d) Suppose you have been given the computer aided design model of the robot satisfying the necessary clearances and dimensions to hold the parcel. Using the necessary components, you have been assigned the task of programming the robot such that it can carry out the assigned task of delivering the parcel to the consumer doorstep navigating the traffic, turns and other obstacles. Explain how you would achieve this with the code and circuitry to substantiate your claim. It is allowed to take the necessary assumptions if you are certain that it is outside the scope of robotics to obtain the necessary data and then derive conclusions pertaining to that specific aspect.

In circuitry the components we're gonna use are:

- Raspberry pi
- Lidar
- GPS Module
- Gyroscope Module MPU6050
- Battery
- Encoders (for detecting the speed of the bot)
- Camera

Coding part:

For coding obviously I'm gonna go with ROS2 (Robot Operating System v2) with python .

First,

I'll create a workspace for this bot and the main thing for this robot is to maintain its balance. So, I'll create a specific package for maintaining the balance of the robot. The communication type for this package will be publisher and subscriber, the publisher will publish the current data from the gyroscopic module (MPU6050)

And the subscriber will receive it and compare it with the conditions where it will be stable and according to the deviation value the call back function of the subscriber node will publish the velocity of the motor msg, required to maintain the balance.

Then,

I'll create another package for navigating the robot and in this also the communication type will be publisher and subscriber. The nav2 module is used to make this part easier. SLAM (simultaneous location and mapping) is used since it can travel to different unplanned unmapped areas. The data from lidar is used for mapping and the data from camera is used to detect the traffic signals and road crossings (basically things/data that are unable to obtain from lidar). The data from gps is used to find the current location of the robot and the Google map API key is used to interface with google map for the directions of the delivery of the parcel.

Then,

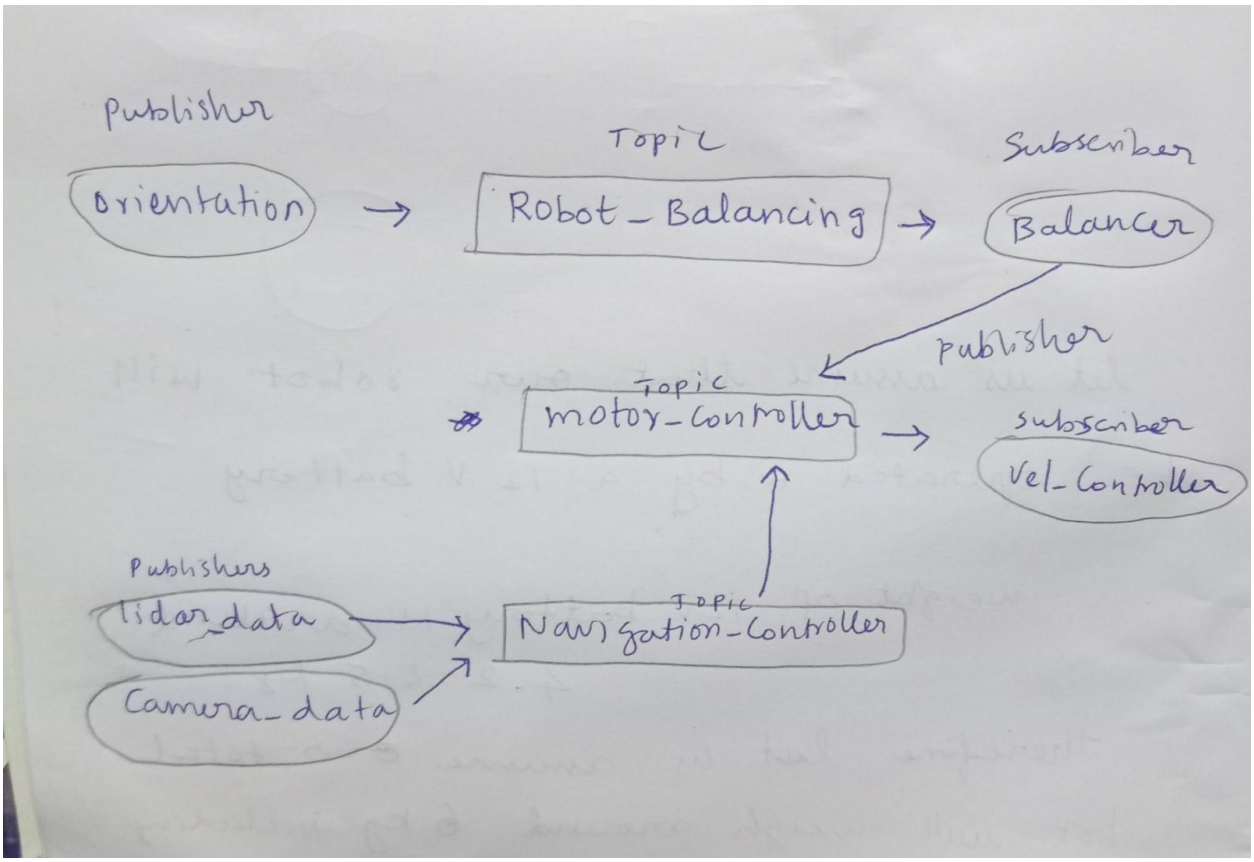
I'll create a specific package that is used to control the motor. The communication mode is publisher and subscriber. The publisher will send the current velocity of the motor and subscriber will receive the command velocity (that is another package, for example the balancing package will send commands to control the velocity of the motor) that will be received by this and this will control the motor via Arduino ---> motor driver --> motor.

