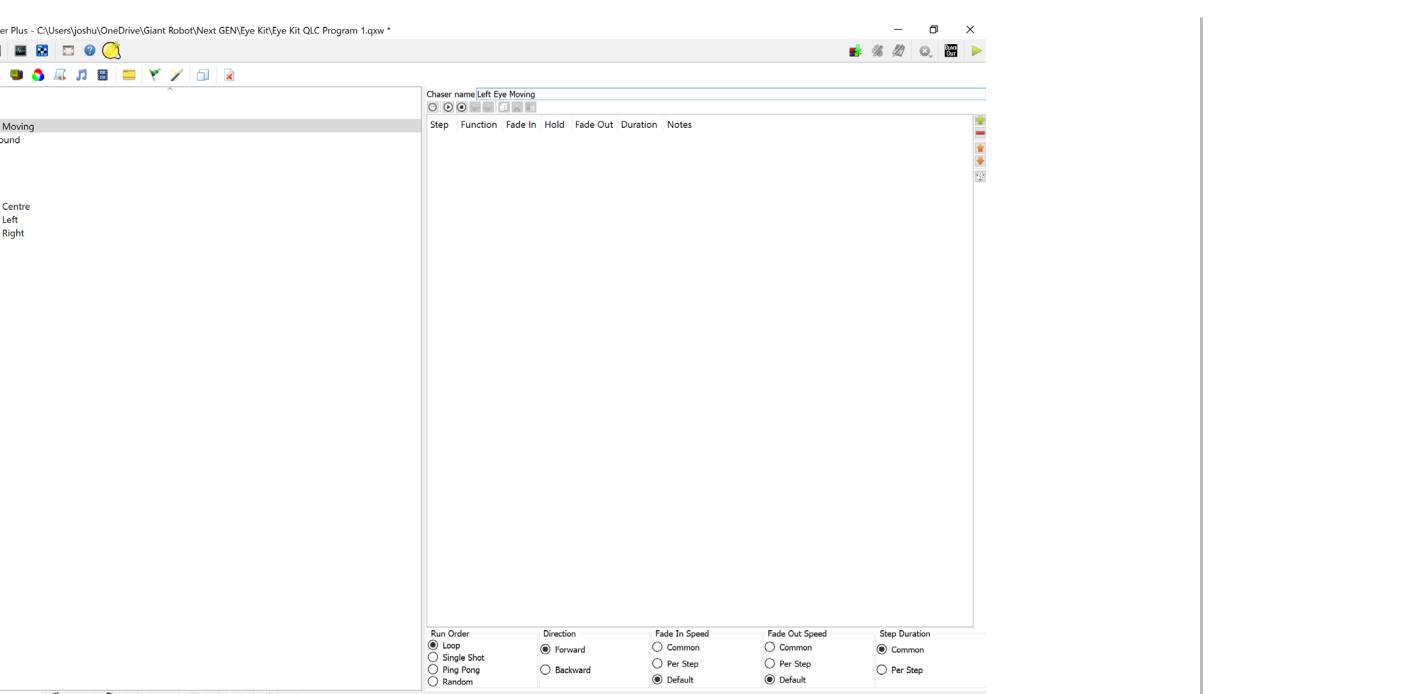
Clone this scene now and name our third and final scene ‘Left Eye Centre’. Set the slider to a value of 127. For ease, you can type the value into the top of the slider.



