CG1112 Engineering Principles and Practices for CEG

Vincent Connection Guide

1. Objective

   The objective of this guide is to help you connect up Vincent's key components. This guide will not cover issues like how to lay out the various electronic and mechanical components on Vincent. You will need to rely on your creativity for this.

2. The Vincent Challenge

   The Basic Vincent Challenge

   In the Vincent Challenge, you will be building a robot named Vincent that is controlled over the internet (or "over the cloud" as many clueless-noobs-pretending-to-be-tech-experts are wont to say). Vincent will be carrying a Light Detection And Ranging (LIDAR) unit that will map the surrounding area (as well as preventing him from crashing into walls and other objects).

   You are to use Vincent to explore and map out a room remotely. How remotely? Literally in any part of the world, from Singapore. However due to the realities of budget constraints, Vincent will be in NUS but in a different room from where you are.

   As you control Vincent, he will be streaming back a live map of the room he is in, and you will display the map on your screen.

   You will be scored on how well you map the room within a given time frame.

   The Bonus Vincent Challenge

   You will gain bonus points if Vincent explores the room fully autonomously, without any input from you, and streams back a map of the room.

3. <u>Preliminaries</u>

   Charge the Eneloop batteries and the power bank.

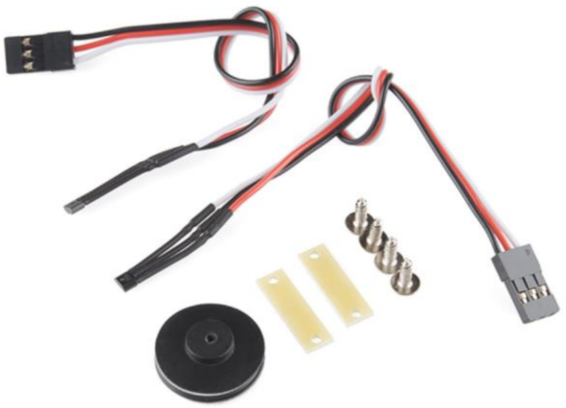
4. <u>Assembling Vincent</u>

   a. Locate the Magician Chassis packet. It contains components that look like this:

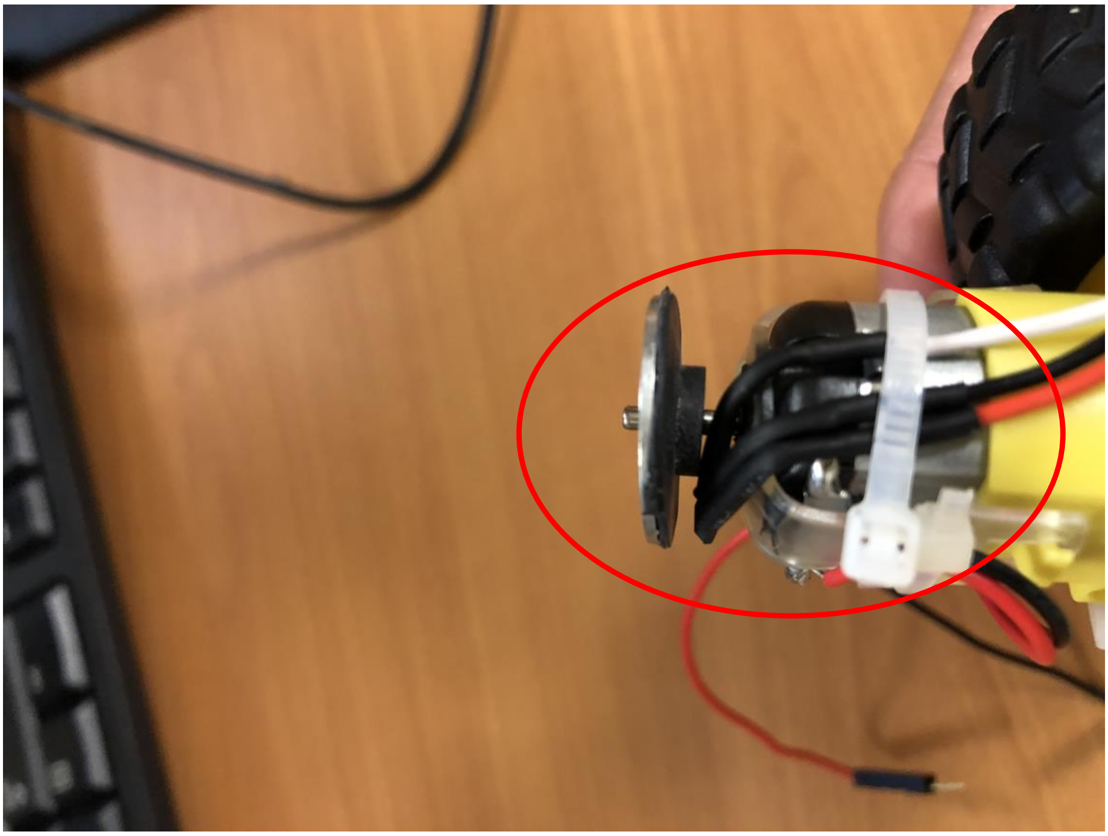
   b. Unpack the contents of the Magician Chassis, and remove the Assembly Instructions for your reference. It is a piece of paper that looks like this:

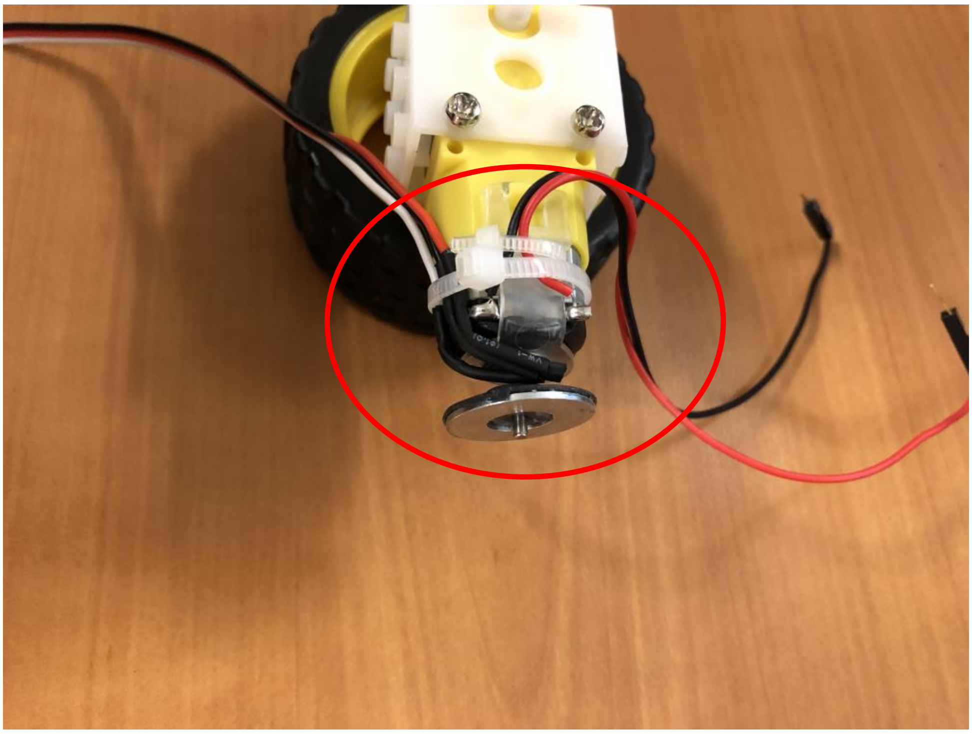
   c. Perform steps 1 and 2 of the Magician Chassis Assembly Instructions.

d. Locate the Wheel Encoder packet. The contents of the Wheel Encoder Packet look like this. The two silver/black disks are four-pole magnets, while the two skinny black objects with the red, white and black wires are Hall Effect sensors. The idea is that when the wheel turns the magnets, the Hall Effect sensor will detect the magnets and trigger pulses.