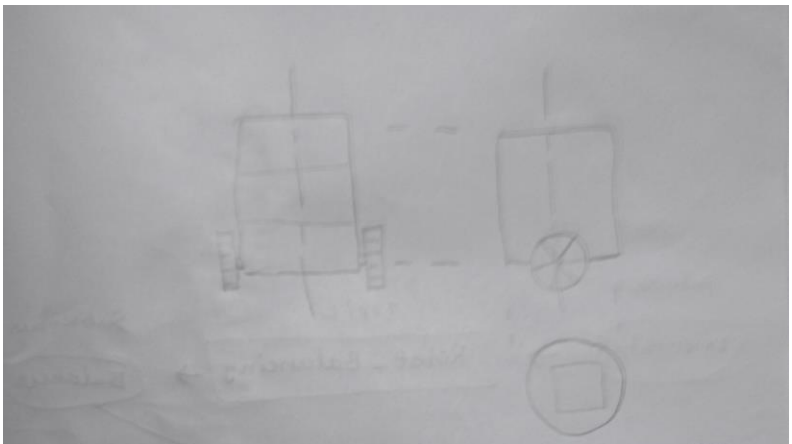
Here basically we're using the raspberry pi as a high-level controller which deals with image recognition, navigation, balancing and Arduino as a low-level controller which controls the speed of the motor via motor driver.

For detecting traffic signals, road crossings, vehicles etc.

I'll use ML (machine learning) and image processing using python and openCV to detect whether the signal is green, yellow or red and to detect the whether the obstacle is human, vehicle or immobile object and to make decision upon the direction of motion.

Here is the simple block diagram / work flow of ros .





