UNIVERSITI PUTRA MALAYSIA

FARMBOT GENESIS SETUP FOR INDOOR FARM MANAGEMENT

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APPROVAL SHEET

This project report here to entitle "FARMBOT GENESIS SETUP FOR INDOOR FARM MANAGEMENT" was prepared and submitted by MOHAMAD AZRI BIN ZAINAL in partial fulfillment of the requirement for the degree of Bachelor of Engineering (Agricultural and Biosystem) is hereby accepted.

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ABSTRACT

Robotic in farming are being developed to help agricultural management of farm in seeding, irrigating, monitoring (environmental) and most important is soil analysis. Robotic in farming will make the farming precise because all parameters can be set from the start of crops planting process until its harvest. Robot can replace specific task base on how it is designed and the crops chosen to be planted. The design of a robot will usually be specific to its chosen task especially in agriculture where processes and crops are very different.

Robotic in farming had been developed as early as 1920s with research incorporating automatic vehicle guidance and it has led to advancement between 1950s and 1960s of autonomous agricultural vehicle . Robotics have mostly been incorporated in indoor environment by industries for decades since outdoor robots are more complicated and difficult to be develop because of the dynamic environmental effect and the most important thing is the safety of the robot itself.

Farm-Bot Genesis is a small scale open-sources farm robot constructed from v slot aluminium extrusion and aluminium plate and bracket. It is driven by four stepper motors with rotary encoders and Farmduino (previously using Arduino with Ramp shield) microcontroller driven by Raspberry Pi 3 computer. Farm-Bot

was design to work in a specified field area which manage and monitor the growth of crops in that farming plot. This plot can be an indoor and outdoor raised bed or even an outdoor field.

The robot can be set up as small as $1m^2$ until maximum 18 m^2 with crops as tall as 1m height. With some additional hardware modification it maybe possible to scale the Farm-Bot concept to cover approximately 50 m^2 and maximum plant as tall as 1.5 m height.

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INTRODUCTION

1.1 Overview

Farming robot is one of the new thing implement in farming sector. robot used in agriculture sector is more to replace human working in the farm and reducing human labour instead.in certain cases , a lot of reason and factor considered to doing human task in agriculture. Robots can be used to doing human task like seedling , irrigate and also monitoring the crops. Robots also can give a lot of benefit in the agriculture industry such as producing high quality yield, lower production cost and the main thing is decreasing the needing manual labour in the industry.

All country in the world is getting issue in labour needed in this sector especially in Malaysia. Most off the workers in from outsource which is the young generation is not more interested working directly in the farm because off the new technologies now days. The data show decreasing of output yield in vegetable in Malaysia in 2013 until 2017 which is show output have problem from number showing in the statistic as below.

Figure 1: Statistics decreasing yield 2013-2017

From the statistics shown the decreasing yield drastically and it show us something was happened in the sector the decreasing is because we can see planted area getting more smaller because of development area getting bigger so indirectly effect the planted area also yield.

Another factor of the reducing yield is the weather some crops can't grow in the bad weather condition as we know Malaysia is high in rain fall also high humidity covered area must be provided complete with lightning to get a good crops grow and can produce high yield. When the area covered its more suitable too use robot mechanism that can be automated seedling, irrigate the crops and also monitoring all the system

1.2 Problem Statements

1.2.1 Labour Problem in Malaysia

As we know labour is important thing in agriculture sector and it will give the impact for the chain if didn't have any enough labour in Malaysia. The main problem is the local younger generation didn't interested to get involve in agriculture sector which is they didn't see the agriculture is a good opportunity in getting salary from the sector more labour come from outsider especially Bangladesh, Indonesia and some other country working in the sector. the labour shortage is threatening agricultural sector, which can lead to severe financial losses for farmers and rising vegetable prices it will be huge impact for the industries when production can't supply to consumers when demanding for vegetable is high so country must import the vegetable from outsource to remain the demand in Malaysia. It will be increase the cash flow and make our currency flow to outside from Malaysia.it will effected the income for Malaysia instead of the shortage issue is very serious to take action also find solution.

1.2.2 Initial Cost is high

initial cost for starting the fully automated system for farming is very high cost because it new thing to develop in Malaysia, all equipment is imported from outsource because of all new technologies is from the country that more advance in agriculture they have developing new thing for increasing production and yield for agriculture crops. All of the advance country keep up research n developing new thing to producing new technologies and try to decreasing the cost to get high volume in yield and increasing profit from the agriculture sector developing new thing is very challenging because of changing from conventional farming to develop old place with new thing it very high cost but they must thing all the technologies is more long lasting in production also very precision to get back the fast Return Of Investment in their project and producing the high value crops and yield.

1.3 Objectives

The objectives of this study are:

1. Design and build of an indoor raise bed for planting
2. Assemble the mechanical and electronics parts of the Farm-Bot Genesis v1.2 system
3. Draw and 3D print missing parts from a Farm-Bot Genesis v1.2system
4. Install software and test run the Farm-Bot Genesis v1.2 system

1.4 Scope of Study

This research will only base on using the software and hardware for planting crops moving by 4 stepper motor and powered by Raspberry Pi3 computer to monitoring all activities in the Raise bed . Monitoring crops using High definition camera on monitoring crops weed and the soil sensor itself , set-up the hardware and determine how It's going to move also study about installation the programme in farm-bot set up using raspberry Pi 3 computer and farmduino micro controller for version 1.4 is using to support the movement of farm-bot.

1.5 Significance of Study

The farm-bot movement is using the track in X- axis , Y- axis and Z- axis and the track will allow the system in farm-bot move in the perfect precision and very efficient in moving the axis will intruct to the motor. Have a few reason why track are superior using them :

- The track will provided great precision and make the robot go to the position and make return very fast
- Track would not make the soil compacted if compare to the tractor wheel moving in the farm
- If the structure of the plant very pack can be created and managed very well

1.5.1 Cross-Slide

The Cross-Slide moving the Y-Direction across the Gantry. This motion provides the second major degree of freedom (DOF) for robot moving to the targeting place and allows operations such as planting irrigate and weeding to be done anywhere in the XY plane. The Cross-Slide is moving use a Y-Direction Drive System and functions as the base for the Tool Mount and Z-Direction Drive System.

CHAPTER 2

LITERATURE REVIEW

2.1 Scholar on farm bot

Farm bot is the machine with open source design with automated to do precision farming is a same like 3d printer the different is the tip/nozzle farm bot have seed injector, watering nozzles sensor and more. Technologies is following all this features:

- CNC XYZ Movement: Using an Arduino and Raspberry Pi, the Farm Bot tool head can be precisely positioned for a variety of operations such as soil preparation, seeding, watering, fertilizing, weed control, and data acquisition.
- Complete Control: Farm or garden layouts are designed with a drag and drop web-based interface allowing complete customization from any device. Operations are auto-scheduled ensuring your plants never miss a day of watering.
- Fully Optimized: A decision support system automatically adjusts water, fertilizer, and pesticide regimens; seed spacing, timing, and more based on soil and weather conditions; sensor data, location, and time of year.
- Dozens of Applications: From small raised beds to retrofitted greenhouses, to urban rooftops, to commercial and industrial applications; Farm Bot is scalable and modular to work in any situation.
- Best of all, everything is free and open-source

2.2 Robotic Farming

Farm Bot is an open- source and scalable automated precision farming machine and software package designed from the ground up with today's technologies. Similar to today's 3D printers and CNC milling machines, Farm Bot hardware (shown in Figure 4.1) employs linear guides in the X, Y, and Z directions that allow for tooling such as plows , seed injectors, watering nozzles, and sensors, to be precisely positioned and used on the plants and soil. The entire system is numerically controlled and thus fully automated from the sowing of seeds to harvest. The hardware is designed to be scalable, simple, and hackable. Using the open- source web- based software package, the farmer can graphically design their farm to their desired specifications and upload numerical control code to the hardware. Other software features include storing and manipulating data maps, a decision support system to facilitate data- driven design, access to open data repositories, and enterprise class analytics. Farm Bot has several distinct advantages over today's methods and technologies that will be explained in sections 4.1 through 4.8 and the rest of the paper