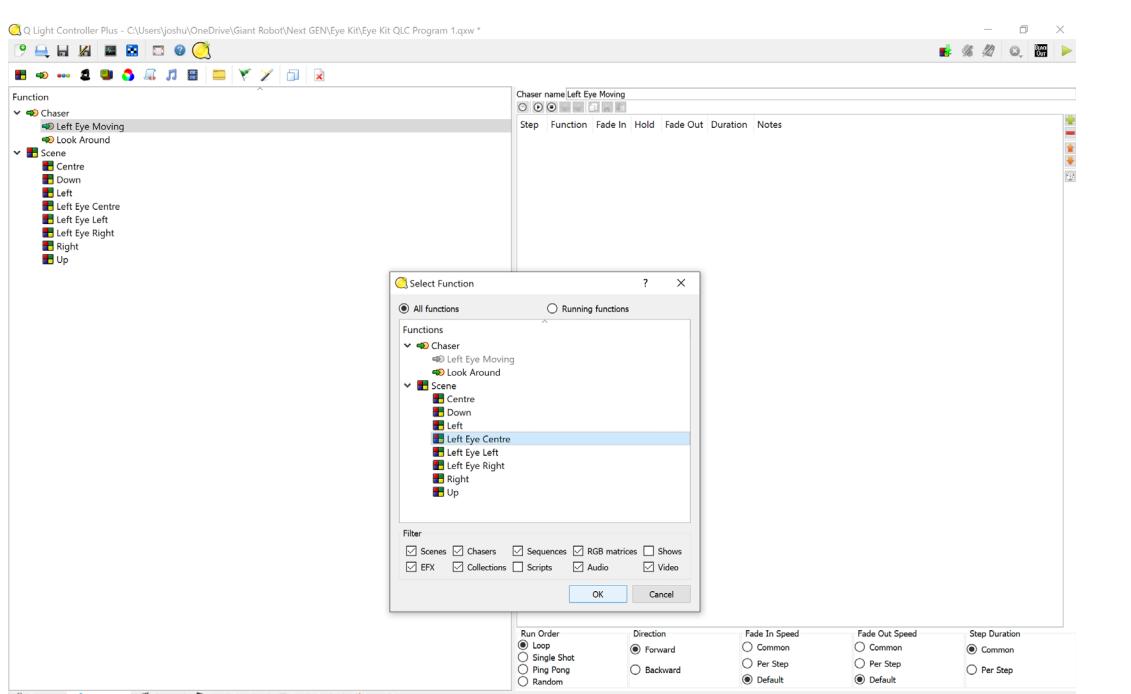
Click the green ‘+’ to add a fixture, and select the ‘Left Eye Horizontal’ fixture. Then press ‘Okay’. This will add the fixture to our scene.



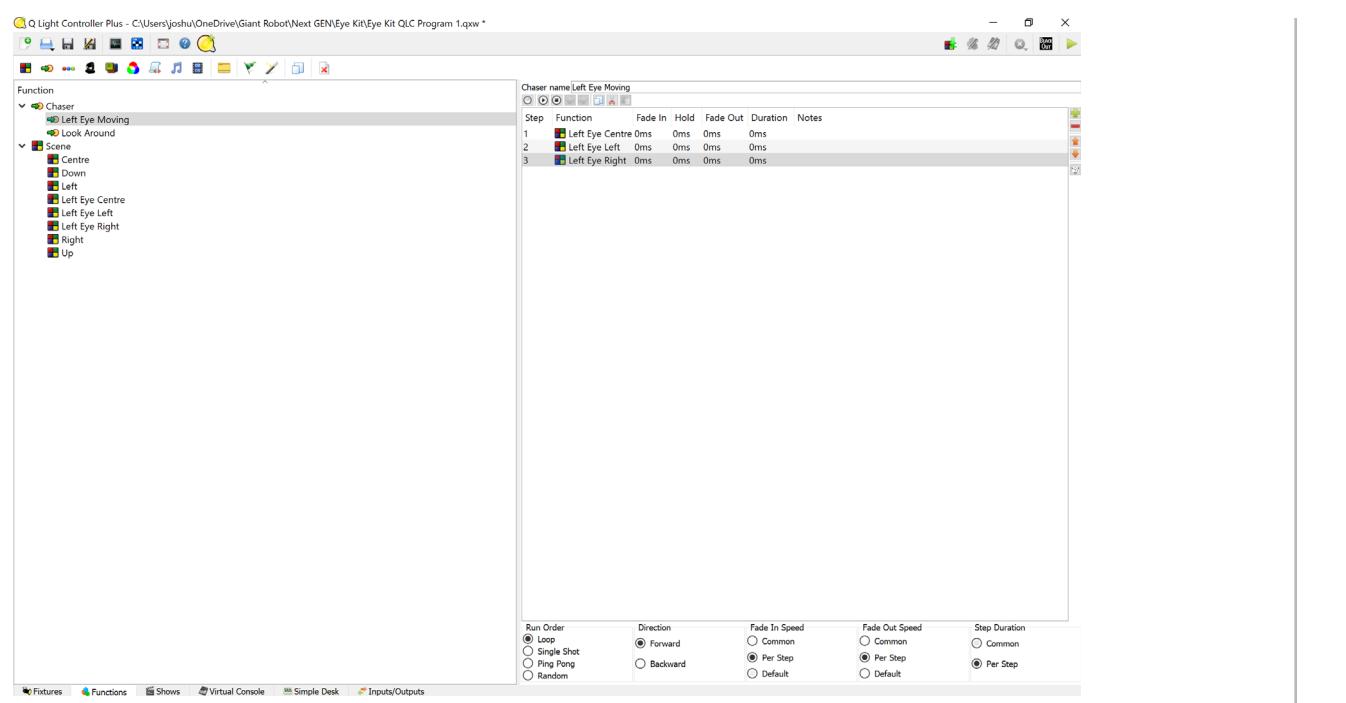
Click on the ‘Left Eye Horizontal’ tab that has now appeared in the scene editor. To enable the fixture, click the check box at the top of the slider, and move the slider to the top.



