**Dynamic Map Building and Updating Algorithm**

Problem outline map consists of a grid and grid is made up of multiple grid cells. Grid cells that are obstacle free and where AIV can move are called active grid cells. Grid cells that have same obstacle in them due to which those grid cells are inaccessible are called inactive grid cells. During the operation of the AIV, it should know which grid cells are active and which are inactive, so that the AIV can plan and trace a path accordingly. This data should be up to date and accurate. The biggest challenge in acquiring this data is that the environment consists of static, dynamic, semi static obstacles. That is some part of the environment is changing, some part is not at all changing and some part will change slowly with time. In this algorithm each grid cells has two states (active,inactive) and each grid cell can have 3 penalties. This algorithm tackles this problem. Motor Encoders and proximity sensors are used for this algorithm. With the help of motor encoders we can track live position of the AIV ( explained previously) , when an obstacle comes we can find out the distance of the obstacle from the AIV using proximity sensor. We can find the grid cells of the obstacle as we know the grid cell in which the AIV is present. If the grid cells has obstacles and the status of that grid cell was active then the grid cells gets a penalty. If a grid cells get a 3 penalties, then that grid cell is given the status of inactive until the obstacle is gone. AIV will keep checking if the obstacle is gone or not on the regular basis. If the obstacle is gone, the grid cell will be given the status of Active irrespective of its previous status and penalty will be set to 0. When path planning is done AIV will plan path through and any Active grid cell irrespective of its penalty.

**LITERATURE REVIEW**

The knowledge of the existing technology is important for the proper design of any robotic system. Mechanical architecture, sensor technology and navigation control strategy are important fields to consider for the development of a mobile robot for any specific task. In this literature survey we also studied about trends in autonomous vehicles, ways to achieve autonomy and lastly methods to solve the localization problem.

An autonomous intelligent vehicle is one that can drive itself from a starting point to a predetermined destination in ‘autopilot’ mode using various in-vehicle technologies and sensors. [1] This paper shows how the field of autonomous automation with a detailed chronology and help one to understand the trends in autonomous vehicles in past, present and future. There are various advantages of autonomous driving such as reduction in traffic congestion, efficient use of fuel resources and lastly there would be less number of accidents. Disadvantages are that they are much expensive than normal vehicles, prone to hacking and failure of sensors could lead to major accidents. Key enablers of this rapid market and technology transformation are sophisticated sensor, antenna, and data connectivity technologies that work together. These components sense the environment, within and outside the vehicle, and receive, act upon, and transmit data in real-time to devices throughout the vehicle and in the physical world the vehicle navigates.

The applications that realize these increasing levels of vehicle autonomy can be categorized as in-vehicle networks (e.g. real-time vehicle diagnostics or online applications), infotainment, and safety applications.

Autonomous driving is an important trend of the automotive industry. The continuous research towards this goal requires a precise reference vehicle state estimation under all circumstances in order to develop and test autonomous vehicle functions. [2] This paper shows the continuous ongoing research on autonomous vehicles and how to pinpoint the surroundings of the vehicle. Author mainly focused on three ways on how to estimate the position of vehicle. First robust standstill detection based purely on signals from an Inertial Measurement Unit. Second, a vehicle state estimation by means of statistical filtering. Third, a high accuracy LiDAR-based positioning method that delivers velocity, position and orientation correction data.

Autonomous mobile robots operate by sensing and perceiving their surrounding environment to make accurate driving decisions. A combination of several different sensors such as LiDAR, radar, ultrasound sensors and cameras are utilized to sense the surrounding environment of autonomous vehicles. These heterogeneous sensors simultaneously capture various physical attributes of the environment. [3] This paper shows a particular approach making a autonomous mobile robot which is using a LIDAR and a wide range camera for free space detection and shows how to align output of both sensor using a geometrical model. Following that a Gaussian Process (GP) regression-based resolution matching algorithm to interpolate the missing data with quantifiable uncertainty.