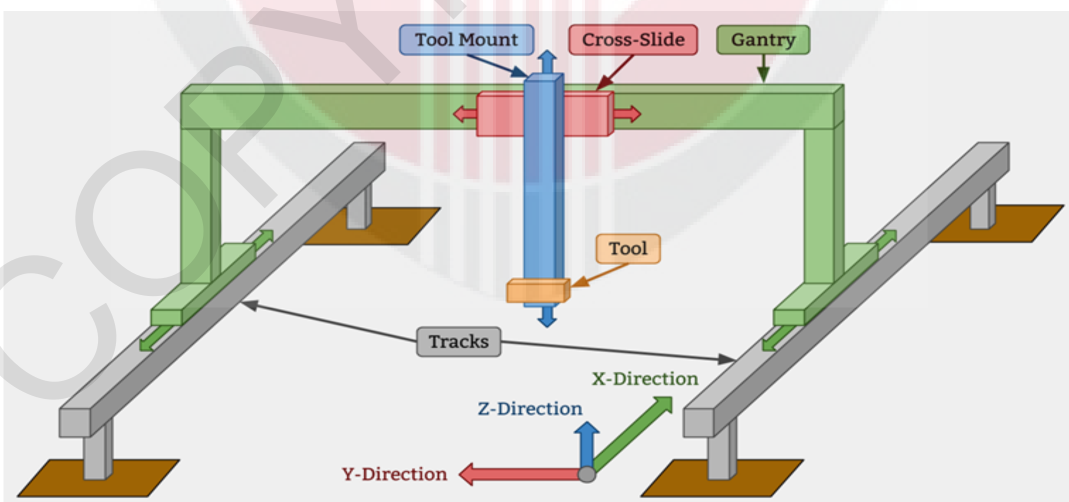


Figure 2: FarmBot high level hardware overview and coordinate system

2.3 Financial and Human cost in farming.

financial and human cost lately in Malaysia have increase because of the economic factor a few sector that directly using machinery have been increase drastically because of the fuel fluctuate of fuel and currency exchange as we know Malaysian MYR have going down because of a lot factor. All part and services have increase their prices to cover profit getting smaller day by day because of the efficiency of human labour is been shortage because younger generation no more interested in agriculture. Human labour is directly depend on outsiders working in this sector and also give a big impact for getting more profit demanding for higher salary is the issue.

2.4 Raised Track Vs Low Tracks

Farmbot is recommended properly growing taller plant because of the gantry cross slide and z – axis. A;ll the tools must be adequate for the vertical clearance from the plant atleast 1 meter from the ground (raised bed) top surface and its can be provided for 2 ways in assembling the track :

1. Using raised track and low – profile Gantry
2. Using low track with tall gantry.

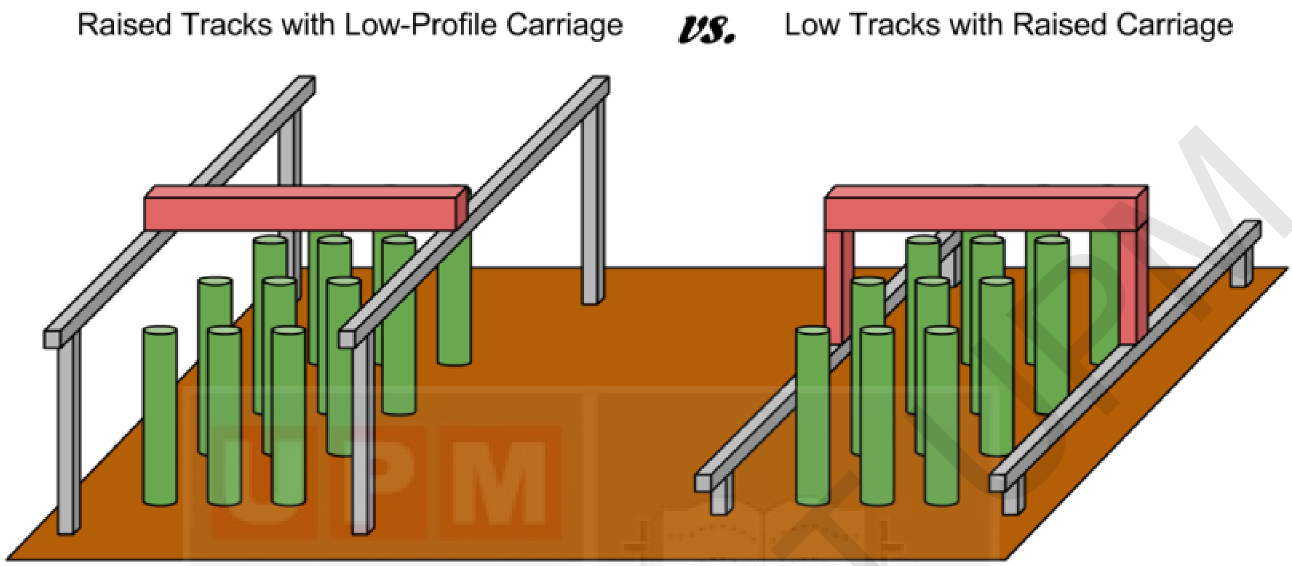


Figure 3: Raised Tracks Vs Low Tracks

Generally , using low tracks with a tall gantry is the better design, especially for larger applications because it saves on material cost, is less of an eyesore, blocks less sunlight, and would be easier to maintain. However, in the case of a FarmBot being installed in a greenhouse or other structure, utilizing the existing walls to support the tracks higher may be a better solution.

CHAPTER 3

METHODOLOGY

3.1 Build and Assembled The Raised bed

Raised garden beds are fairly easy to construct, even easier to maintain, Raised beds are an easy way to get into gardening. A raised garden bed (or simply "raised bed") is a large planting container that sits aboveground and is filled with soil and plants. It is a box with no bottom or top a frame, really that is placed in a sunny spot and filled with good-quality soil to become a source of pride and pleasure, and a centre piece of the garden.it also can be use for the indoor farming but sunlight will be change to the LED and make crops growth as usual with condition enough sun lighting like outdoor raised bed.

Raised bed have a lot of benefit to be consider using it as platform growing n planting rops this is the reason why we should using rasied bed :

- Garden chores are made easier and more comfortable thanks to less bending and kneeling. Save your knees and back from the strain and pain of tending the garden.

- Productivity of plants is improved due to better drainage and deeper rooting.

- Raised beds are ideal for small spaces where a conventional row garden might be too wild and unwieldy. Raised beds help to keep things organized and in check.

- Planting in a raised bed gives you full control over soil quality and content, which is especially important in areas where the existing soil is rocky, nutrient-poor, or riddled with weeds.

- Raised beds allow for a longer growing season, since you can work the soil more quickly in the spring in frost-hardened regions, or convert the bed into a cold frame in the fall.

- Fewer weeds are seen in raised beds thanks to the bed being elevated away from surrounding weeds and being filled with disease- and weed-free soil.

- Raised beds allow for easier square-foot gardening and companion planting.

3.1.1 Build raised bed

- Determine size to attach farm bot on the top of raised bed
- Size must be in minimum 1ft x 1ft x1ft but for farm bot recommended size is 8ft x 4ft x 1ft (depth).
- To support timber beds, place wooden stakes at every corner (and every few feet for longer beds). Place on the inside of the bed so that the stakes are less visible.
- Drive the stakes about 60% (2 feet) into the ground and leave the rest of the stakes exposed aboveground.
- Ensure that the stakes are level so that they're in the ground at the same height, or you'll have uneven beds.
- Set the lowest boards a couple inches below ground level. Check that they are level.
- Use galvanized nails (or screws) to fix the boards to the stakes.
- Add any additional rows of boards, fixing them to the stakes

3.1.2 Raised Bed Soil Recipe

For a 4 x 8-foot raised bed:

- 4 bags (2 cubic feet each) topsoil (Note: Avoid using topsoil from your yard, as it may contain weeds and pests.)
- pails (3 cubic feet each) peat moss
- bags (2–3 cubic feet each) compost or composted cow manure
- 2-inch layer of shredded leaves or grass clippings (grass clippings should be herbicide- and fertilizer-free)

3.2 Assembling the mechanical and electronic component

3.2.1 Assembling Tracks

FarmBot's tracks allow the gantry to move precisely along the x-axis. They are designed to attach to a raised bed or similar supporting infrastructure. The tracks are composed of two 1.5m long aluminium extrusions butted up against each other end-to-end for a total track length of 3m on Genesis models, and four extrusions end-to-end for a total track length of 6m on Genesis XL models. The two tracks must be a parallel distance apart between 0.5m and 1.5m for Genesis, and 1.5m and 3m for Genesis XL so that the gantry may span the distance between them. If you position your tracks closer together than the maximum, you may consider cutting the gantry main beam so that it does not inconveniently extend beyond your tracks very far.