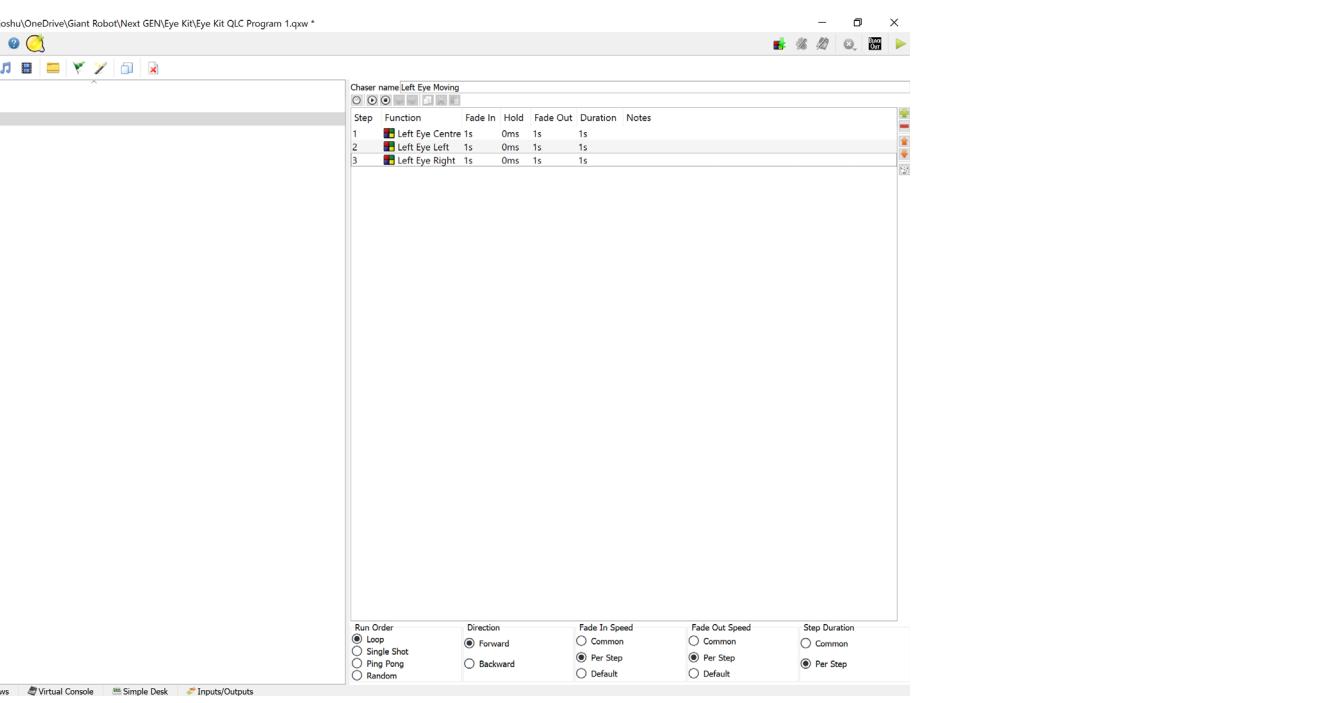
We will now make our chaser. Click on the new chaser button, and a chaser editor will open. Name the chaser ‘Left Eye Moving’.



