**Literature review:**

Research 1: **Design and Development of Autonomous Delivery Robot [1]**

This research published by Visvesvaraya National Institute of Technology discusses the design of an autonomous delivery robot with some limitations. This project is capable of carrying a maximum weight of 2kg this low-bar line is due to the use of low torque motors. To carry higher weights the use of higher torque motors is essential. On the other hand, the motors used were 300rpm which increases the ability of moving the robot much faster ensuring it is within the road speed limits. For the main board the project uses Nvidia Jetson TX1 for controlling and running global and local planning algorithms. It also uses an Arduino Mega to control the motors and handle the sensors' readings. The communication between the two boards is done using rosserial to publish the sensors' data and for getting the commands to control the motors. The design uses multiple components to provide much accurate localization and obstacles avoidance, one main component used is a RGBD camera which is used to get the front view with 3D depth map with addition to a laser range finder which gives a 2D depth map. Another component used for an accurate localization of the robot and for the purpose of determining the orientation of the robot is the inertial measurement unit (IMU) which includes an accelerometer, a gyroscope and magnetometer for a better estimate of the position. To avoid collision, an IR sensor with a range of 4-30 cm is used as the last option to save the robot from collision.

For this project, a map-based localization approach is implemented but however, this leads to a potential problem resulted from the accumulative errors of the used sensors (e.g., the GPS could have an error that reaches to 10 meters), For this reason this paper suggests the use of statistical filters for more accurate localization. The paper discusses another essential topic for navigating an autonomous robot which is the availability of high-definition maps known as ADAS maps, which could lead to an accuracy of 10 cm. Although the project did not use SLAM (Simultaneous Localization and Mapping), but the paper suggests the use of SLAM as a solution to improve the accuracy of mapping localization of the robot. The paper also discusses the used algorithm for path finding, in this case it is the A-star algorithm. Although it is not the best algorithm in finding the shortest path, but the researcher justifies that the project needs a fast algorithm more than an accurate but slow one to avoid getting stuck. however, the researcher suggests further research to be carried out for the optimization of the grid generation.

**Project Scope :**

For this project, the following must be clear for all parties:

* The design is targeted to be specific for the KAU Campus.
* The information gathering will be done with the guidance of the advisor and includes all the team members.
* Team members will provide all the required resources needed to implement the solution.
* Team members are responsible of any financial obligations that could be a result of purchasing a required component or subscribing to a license.

draft (remove it after accepting):

* the reasearcher suggests Further research could be carried out for the optimization of problems related to occupancy grid generation, nding the time to collision, generating energy ecient paths etc

For this project, a map based localization approach is adopted. Generally sensors like a GPS or GNSS are used to estimate the position in the world using the method of trilateration. However, a GPS may have an error from 1 - 10 metres. The errors may be attributed to a number of errors like -> solved using

* ROS is used for communication between the various modules.
* ~~Mainboard (Nvidia Jetson TX1) it has Nvidia Maxwell GPU (256 CUDA cores) enables fast for deep neural networks, it runs global planning algorithm, the local planning algorithm, control algorithm and sensor fusion algorithms~~
* ~~Control board (Arduino Mega): lower-level control , controls both the motors (main drive and steering) and handles all the sensors. communicates with the main processor (Nvidia Jetson TX1) through rosserial to get commands for the motors and to publish sensor data.~~
* ~~For identfing the obstacles and localization it uses an RGBD camera mounted to get front view image and front 3D depth map~~
* ~~Also YDLIDAR X4: Laser range nder which gives a 2D (planar) 360 degrees depth map d for perception and planning. Useful for localization of robot and identifying obstacles.~~
* ~~It uses An inertial measurement unit (IMU). SparkFun IMU Breakout MPU9250 with 3-axis accelerometer, 3-axis gyroscope, and a 3-axis magnetometer. Useful for localization of robot.~~
* ~~For the worest case scenario, to avoid collision it uses IR Sensor to be used as the last line of defense against collisions. It has a range of 4-30 cm.~~
* ~~It uses GPS Module for global position useful for global planning~~
* ~~One down side the motors used for this robot has high 300rpm which good but the tourk is too low thus result a poot payload capacity, as this robot is only capbale of 2kg~~
* ~~The robot weighs about 5kg and has a payload capacity of 2kg~~
* ~~One of the major aspects for the navigation of autonomous robots in outdoor environments is the availability of a specialized high-denition (HD) maps~~
* ~~HD-maps also known as ADAS maps s are generally used for autonomous navigation applications , benefits High accuracy of object(in this case the robot) locations, upto 10cm~~.
* multiple layers of information about the lanes, which way they travel, road intersections
* ~~Another way of solving this problem of localization and mapping is through SLAM (Simultaneous Localization and Mapping)~~
* ~~The purpose of SLAM is to generate a map and using the information in the map to simultaneously deduce the location of the robot in the map. However, the implementation of SLAM is not in the scope of this thesis.~~
* A map is useless to a robot if it contains no information about its environment
* Mentioned a model of 5 layers map
* The … mentions that The problem of localization can be approached by two methods [10]: 1. Map based Localization - Map is available prior to the process of localization 2. Simultaneous Localization and Mapping - The pose of a robot and the map of the environment are estimated at the same time. However for their project theyyy used map based localization appe=roache
* ~~This introduced another problem, as the GPS has has an error of 1 – 10 m, and other sensors used also have errors the accumaltive errors the accumulation of these errors could be unneglegtible, the … suggested the use of probabilistic flters for more accuracte localization.~~
* ~~For the purpose of determining the orientation of the robot, we use an inertial measurement unit(IMU). IMU is generally present in most of the robots and even smartphones~~
* Hence, IMU sensor is one of the most important sensor attached on an autonomous robot. An IMU not only gives information about the heading of the robot, but also about the acceleration of the robot which can be fused with other sensors to get an accurate position or velocity estimate.
* For path finding this robot used A\* algorithm to find the path between two points, although it is not exact in finding the shortest path, but the research…er argues that it is faster than other algorthims to prevent getting stuck also the reasearcher suggests Further research could be carried out for the optimization of problems related to occupancy grid generation, nding the time to collision, generating energy ecient paths etc

Research 1: SSD Real-Time Illegal Parking Detection Based on Contextual Information Transmission[3]

Xiangtan University from China published another paper on detecting illegally parked vehicles. It uses improved Single shot multibox detector (SSD) based on deep learning. Additionally, it uses Spatial transformation networks (STNs) to produce contextual information transmission to boost the performance. The process starts with status analysis to bound the vehicles inside boxes, then the distance between two