3.2.2 Shortening the tracks

The easiest way to shorten your tracks is to remove extrusions. Should you want an overall track length different than the 1.5m increments the extrusions afford, then you will need to use a hacksaw or horizontal band saw to cut the extrusions to your desired length. You can shorten your tracks to a minimum length of around 0.5m.

3.2.3 Lengthening the tracks

If you would like to extend your tracks, you will need additional extrusions, connecting plates, cable carrier supports, and hardware, as well as longer x-axis cable carrier, belt, wiring, and tubing.

Here is how to make the installation tracks on the raised bed once its done assembled indoor condition. The step show what is the important thing to assemble the thing to understood clearly about farmbot hardware tools to be assemble.

Step 1 Lay out the track extrusions

Lay out all of the track extrusions in the location that you want to attach them to your supporting infrastructure. Make sure that extrusions are fully butted against each other. This will help you attach the plates in the correct location

Step 2 Attach a track end plate

Position a track end plate as shown below and screw it into the supporting infrastructure with three wood screws.

3.2.4 Vertically aligned

All of the track extrusions must be the same height and aligned along their length so that the gantry can move across the tracks smoothly. This means that all of the track end plates and track joining plates need to be vertically aligned.

We've added small notches into the track end plates and track joining plates so that you can position the plates with perfect vertical alignment with respect to your supporting infrastructure and each other. You should only use these notches if the top edge of your supporting infrastructure is level and straight.

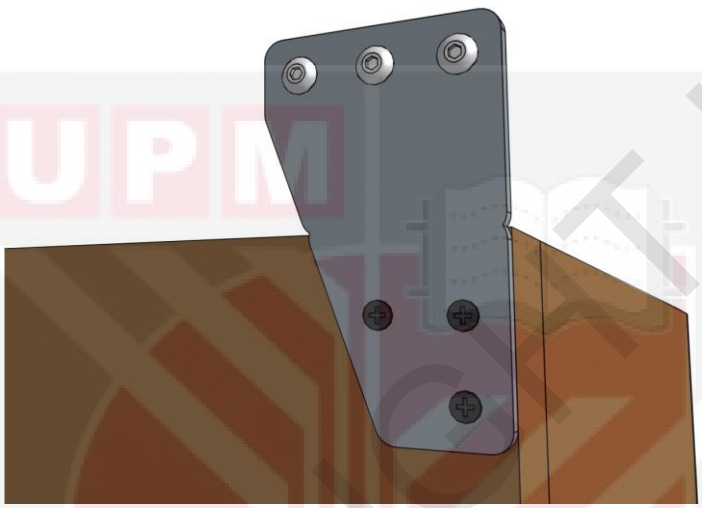


Figure 4: Positioning bracket for track right side

If the top edge of your supporting infrastructure is not level or straight, then you will need to manually ensure that your track plates are vertically aligned with other means. Because the gantry has wheels that ride on the bottom face of the track extrusions, you need to ensure that the bottom of the track extrusion will be at least 25mm away from the top of the supporting infrastructure so that the wheels have adequate clearance.

Step 3 Attach a track joining plate

Position a track joining plate such that one half of it will be able to attach to each track extrusion and so that it is vertically aligned with the first track end plate. Screw the plate into the supporting infrastructure with four wood screws.

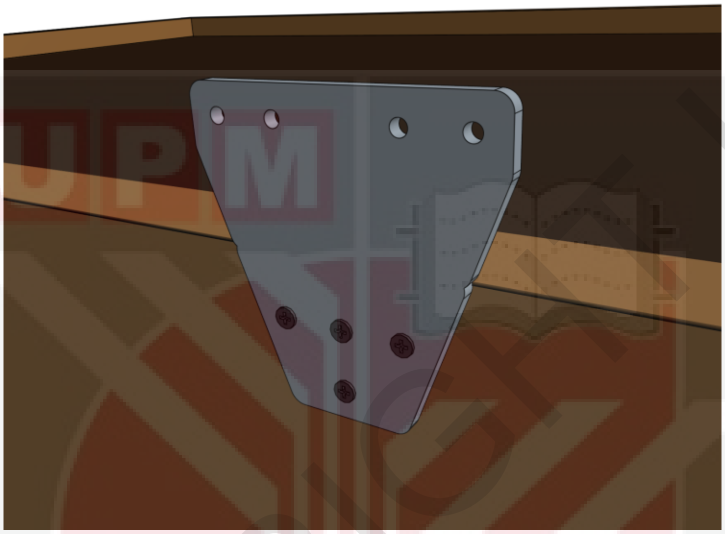


Figure 5: Centre of bracket positioning

Lightly screw four M5 x 10mm screws and tee nuts to the track joining plate. Orient the tee nuts horizontally.

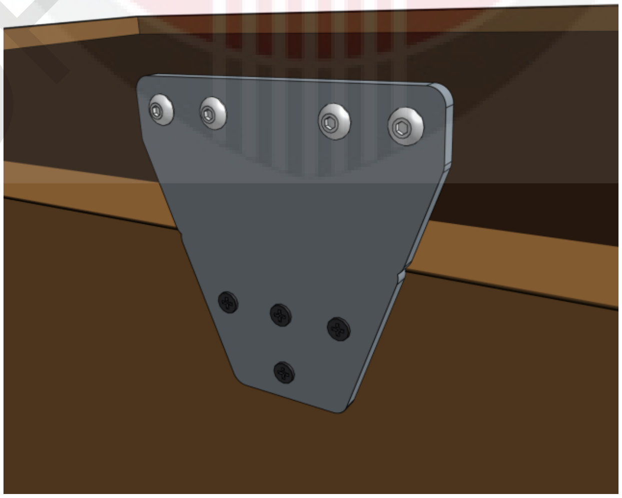


Figure 6: Screw positioning for tightened

Step 4: Attach the first track extrusion

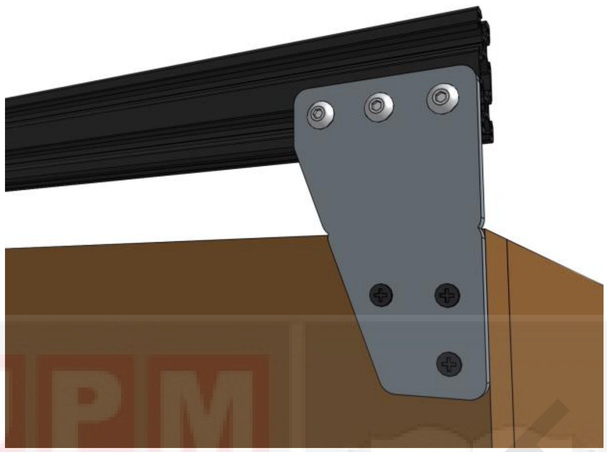


Figure 7: Tracks screwed to bracket

Lift the track extrusion and position the lower V-slot onto the tee nuts of the track end plate. Lightly tighten one of the M5 x 10mm screws using the 3mm hex driver to prevent the extrusion from falling off, while still allowing it to move loosely.

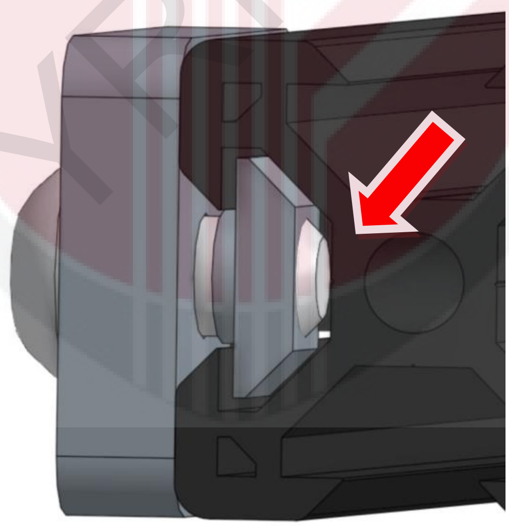


Figure 8: Screw positioning once tightened

In order for the tee nuts to fasten the extrusion to the plate, the tee nuts must rotate 90 degrees when you begin tightening the screw so that the tee nut's flanges can grip the inside faces of the extrusion slot. You can see how this works by looking in the end of the extrusion slot when you tighten a screw and tee nut. If the nut doesn't grip the slot the first time, simply loosen the screw and try again.