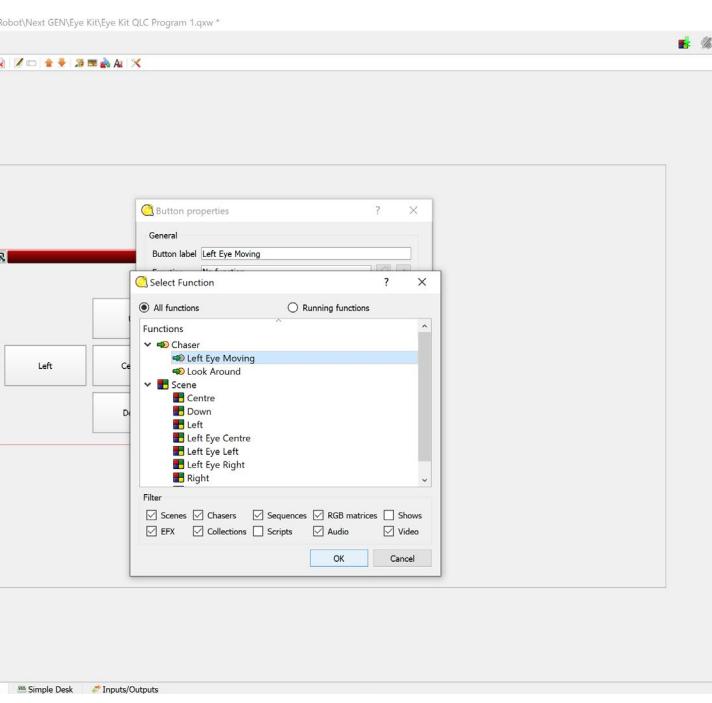
Click the add scene button and insert the ‘Left Eye Centre’ scene. Then repeat this to add ‘Left Eye Left’ and ‘Left Eye Right’.



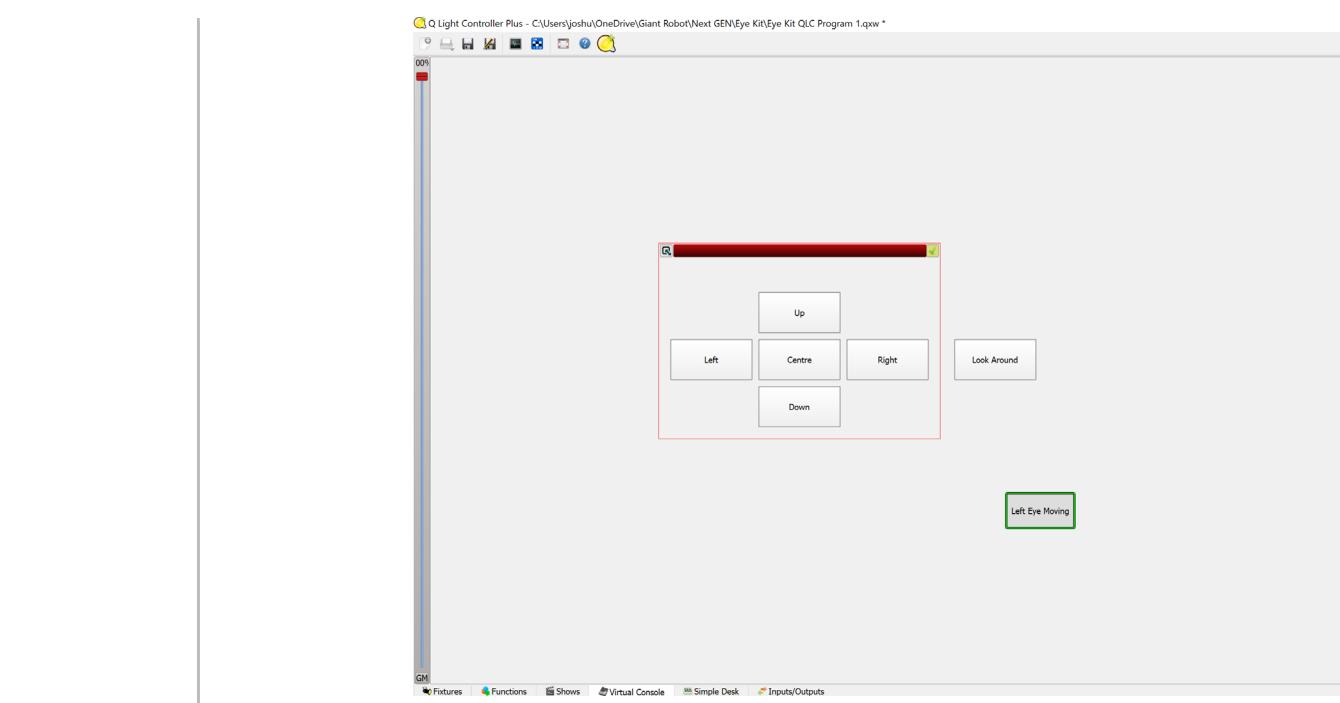
Next, ensure the options for 'Fade In Speed', 'Fade Out Speed' and 'Step Duration' are all set to 'Per Step'. This means each scene can be assigned its own duration.