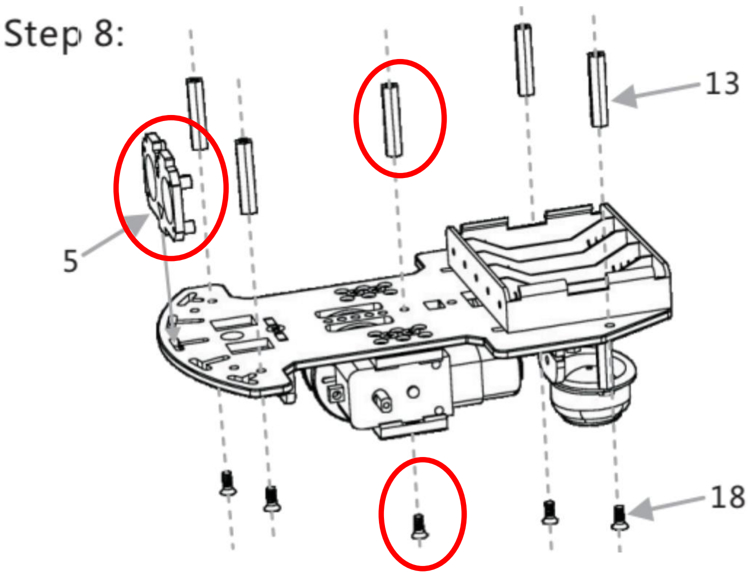
e. Unpack the Wheel Encoder, and mount one magnet and one encoder on each motor, using the following picture as guide. If you do not have a cable tie, get creative. The magnet and encoder are circled.





NOTE: This motor uses a 48:1 gear to drive the wheels, so whatever reading you get from the encoder, remember to divide by 48 to get the actual reading.

f. **SKIP STEPS 3 AND 4 IN THE MAGICIAN ASSEMBLY INSTRUCTIONS.**
g. Continue with steps 5, 6 and 7.
h. In Step 8:
   - DO NOT MOUNT THE COMPONENTS CIRCLED BELOW:



i. **SKIP STEP 9 FOR NOW UNTIL YOU HAVE FINISHED MOUNTING YOUR ELECTRONICS.**

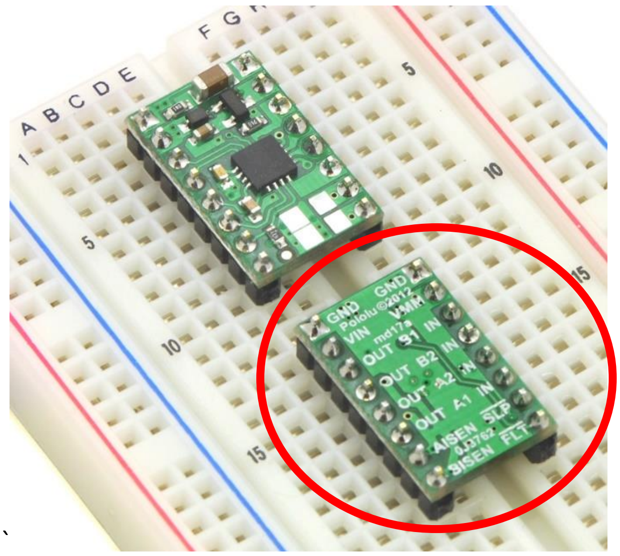
5. Connecting the Electronics

a. **READ THROUGH THIS WHOLE SECTION <u>AND PLAN HOW TO LAYOUT YOUR ELECTRONICS AND ELECTRICALS ON THE MAGICIAN CHASSIS</u> BEFORE STARTING. IF YOU DON'T, IT IS VERY LIKELY YOU WILL NEED TO DISMANTLE SOMETHING AND RESTART AGAIN. VERY FRUSTRATING. <u>DON'T SAY WE DIDN'T WARN YOU.</u>**

b. Assemble the DRV-8833 Dual Motor Driver Carrier:

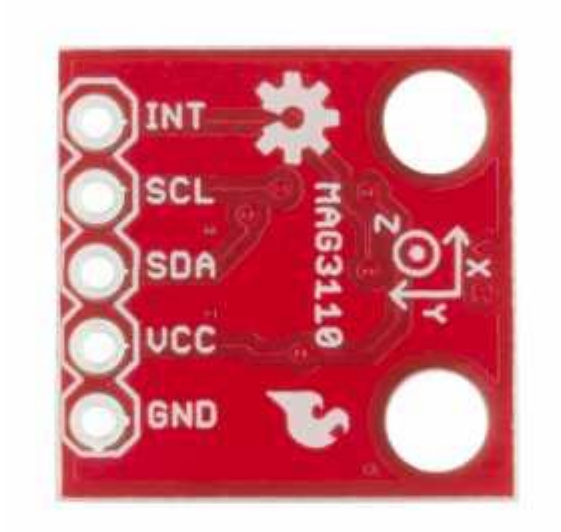
   i. Locate the packet containing the DRV-8833. It looks like this:

   ii. Solder on the pin headers. You can solder them on either side of the board, but it's a good idea to solder so that you can still see the labels, as shown circled below:



c. Triple-Axis Magnetometer

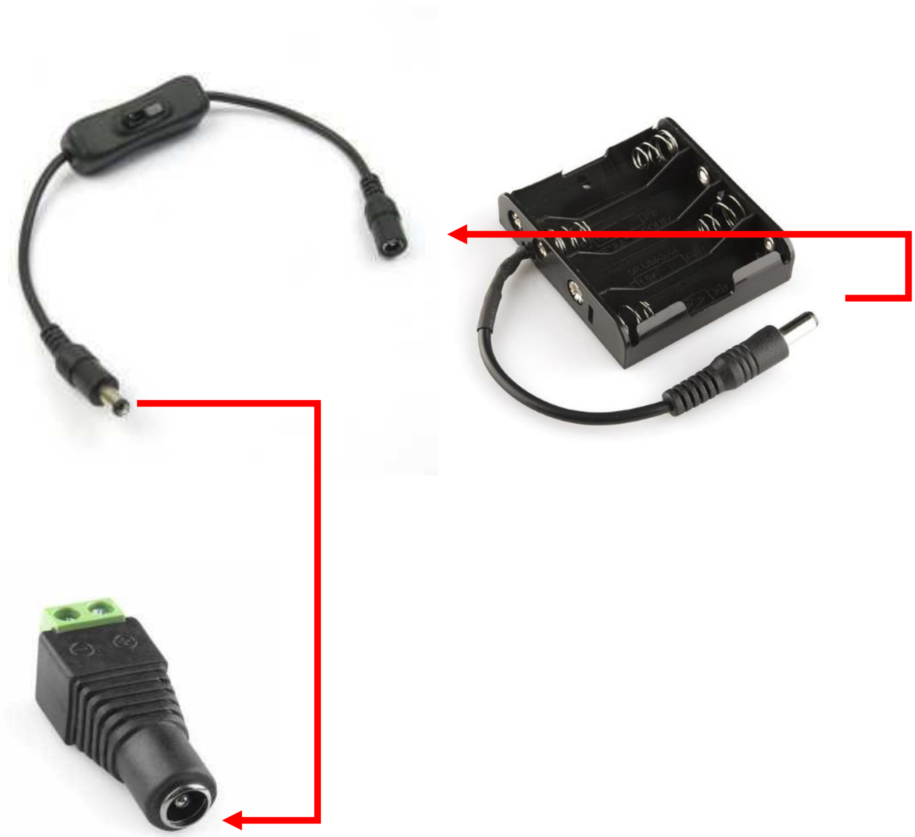
   This is the magnetometer:



Solder the pin header on, with the chip side FACING UP. Put this aside in your robot kit for a future studio.

d. Connecting the motor power:

Connect the battery carrier male plug to the inline switch’s female jack, and the plug on the inline switch’s male plug into the 2.1 mm female jack provided.



e. Connecting Up the DRV-8833 Dual Motor Driver Carrier.