Lift the other end of the track extrusion and position the lower V-slot onto two of the tee nuts in the track joining plate. Verify that the track extrusion is positioned correctly, and then fully tighten all five of the M5 x 10mm screws that fasten the extrusion to the two plates.

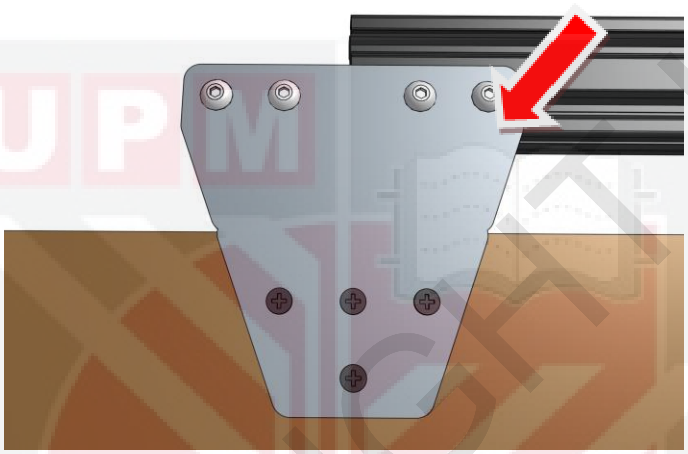


Figure 9: Track assembled for centre plate

Step 5 Attach the next extrusion

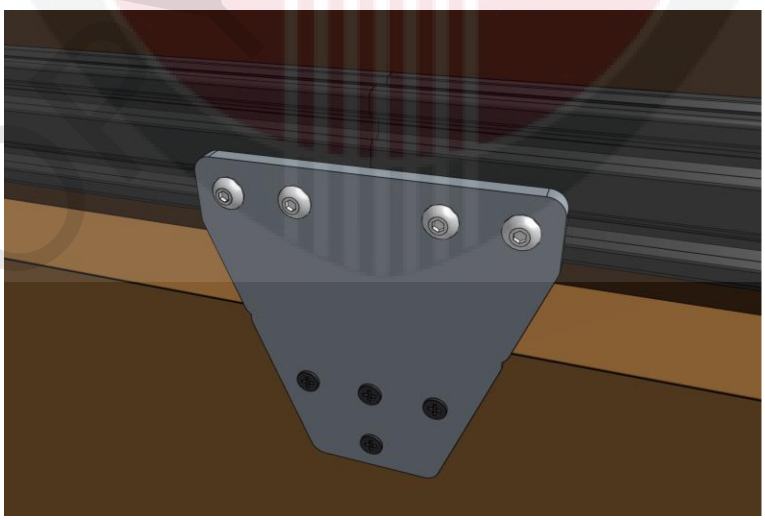
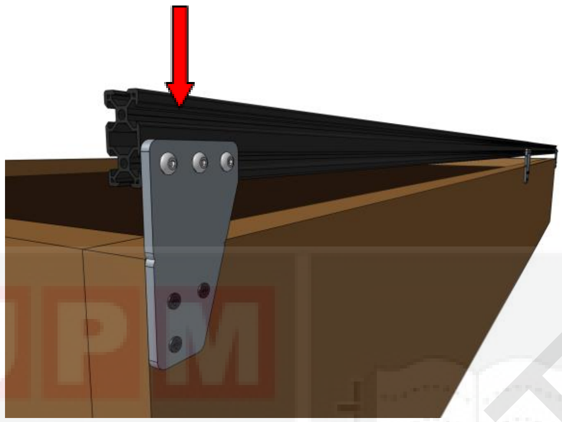


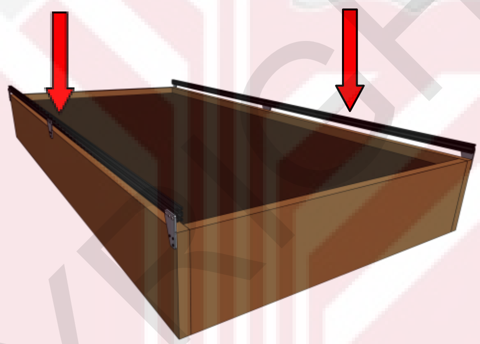
Figure 10 : Track connected at the centre of brackets

Lightly tighten the M5 x 10mm screws using the 3mm hex driver to prevent the extrusion from falling off, while still allowing it to move loosely.

Step 6 Attach the second track end plate

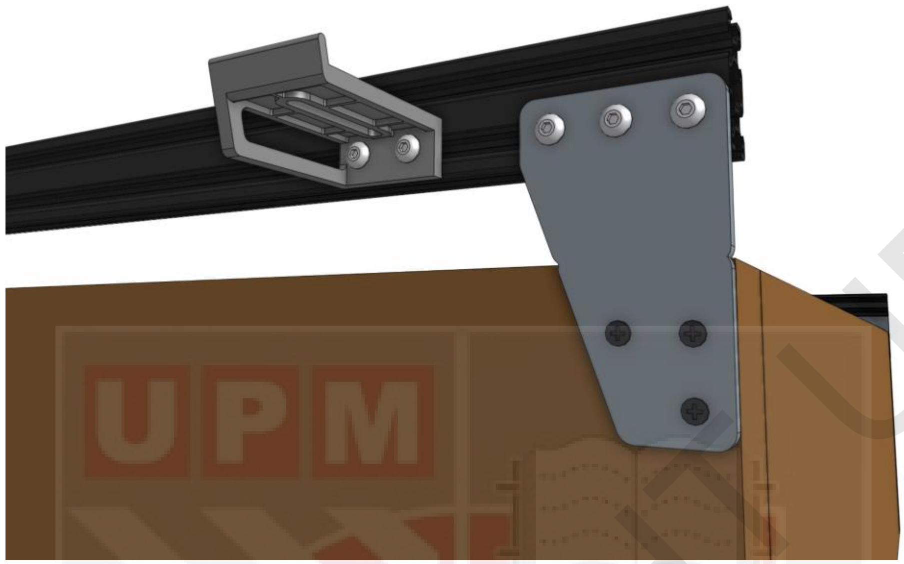
Follow the instructions in Step 2 to attach the second track end plate and final track extrusion. Securely tighten all screws.

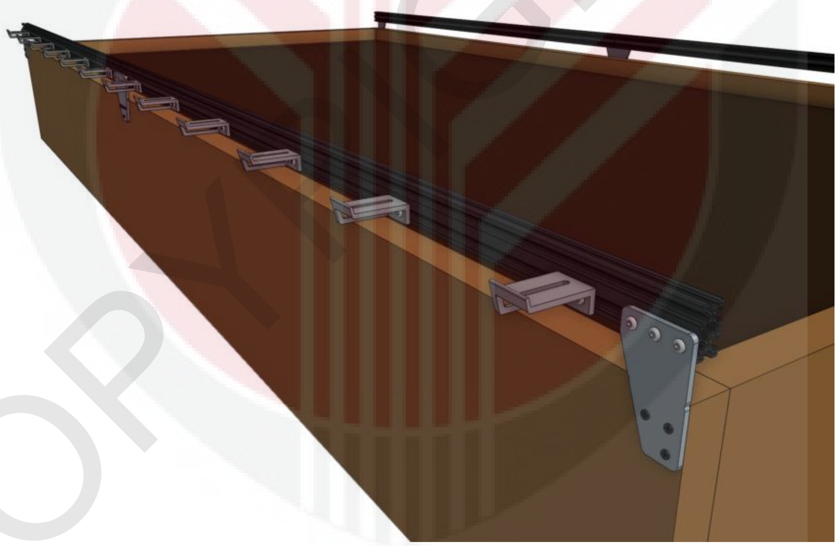




Repeat steps 2 through 5 for the track on the other side of the bed.

Step 7 Add the horizontal cable carrier supports





3.2.5 Assembling gantry

Figure 11 : Gantry Positioning completely assemble

3.2.5.1 Part A

Step 1: Attach the upper V-wheels

On the opposite side of the gantry wheel plate, add an M5 washer and an M5 locknut to the M5 x 30mm screw. Tighten the wheel assembly using the 3mm hex driver and the 8mm box wrench.