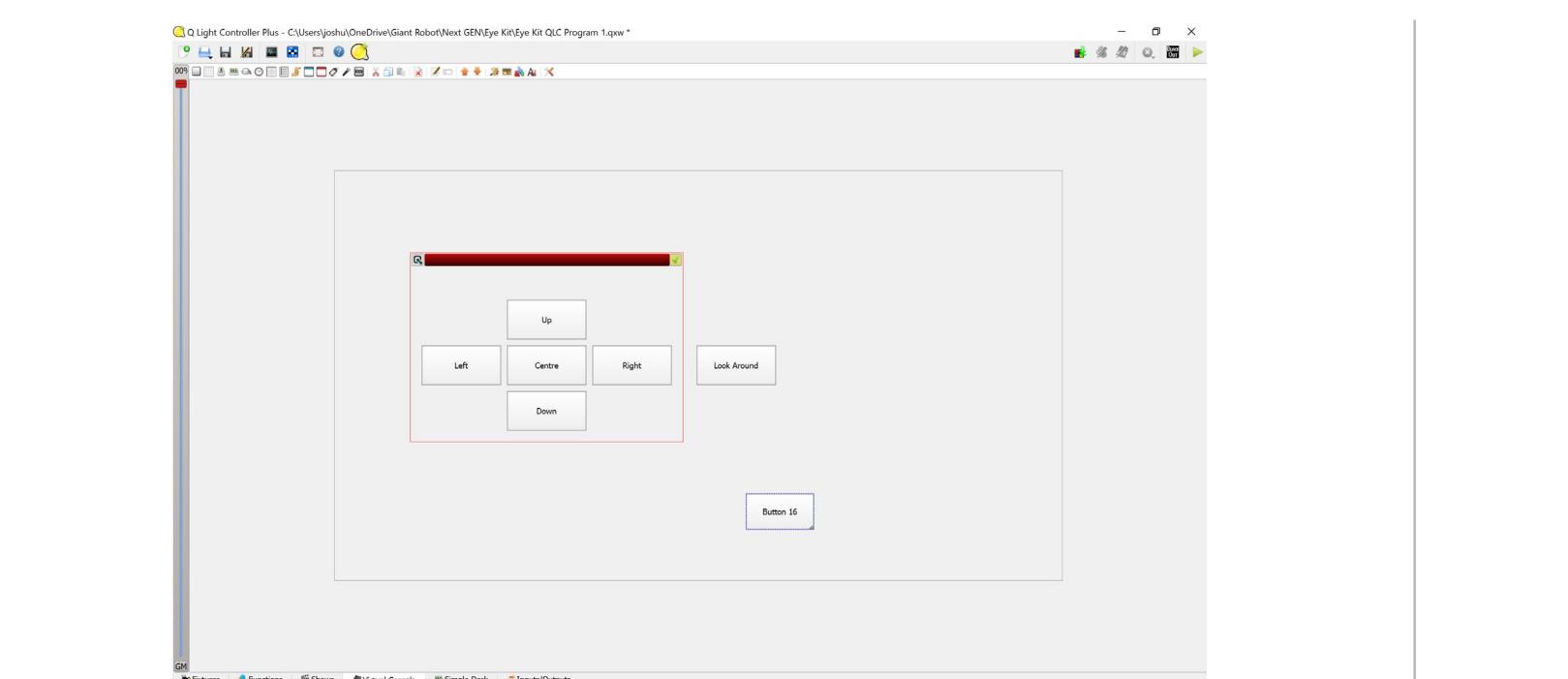
Next, adjust the 'Fade in Speed' and 'Fade out Speed' values to '1s', (meaning one second) by typing them in the relevant boxes.