We will now connect up the DRV-8833 Dual Motor Driver Carrier. The DRV-8833 contains a pair of H-bridges that will drive the motors. You will need to connect TWO power supplies to the DRV-8833. VIN and GND (on the same side as VIN) will be connected to the four Eneloop batteries to supply power to the motors. VMM and GND (on the same side as VMM) will be connected to the 5v and GND on the Arduino.

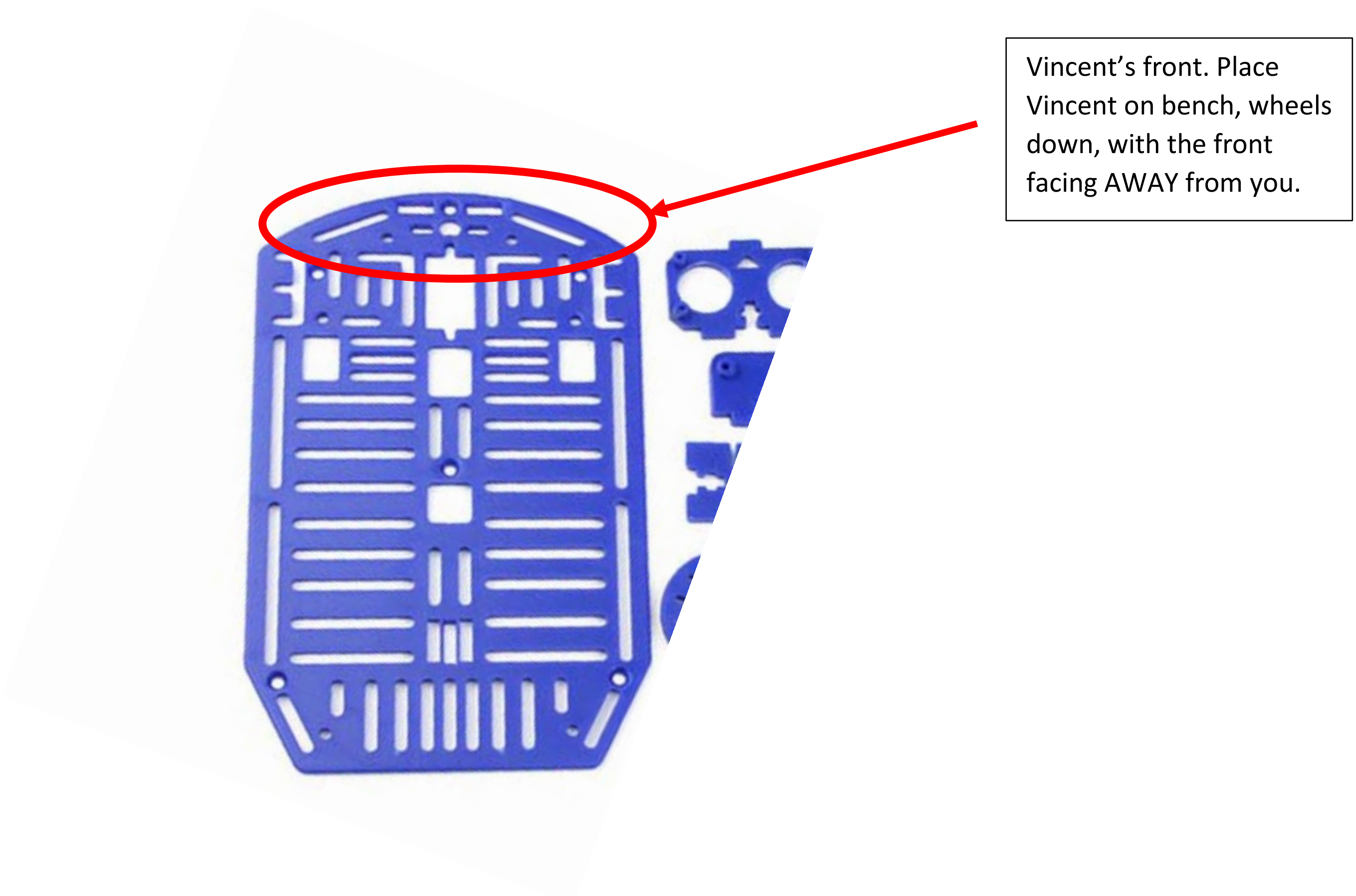
The remaining pins are connected either to the PWM outputs on the Arduino, or to the motors.