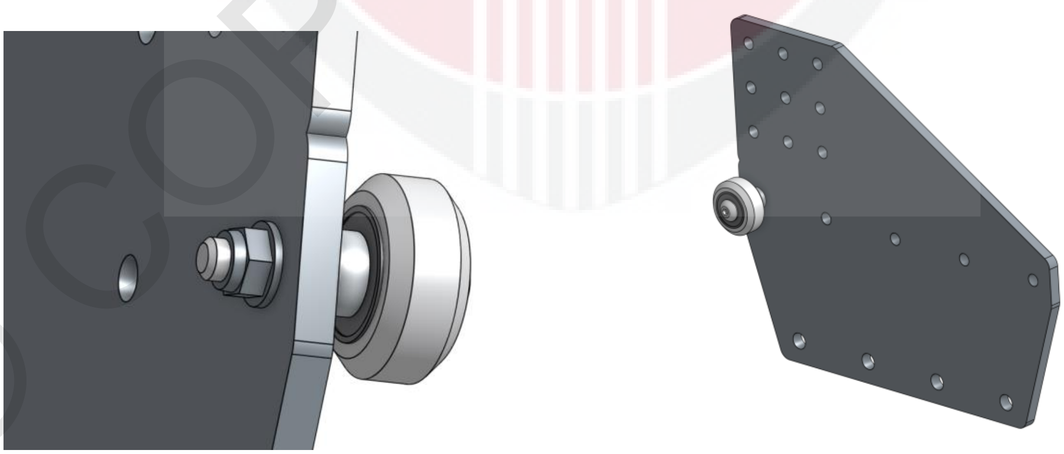


Figure 12: V wheel positioning and assembling

Step 2: Attach the lower V-wheels

Insert an eccentric spacer into the gantry wheel plate.

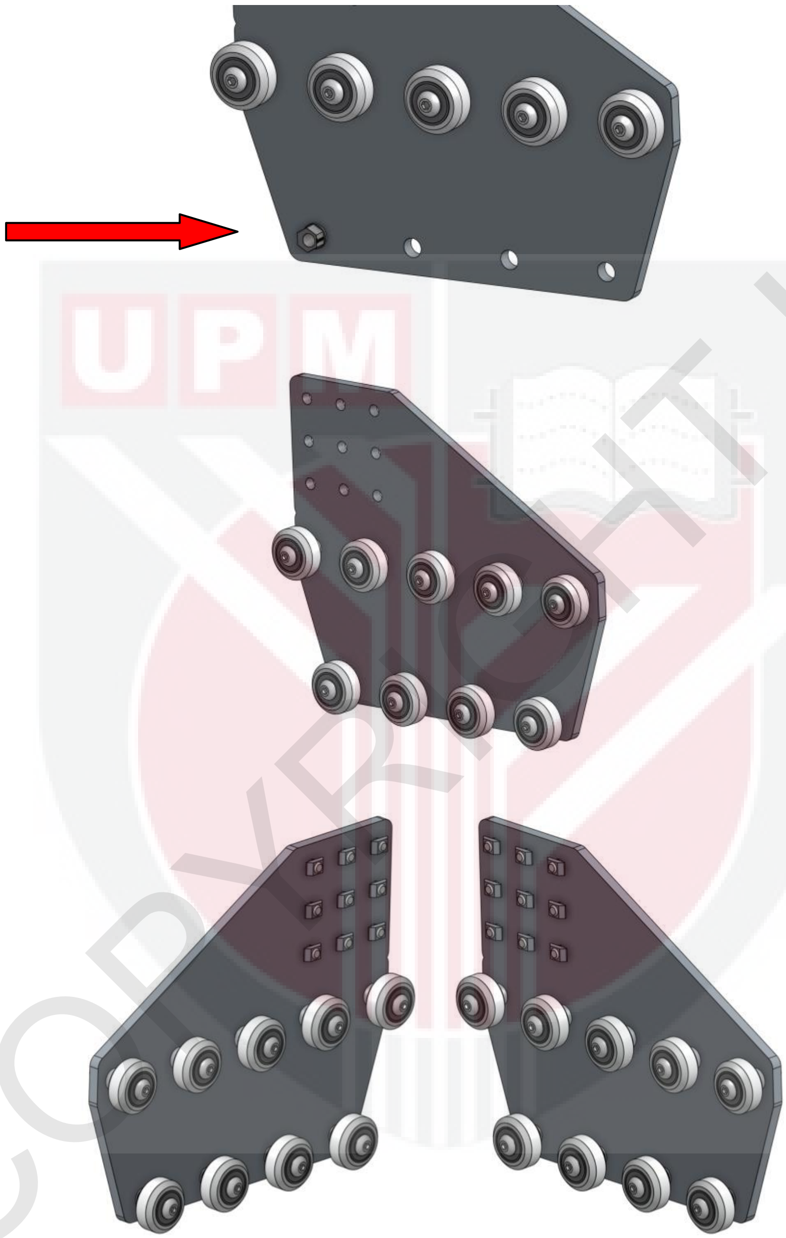


Figure 13: V wheel completely assembled

3.2.5.2 Construct the Gantry Structure

Step 1: Attach the plates to the columns

Position the gantry column onto the gantry wheel plate assembly. The extrusion should reside on the same side of the plate as the V-wheels and the end of the extrusion should be aligned with the notch in the plate. Tighten the M5 x 10mm screws using the 3mm hex driver.

Figure 14: complete with upper track

Step 2: Attach the gantry corner brackets

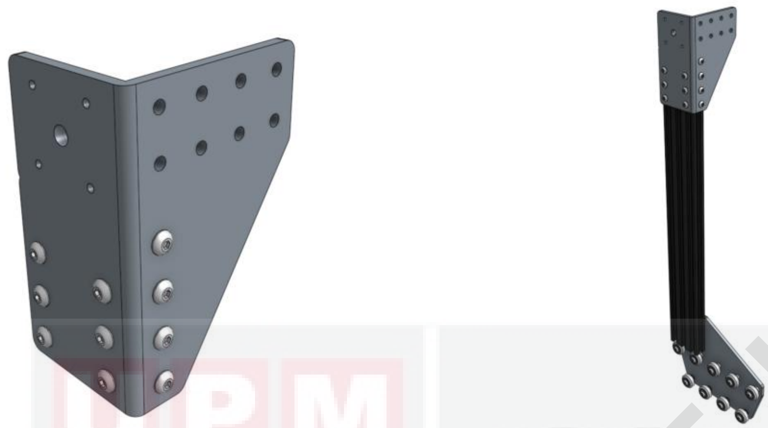


Figure 15: Connected with corner brackets for each side

Step 3 Slide the gantry columns onto the track

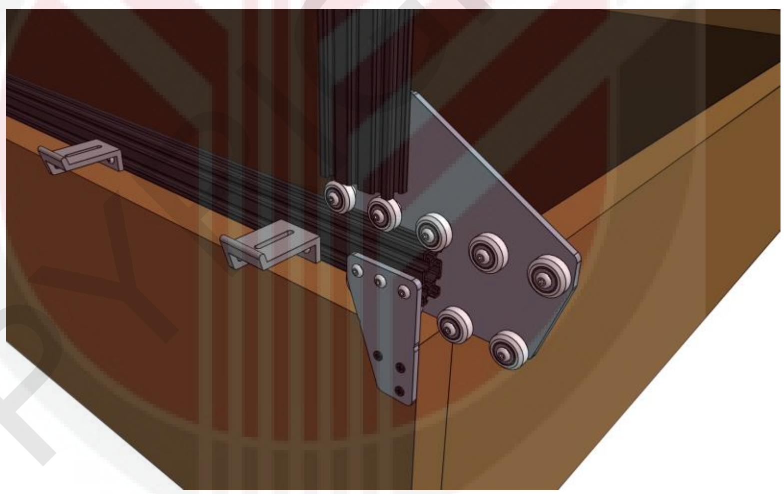


Figure 16: V wheel testing in the track in the right positioning

Slide the gantry columns onto the tracks. The direction that the wheel plates extend from the column is towards the front of FarmBot.