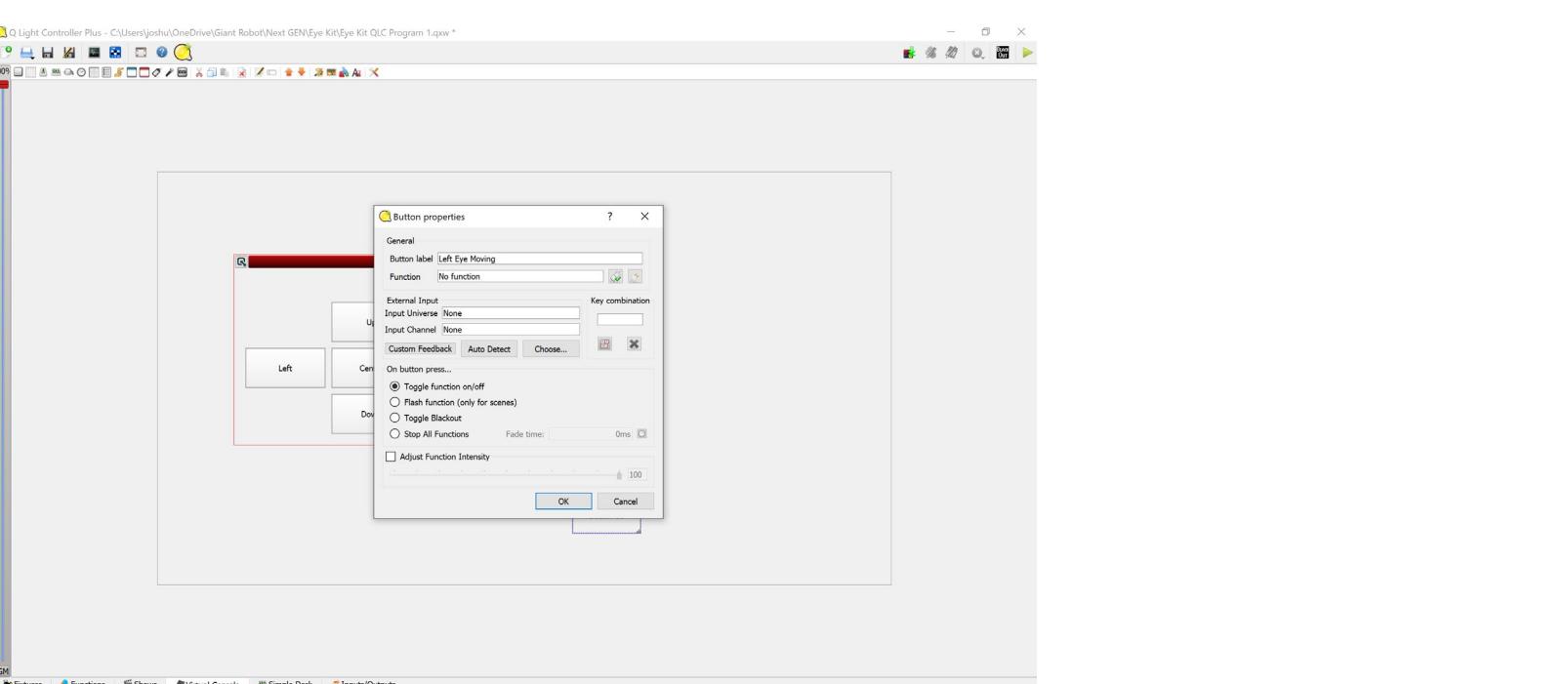
In the next dialog box that has opened, select the Left Eye Moving chaser, and click okay. Click okay again to be returned to the virtual console.