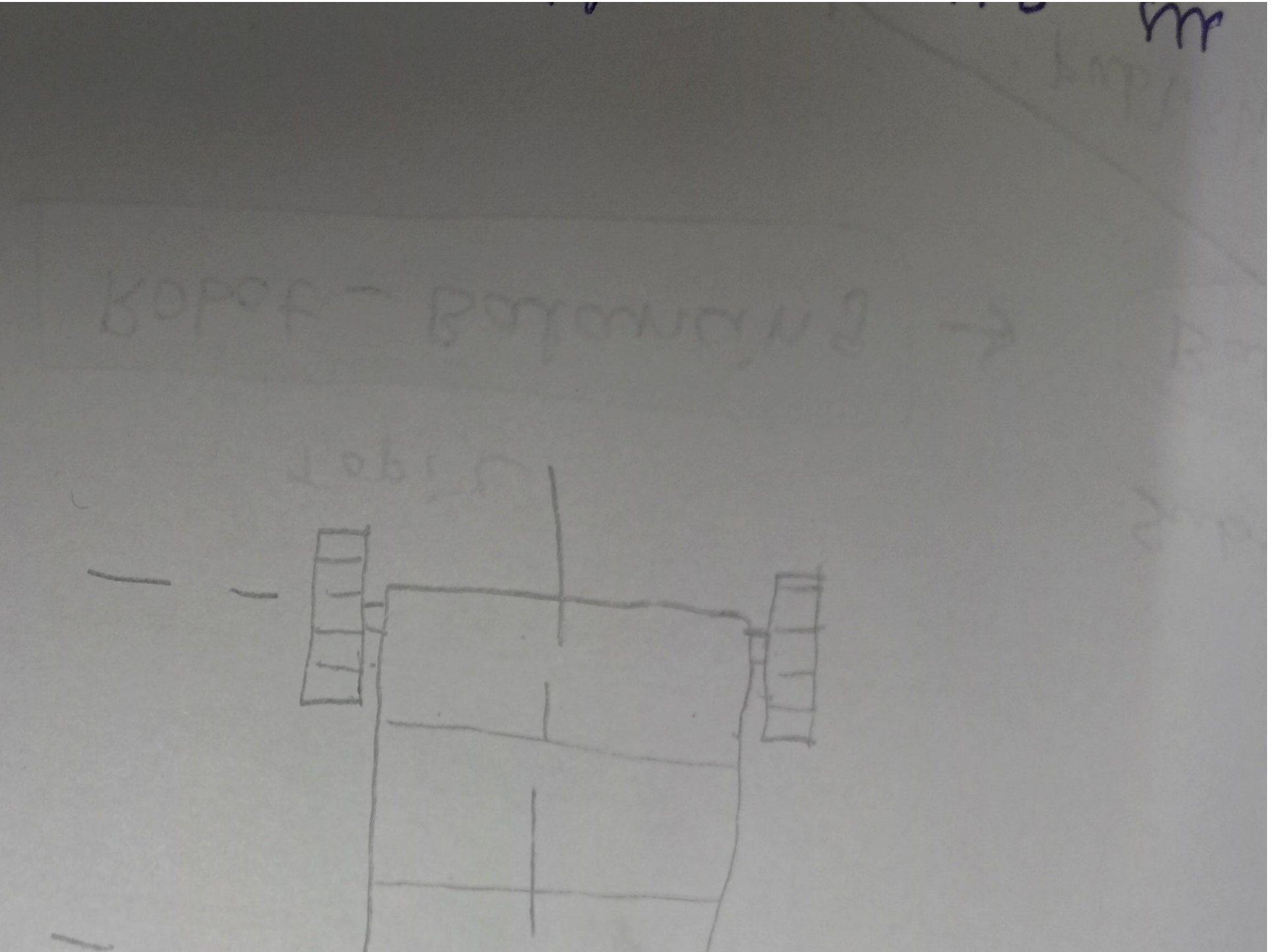
let us assume that our robot will be operated by a 12 V battery

weight of 12V battery is around 4.2-4.5 kg.

Therefore let us assume our total bot will weigh around 6 kg including all metal frames (without package) & Components ~~inc~~

While carrying the package it will weigh around (assuming it can hold up to 4 kgs) 10 kg (max)

Then lets fix the Speed of the robot to be 20 km/hr (max)



Therefore

mass of bot = 10 kg

max. speed / velocity = 20 km/

So we need high torq

bot

If we assume the ac

(initial) to be

F = 10 × 5 = 50 N

m x a

F = 10 x 2 = 20

let us assume the radi

wheel to be 5 cm which

Torque