Step 4 Attach the main beam

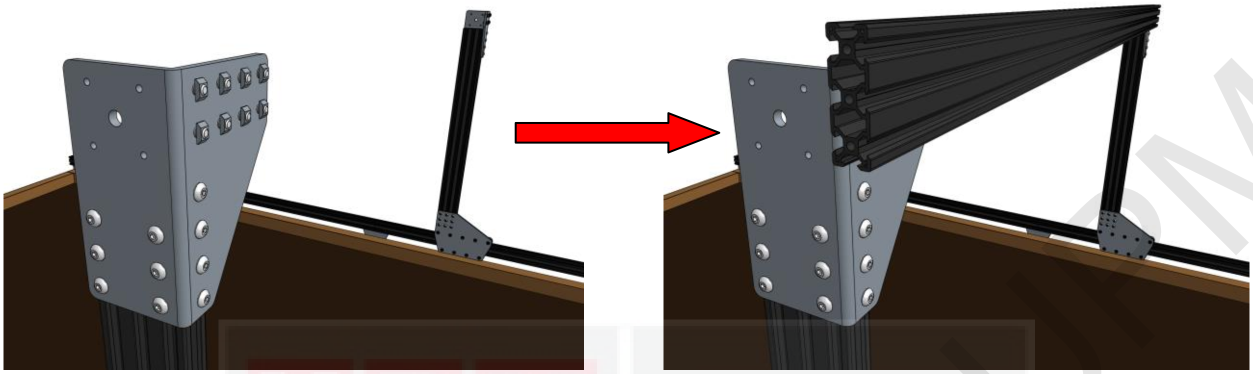


Figure 17: Assembling upper track for y-axis

Lift up the gantry main beam and position it onto the front of the gantry corner brackets. The tee nuts should fit into the lower two extrusion slots of the main beam such that the top face of the main beam is 20mm above the top faces of the gantry corner brackets.

3.2.6 Attach the Drivetrain

Step 1: Attach the gantry motors

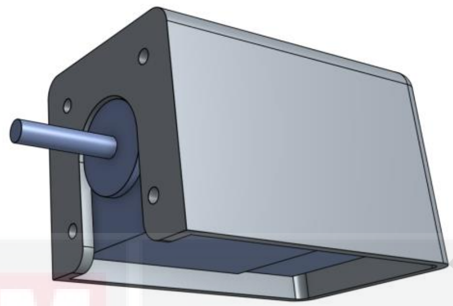


Figure 18: Stepper motor

Slide a motor into a horizontal motor housing, ensuring that the shaft of the motor is coming out of the housing and that the motor and encoder connectors are facing down through the open bottom of the housing.

Position the motor and housing onto the gantry corner bracket and attach it with four M3 x 12mm screws.

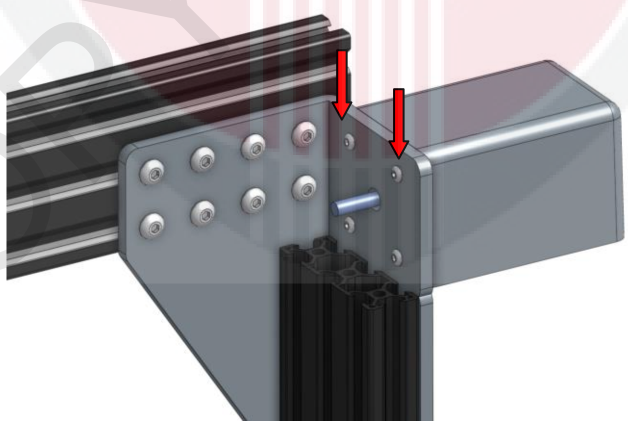


Figure 19: Stepper motor mounted to the track.

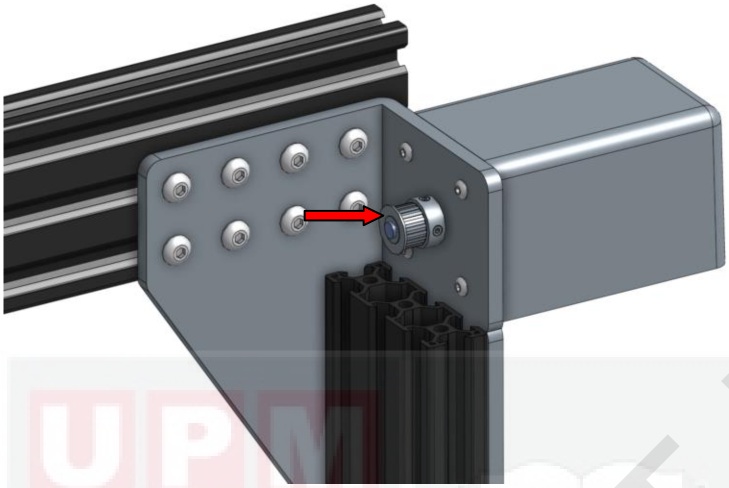


Figure 20: GT2 pulley positioning

Slide a GT2 pulley onto the motor shaft and tighten the two setscrews with the 2mm hex driver.

Make sure that the two setscrews contact the two flat areas on the motor shaft.

Step 2: Install the horizontal cable carrier supports

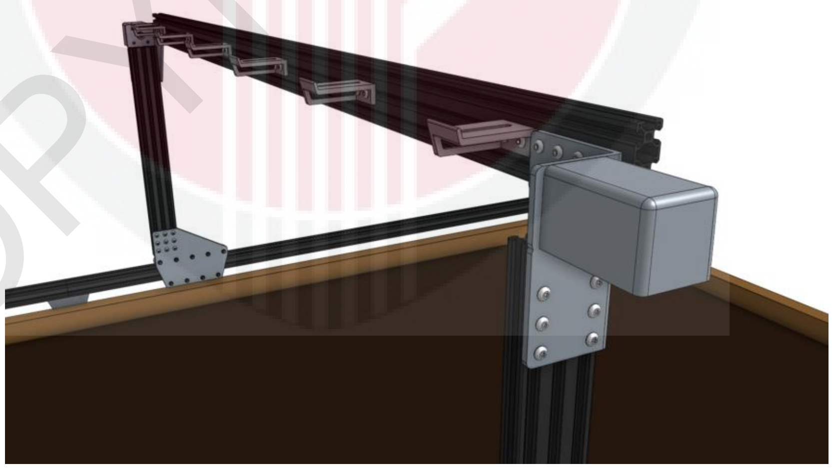


Figure 21: Complete assembled stepper motor

Attach six horizontal cable carrier supports to the back side of the gantry main beam using two M5 x 10mm screws and M5 tee nuts for each support. The supports should reside in the middle slot of the main beam extrusion and be equally spaced along its length.

3.2.7 Feed and Secure the Belts

Step 1: Feed the belts

Drop the ends of one of the x-axis GT2 timing belts down the two large openings of a gantry column, ensuring that the belt teeth engage the GT2 pulley. Grab the ends of the belt at the bottom of the gantry column and feed them under the V-wheels of the gantry wheel plate, then along the top of the track extrusions to the ends of the tracks. The flat side of the belt should be in contact with the V-wheels.

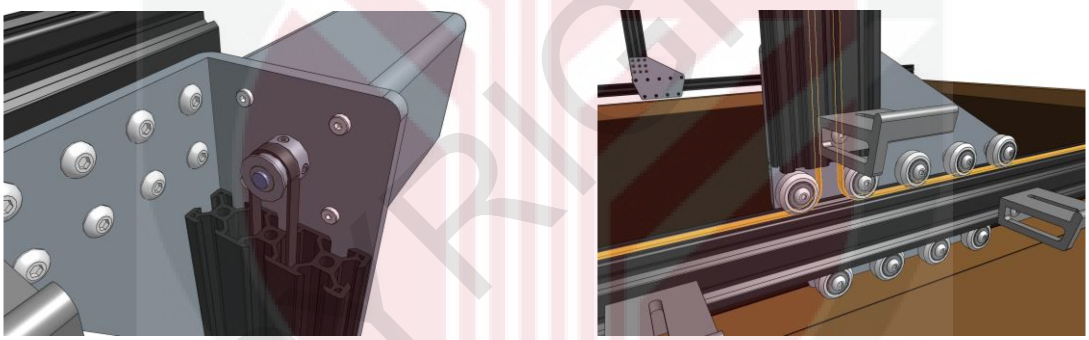


Figure 22: Belting assembling and positioning for movement

Step 2: Secure the belts

Secure the end of the belt to the front end of the tracks by using a belt clip, M5 x 10mm screw, and M5 tee nut.The belt must be wrapped through the clip as outlined in the belt clip installation guide.Secure the belt clip by tightening the M5 screw.

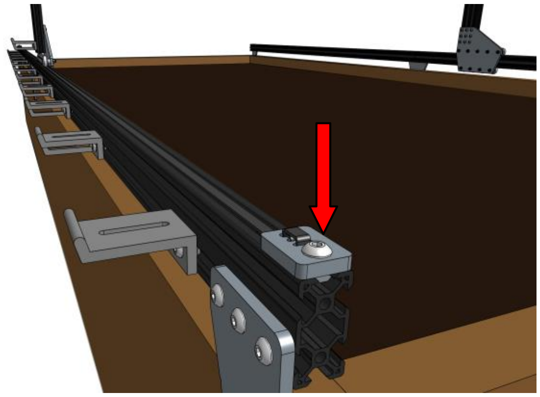


Figure 23: Track belt are lock it the end of track.