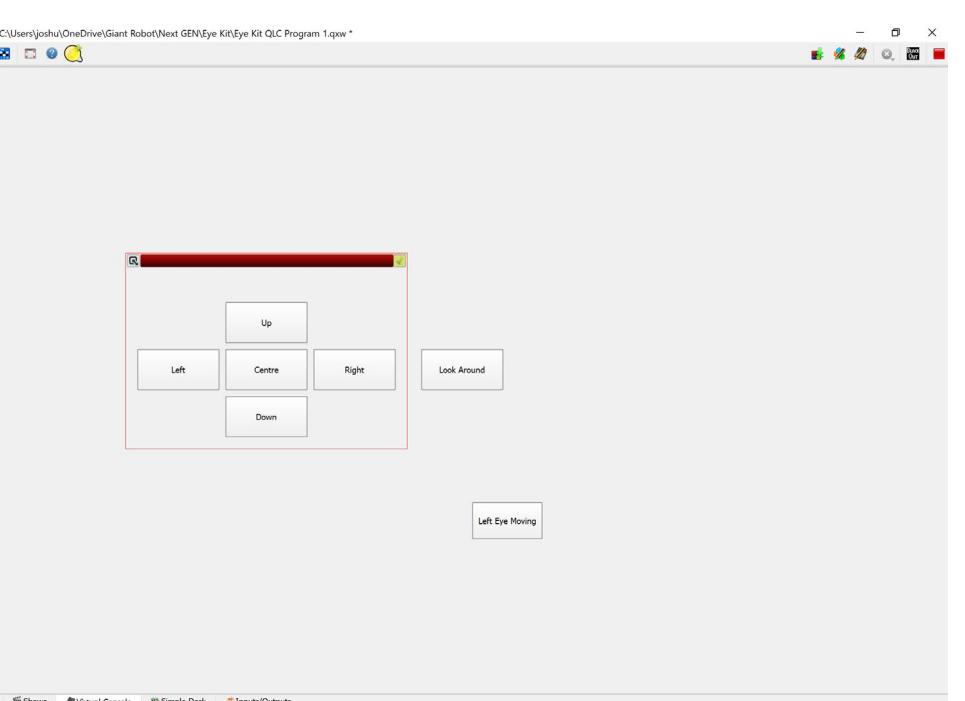
Click the green 'play' symbol in the top right of the window to start the show, and click our new button to see the chaser run on the eyes.