<u>Step 1</u>

We would like to standardize how you connect the motors to the DRV-8833, so to begin:

Place the Magician Chassis on the lab bench with the curved end facing AWAY from you (the curved end will be Vincent's front.)

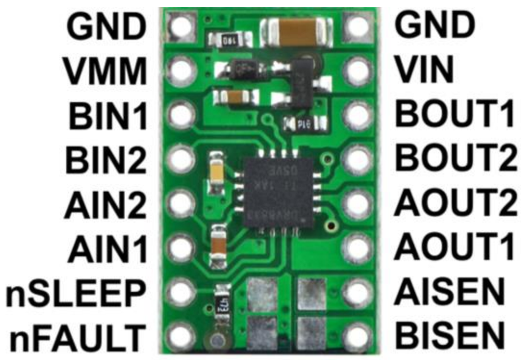
The left motor will be designated as MOTOR 1, and the right as MOTOR 2.



<u>Step 2</u>

Mount the DRV-8833 on a breadboard.

Connect up the DRV-8833 this way:



Pin	Description	Connect to:
VIN	Motor Power Supply VCC	+ screw of the 2.1mm female jack
GND (right side)	Motor Power Supply GND	- screw of the 2.1mm female jack
BOUT1	Motor 2 +ve	Red wire from RIGHT motor.
BOUT2	Motor 2 –ve	Black wire from RIGHT motor.
AOUT1	Motor 1 +ve	Red wire from LEFT motor.
AOUT2	Motor 1 –ve	Black wire from LEFT MOTOR
VMM	VCC from Microcontroller	5V on Arduino UNO
GND (left side)	GND from Microcontroller	GND on Arduino UNO
BIN1	Motor 2 control	Arduino pin 10
BIN2	Motor 2 control	Arduino pin 11
AIN1	Motor 1 control	Arduino pin 5
AIN2	Motor 1 control	Arduino pin 6

Leave the remaining pins unconnected.

Now when you do analogWrite on pins 5 and 10, Vincent will run in one direction (yet to be determined), and when you do analogWrite on pins 6 and 11, he will run in the opposite direction.

f. Connecting the Wheel Encoders

i. Wheel encoder power supply:

Both wheel encoders come with a 3-way cable, with red and black wires. These supply power to the Hall Effect sensor that is used to detect how many revolutions the wheel makes.

Connect the red wire of both encoders to 5V on the Arduino, and the red wire of both encoders to the GND on the Arduino.

ii. Wheel encoder signal:

Ensure that Vincent’s front is away from you.

Connect the white wire from the encoder mounted on MOTOR 1 (left motor) to **pin 2** of the Arduino, and the white wire from the encoder mounted on MOTOR 2 (right motor) to **pin 3** of the Arduino.

If you recall from Week 5 Studio 1, pins 2 and 3 are external interrupts INT0 and INT1 respectively. This way when the wheel turns, the pulses generated will trigger interrupts on the Arduino that can be caught with ISRs.

g. Connecting up the Arduino UNO

Use the full sized USB cable to connect the UNO to one USB port of the Raspberry Pi.

h. Connecting up the Raspberry Pi

Step 1. Power Up

Use the micro-USB cable and power up the Pi with the power bank.

Step 2. Configure Pi for SSH Access

Configure the Raspberry Pi as per Week 1 Studio 1. Ensure that you can ssh into your Pi using any of the techniques in that Studio.