Step 1: Attach the gantry V-wheels

Use three M5 x 30mm screws to attach three V-wheels with eccentric 6mm spacers to the holes shown. The V-wheels should be secured with an M5 washer and an M5 locknut on the other side.

Step 2: Add the Z-axis V-wheels

Flip the cross-slide over so that all of the V-wheels you have added so far are facing away from you. Use two M5 x 30mm screws to attach two V-wheels with normal 6mm spacers to the holes shown. Secure these wheels with an M5 washer and an M5 locknut on the other side of the plate. Use three M5 x 30mm screws to attach three V-wheels with eccentric 6mm spacers to the holes shown. The V-wheels should be secured with an M5 washer and an M5 locknut on the other side.

Step 3: Attach the delrin leadscrew block

Insert two M5 locknuts into the delrin leadscrew block's hexagonal counterbores. With the locknuts and delrin block facing you, attach it to the side of cross-slide plate as shown. Secure the block using two M5 x 16mm screws from the opposite side of the plate.

Step 4: Slide the cross-slide onto the gantry main beam

Once you have adjusted the eccentric spacers, slide the cross-slide onto the gantry main beam.

Step 5: Feed and secure the belt

Use a belt clip, M5 x 10mm screw, and M5 tee nut to secure one end of the y-axis GT2 timing belt (2m long for Genesis, 3.5m long for XL) to the end of the gantry main beam. The belt must be wrapped through the clip as outlined in the Belt Clip Installation reference guide. Feed the belt under the end V-wheel of the cross-slide, then over the GT2 pulley and under the remaining three V-wheels. The flat side of the belt should be in contact with your V-wheels while the toothed side should engage with the teeth on the pulley. Secure the belt at the other end of the gantry with another belt clip, M5 x 10mm screw, and M5 tee nut. Put a small amount of tension on the belt as you tighten the M5 screw.

3.2.8 Cross-Slide

Step 1: Attach the gantry V-wheels

Use four M5 x 30mm screws, M5 washers, and M5 locknuts to attach four V-wheels with normal 6mm spacers to the cross-slide plate Make sure you attach the V-wheels to the correct side of the cross-slide plate as shown.

Wheels with normal spacers.Wheels with normal spacers.Use three M5 x 30mm screws to attach three V-wheels with eccentric 6mm spacers to the holes shown. The V-wheels should be secured with an M5 washer and an M5 locknut on the other side. Bottom three wheels with eccentric spacers.Bottom three wheels with eccentric spacers.

Step 2: Add the Z-axis V-wheels

Flip the cross-slide over so that all of the V-wheels you have added so far are facing away from you.Use two M5 x 30mm screws to attach two V-wheels with normal 6mm spacers to the holes shown. Secure these wheels with an M5 washer and an M5 locknut on the other side of the plate.Wheels with normal spacers.Wheels with normal spacers.Use three M5 x 30mm screws to attach three V-wheels with eccentric 6mm spacers to the holes shown. The V-wheels should be secured with an M5 washer and an M5 locknut on the other side.Right three wheels with eccentric spacers.Right three wheels with eccentric spacers.

Step 3: Attach the delrin leadscrew block

Insert two M5 locknuts into the delrin leadscrew block's hexagonal counterbores. With the locknuts and delrin block facing you, attach it to the side of cross-slide plate as shown. Secure the block using two M5 x 16mm screws from the opposite side of the plate.

Step 4: Attach the stepper motor

Insert the stepper motor into the horizontal motor housing such that the motor and encoder connectors are facing down, out the open face of the housing. Use four M3 x 12mm screws to attach the stepper motor and motor housing to the cross-slide plate.Orientation is key The motor and housing should be on the same side of the cross-slide plate as the delrin leadscrew block and the motor and encoder connectors should be facing down towards the delrin leadscrew block.

Slide a GT2 pulley onto the stepper motor shaft. Make sure that both setscrews are lined up with the flat spots of the motor shaft. Then tighten the setscrews with the 2mm driver.

Step 5: Add the long cable carrier support

Use two M5 x 16mm screws, M5 washers, and M5 locknuts to secure the long cable carrier support to the cross-slide plate. The bracket should be on the opposite side of the plate as the motor. The washers should be on the same side of the plate as the motor.

Step 6: Adjust the eccentric spacers

In order for the cross-slide to slide smoothly and wobble-free on the gantry main beam, you must first adjust the eccentric spacers of the bottom three V-wheels. Adjust the eccentric spacers using the eccentric spacer adjustment reference guide.

Step 7: Slide the cross-slide onto the gantry main beam

Once you have adjusted the eccentric spacers, slide the cross-slide onto the gantry main beam.

Step 8: Feed and secure the belt

Use a belt clip, M5 x 10mm screw, and M5 tee nut to secure one end of the y-axis GT2 timing belt (2m long for Genesis, 3.5m long for XL) to the end of the gantry main beam. The belt must be wrapped through the clip as outlined in the Belt Clip Installation reference guide. Feed the belt under the end V-wheel of the cross-slide, then over the GT2 pulley and under the remaining three V-wheels. The flat side of the belt should be in contact with your V-wheels while the toothed side should engage with the teeth on the pulley. Make sure that the belt is not twisted anywhere . Secure the belt at the other end of the gantry with another belt clip, M5 x 10mm screw, and M5 tee nut. Put a small amount of tension on the belt as you tighten the M5 screw.

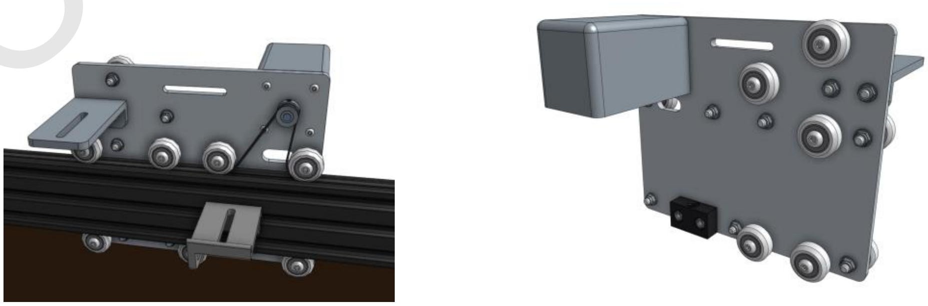


Figure 24: Z-axis complete assembled

3.3 Designing missing part

In this phase have something g missing in assembling the water pump and the vacuum pump holder and cover. Taking the dimension and make decision on the design how to put it on the z axis and the dimension of the holder, considering the angle also want to put the wiring to power up the water pump and the vacuum pump,

Using the tempalary plate designing how it would be look like and be attached to the z axis, dimension is taking including thickness, width and also length. Discussing with supervisor and decide to do 3D printing for the missing part .drawing is using autocad also using the 3D printer to print the holder and cover for both of the parts.

In designing using the autocad is more easier when u have the dimension and early design have make the work easy here u know how to using the tools inside the navigate all the tools inside the taskbar and start to draw the thing. Friendly interface in autocad is make me more easier to doing the drawing activate the drawing tools using them to modified the drawing and using command also make ur work more faster.

Keep on practising in using all the tools will make u much better in doing drawing and find the new gadget combine in using autocad drawing like 3D scanner willm make more fun in practising autocad and also more advance in used it for 3D printing method autocad also can be develop individual workflow in doing the drawing used the knowledge wisely to the industry and alwaye practising because every drawing we do a lot of new thing will finding day by day.

3.4 Programming and Toubleshooting

Configurator is a piece of software built into FarmBot OS that makes it easy to connect your FarmBot to a WiFi network and to your FarmBot web app account. You will not ever need to connect a keyboard and screen to the FarmBot or SSH in over an ethernet connection.

3.5 Configure FarmBot

When the device boots up, it automatically starts up Configurator. Configurator checks for configuration data. Initially, there will not be any configuration data, so the device will not be able to connect to your home WiFi network or your FarmBot Web App account. In this case, Configurator will create its own WiFi network with an SSID named farmbot-xxxx (x representing numeric and letter symbols).