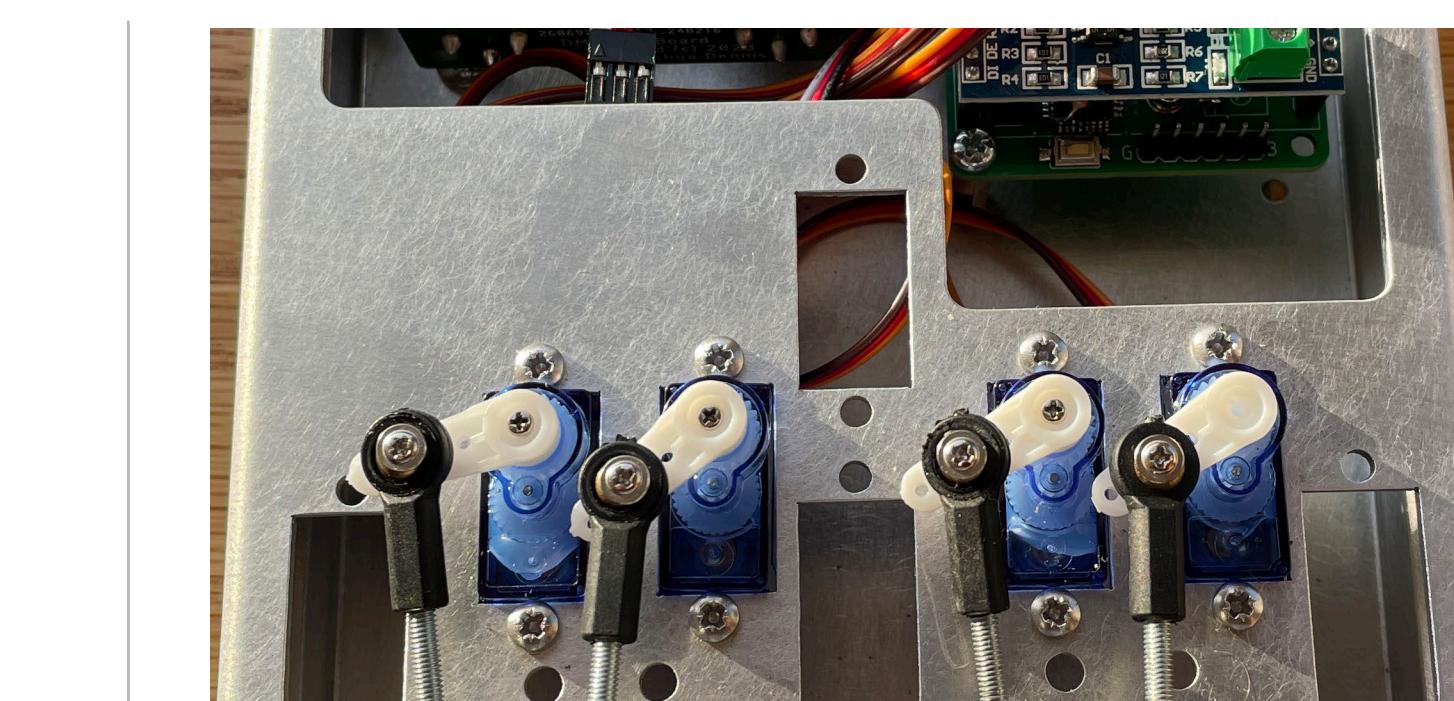
Heading back to the Virtual Console page, we can click the add button symbol to create a button. If you hold the corner of the new button it can be resized.



Double tap on this new button and a dialog box will open. Change the button label to 'Left Eye Moving'. Click on the 'Attach a function to this button' symbol.



You can now build more scenes and chasers on QLC+, and then link them to buttons, sliders and more on the virtual console.



That concludes the main building and programming section of this project, take a look on the following pages to see what else NextGen can offer!

Looking Ahead

You have now completed the NextGen Eye Kit. Throughout this pack you have assembled a set of human like robot eyes, got to grips with a show control software and created your own functions and a mini show.

These are fundamental skills for designing interactive robots that cause people to say 'Wow' or 'That's crazy!' Don't see this as the end, you have just completed Chapter One of your journey.

So where to go now? Continue working with your NextGen Eye Kit and continue to expand it's capabilities. You could use it as the basis of a whole robot head, or if you want to get one that has already been designed, take a look at our NextGen Head Kit.

NextGen is an extensive system with the following products:

- > The NextGen Eye Kit, which you just built.
- > The NextGen Head Kit, consisting of a whole head and neck.
- > The NextGen Hand Kit, with a whole hand, wrist and forearm.
- > NextGen Compact, an intelligent table top robot designed for Human Robot Interaction projects.
- > GREG NextGen, the full sized humanoid robot, that has been talked about around the world.

More information about each of our products can be found on our website.

Good luck with your future projects, and enjoy building!



GREG NextGen V1.0, interacting with people in the summer of 2023.