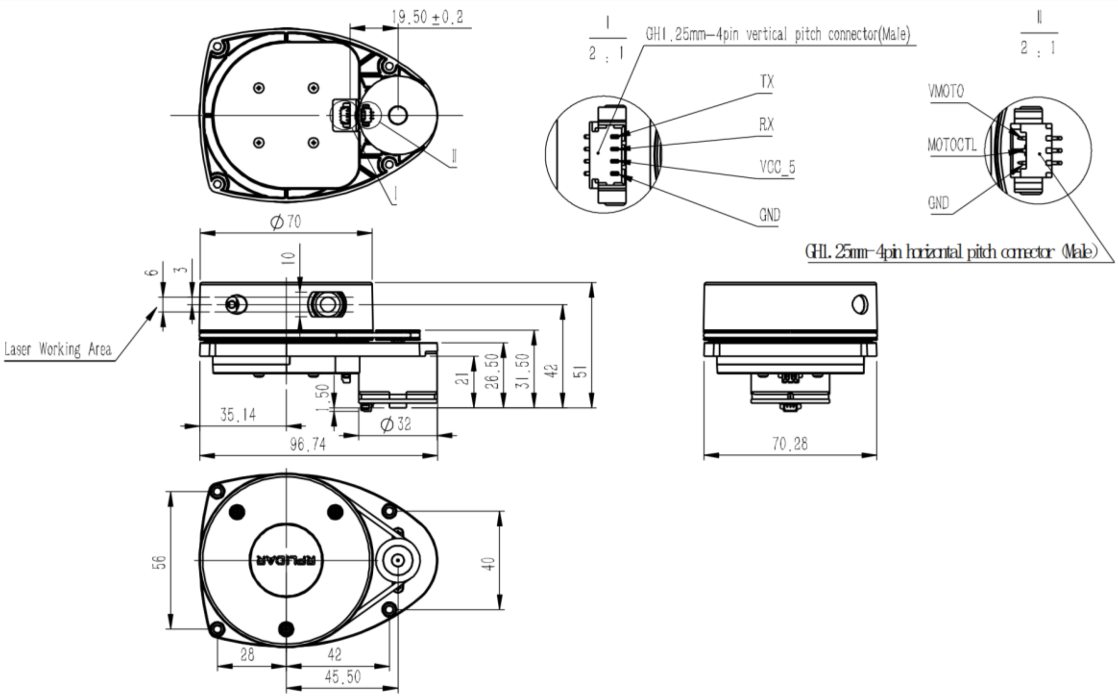
Step 3. Power Down

At the terminal, type:

```
sudo halt
```

Wait for about 10 seconds for the Pi to fully halt, then unplug it from the power bank

i. Now that you have read through everything and know how everything snaps together, plan out how you want to lay out Vincent's electronics. You can use any available space on the chassis. It is a challenge but it can be done. NOTE: You also need to budget space (or figure out a way) to mount the LIDAR in a future studio. Mechanical dimensions (in mm) for the LIDAR are shown below:



j. Perform all of the steps above from Steps b. through to h., laying out all the parts on Vincent's chassis.

k. Finish assembling the chassis as per the assembly guide.

6. Programming Vincent

Start the Arduino IDE and load the enclosed sketch called Vincent.ino.

Click on the robotlib tab, and you will see the code for programming Vincent. In particular there are 4 constants:

M1F, M1R: Motor 1 forward and reverse Arduino PWM pins.

M2F, M2R: Motor 2 forward and reverse Arduino PWM pins.

You may need to tweak these later.

7. Testing Vincent

Step 1. Unplug the Arduino from your laptop and connect it to the Raspberry Pi.

Step 2. Ensure that the inline switch is off.

Step 3. Insert the AA Eneloop batteries into the battery holder.

Step 4. Connect the Pi to the power bank.

Step 5. Switch on the inline switch.

You will now see Vincent running around like a drunken proboscis monkey. He will move forward, turn left, move backwards, turn right, and stop for 2 seconds, then repeat his drunken behaviour.

If he is turning or moving in the wrong direction, adjust M1F, M1R, M2F and M2R until he is behaving correctly.