Step 1: Connect to Configurator

Using your phone or laptop, connect to the farmbot-xxxx WiFi network.Open up a web browser and navigate to setup.farm.bot, to access the Configurator page.Turn off cellular data

If you are using a smartphone you may need to disable cellular data to allow your phone's web browser to connect to the configurator. If you experience a site connection error in the browser, try navigating to 192.168.24.1 instead of setup.farm.bot.

Step 2: Enter credentials

From here, follow the on-screen form to enter:Network connection type Select wireless (WiFi network) or wired (Ethernet) by pressing the corresponding icon. For network interface name and mac address, press the icon.

3.5.1 For connection to a WiFi network:

Select the name (SSID) of the network you would like your FarmBot to normally connect to (for example, your home WiFi network). Alternatively, enter the name of the WiFi network in the manual input box.

Enter the password for the WiFi network. (For other network settings, such as DNS or IP assignment, press ADVANCED SETTINGS.)

3.5.2 For connection to a wired network:

If you need to input additional network settings, such as DNS or IP assignment, press ADVANCED SETTINGS. Otherwise, press the NEXT button.

3.5.3 Hardware board / kit version

Use the dropdown menu to choose the firmware version to install based on what electronics were included with your FarmBot.

FarmBot Version	**Electronics Board**	**Firmware Name**
Genesis v1.2	RAMPS	RAMPS(Genesis 1.2)
Genesis v1.3	Farmduino	Farmduino (Genesis v1.3)
Genesis v1.4	Farmduino	Farmduino (Genesis v1.4)

Email and password for your web app account

Remember: you must have a verified web app account in order for the Farm-Bot to connect to the web app. See instructions for creating and verifying an account here. If you are self-hosting the web application on your own servers, replace "https://my.farm.bot" with your custom server URL (advanced).

Step 3: Submit configuration

Now press FINISH. FarmBot OS will now attempt to connect to the WiFi network and Web App account provided. This will terminate the connection between your smartphone or laptop and FarmBot OS, so you can now close the web browser tab that you were using to complete the configuration process.

Step 4: Check to see if FarmBot is online

Use your phone, tablet, or laptop to connect to your home WiFi network. Navigate to my.farm.bot and watch the status ticker to see when FarmBot comes online and begins sending messages. This should happen within 2 minutes of completing configuration.

Once FarmBot is initialized, try pressing one of the manual movement arrow buttons. You should see FarmBot responding to your commands and sending back messages.If there is a problem with the configuration, such as an incorrect password, then the Configurator program will restart and you will see the farmbot-xxxx WiFi network again. If this happens, try configuring again or consult the troubleshooting guides. There were challenges during testing where the Farm-Bot does not work as expected. However troubleshooting was done with the help of other lecturers and forum users and it was found that the Arduino board contact was faulty

CHAPTER 4

RESULTS AND DISCUSSION

In this project few archivement have been done to the farm bot :

1.Raised bed was built with the size 9 ft (L) x 4ft (W) 1 ft (H)

2. Installation for mechanical and electronic parts were all done following schedule.

3. Motors and encoder for the FarmBot was verified to work as expected.Checked the motion of FarmBot moving in X, Y and Z axis is successful.FarmBot can move as per instruction given from the GUI.

4. All programming for sensor and actuator are done. FarmBot is workingas expected and are able to be used for indoor planting in the future.

4.1 Estimation farmbot calculation for lettuce planting.

4.1.2Layout farm-bot moving for seedling process

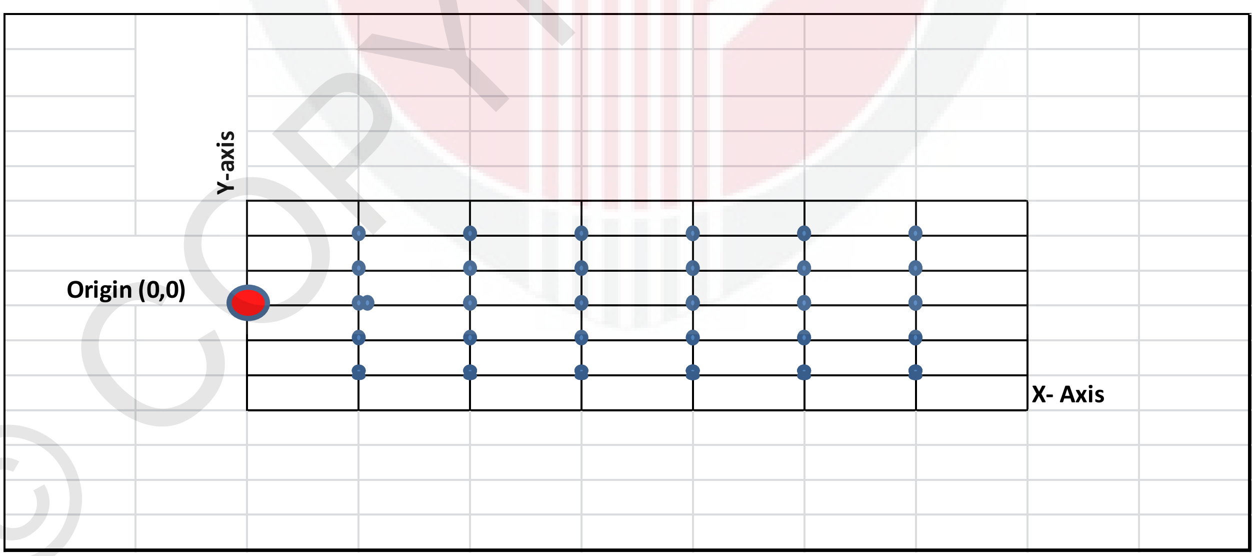


Figure 25:Farmbot layout movement

For farmbot planting layout is planning about 5 row x 5 plant per row and estimation is calculate by certain distance with size (width 1.2192 m X 1.524 m). Crop is planting with full within equal distance recommended.

Distance calculation is using this equation:

For the 1st row

$$2(5x + 6y) + (2z)$$

Movement from origin to the first point is 2 time for x-axis and 2 time for y- axis also moving 2 times for z-axis so it have 5 point

For the 2nd row

$$2(10x + 6y) + (2z)$$

For nth Row

$$2(n(5x + 6y)) + (2z)$$

$$\text{Time Taken} = \frac{\text{Total Distance } (x+y)}{\text{Velocity}(x,y)} + \frac{\text{Total Distance } (z)}{\text{velocity } (z)}$$

Example for calculation for the set up distance between plant centre is x = 0.24m y = 0.30m with the seed pot high from the ground z = 0.15m

Given :

Speed in X -Axis = 80 mm / s @ 0.08 m/s x value = 0.24 m

Speed in X -Axis = 80 mm /s @ 0.08 m/s y value = 0.30 m

Speed in Z -Axis = 16 mm / s @ 0.016 m/s z value = 0.15 m

Example calculation for 1st row

Working distance = 2(5x + 6y) + (2z)

= 2 (5(0.24) + 6 (0.30)) + 2(0.15)

= 6 + 0.3

= 6.03m

	x + y (m)	**Z (m)**
1st row	6	0.3
2nd row	8.4	0.3
3rd row	10.8	0.3
4th row	13.2	0.3
5th row	15.6	0.3
Total Distance Moving	**54**	**1.5**

Figure 26: Table of result calculation

Using the data and set up user define speed given in x-axis , y-axis and z- axis time taken to complete the job 5 row X 5 plant is like below calculation.

$$\text{Time taken complete job } t = \frac{\text{distance}}{\text{velocity}}$$

$$\text{Time Taken} = \frac{\text{Total Distance (x+y)}}{\text{Velocity(x,y)}} + \frac{\text{Total Distance (z)}}{\text{velocity (z)}}$$

$$= \frac{54\text{m}}{0.08\text{m/s}} + \frac{1.5\text{m}}{0.016\text{m/s}}$$

$$= 768.75\text{s @ } 12.81 \text{ minute}$$

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

There were challenges during testing where the Farm-Bot does not work as expected. However troubleshooting was done with the help of other lecturers and forum users and it was found that the Arduino board contact was faulty. Finally the Farm-Bot Genesis v1.2 was successfully assembled on a 9’ x 2’ x 1’ raised bed inside the department robotics lab. The Farm-Bot will be used to plant crops indoor for class learning and for research in the future.

5.2 Recommendation

Suggestion for the future improvements are:

1. LED lighting needs to be installed prior to planting to provide enough light for crops grown indoor.
2. The Farm-Bot should be upgraded to the latest version v1.4. The new version comes with electronics box fully installed and complete with LED lights. Newer version will have better support from the other manufacturers and other users.

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APPENDIX