The technology in recent decades developed at a rapid pace, this results to have innovative solutions that facilitate and make human life safer. [4] This paper shows a design and the construction of a small vehicle which will have sensors and controlled from a central control station and will also sent video feedback, so the operator can monitor the space. Inertial Sensor Units measures values of internal system variables (robot), as the engine speed, the position of the wheel and the speed, the battery level. [4] These type of sensors are wheels or motors encoders (wheel encoders) and for the vehicle’s direction gyroscopes, accelerometers (accelerometer), the magnetometers or a combination of all three called inertial measurement sensor (inertial measurement Unit- IMU). This method can be cost effective when compared to LIDAR and camera sensors but if one sensor gives wrong output then it may befall an accident.

LiDARs are now used in the field of automation, agriculture, archaeology, and also quantifying various atmospheric components. The current manuscripts include the working of LiDAR, its types, history, and different applications of LiDAR. From LiDAR measurements, one can calculate the distance from different objects in space and draw the 3D digital representation of the area in front of LiDAR. [5] This paper provides a description of the optimal lidar target design, the target identification algorithm, and a detailed performance analysis, including the investigation of the achievable lidar data accuracy improvement using lidar-specific ground control targets in the case of various target distributions and flight parameters.

Autonomous Intelligent vehicles are widely used to test many types of algorithms and simulate the driving behaviour as in the real world. [6] This study shows autonomous vehicle implementation which gives a solid solution to this problem in an efficient manner, using a Raspberry Pi and a LIDAR module solely for indoor navigation. If we use LIDAR then we need to maintain a dataset and LIDAR is very costly we compared to IMU i.e. Magnetometer and optical encoder. If these sensors are optimized perfectly then the output is good enough for the bot to understand its location.

Autonomous Intelligent vehicles localization is the problem of tracking a moving robot through an environment given inaccurate sensor data and knowledge of the vehicle’s motion. [7] This paper shows one of the techniques to solve the localization of the bot. It is a probabilistic based method for solving localization problem. By using a Bayesian formulation of the problem, the robot’s belief is represented by a set of weighted samples and updated according to motion and sensor information. It is robust to errors in the map, they necessarily make the results less accurate. This method used for updating the map dynamically during the process of localization, without requiring a severe increase in running time.

Another method for solving the localization problem is SLAM (Simultaneous Localization and Mapping) technique. [8] This paper shows another method for solving the localization problem. SLAM is the mapping of an environment using the continual interplay between the mapping device, the robot, and the location it is in. As the robot interacts with the environment, it not only

maps the area but also determines its own position simultaneously. One problem with MCL is that it requires a static map of the environment. Opposite to this SLAM can find its location in dynamic environment.

We can perform Obstacle Detection for Autonomous Intelligent Vehicles Based on Point Clouds Measured by a LIDAR Sensor [9] This paper addresses this task when only partial scanning data are available. Our method develops the detection capabilities of autonomous vehicles equipped with 3-D range sensors for navigation purposes. In industrial practice, the safety scanners of automated guided vehicles (AGVs) and a localization technology provide an additional possibility to gain 3-D point clouds from planar contour points or low vertical resolution. Based on this data and a suitable evaluation algorithm, intelligence of vehicles can be significantly increased without the need for installation of additional sensors. This paper propose a solution for an obstacle categorization problem for partial point clouds without shape modelling. The approach is tested for a known database, as well as for real-life scenarios. In case of AGVs, real-time run is provided by on-board computers of usual complexity.

References

[1] Bimbraw, Keshav. (2015). Autonomous Cars: Past, Present and Future - A Review of the Developments in the Last Century, the Present Scenario and the Expected Future of Autonomous Vehicle Technology. ICINCO 2015 - 12th International Conference on Informatics in Control, Automation and Robotics, Proceedings. 1. 191-198. 10.5220/0005540501910198.

[2] E. S. Morales, M. Botsch, B. Huber and A. G. Higuera, "High Precision Indoor Navigation for Autonomous Vehicles," 2019 International Conference on Indoor Positioning and Indoor Navigation (IPIN), Pisa, Italy, 2019, pp. 1-8, doi: 10.1109/IPIN.2019.8911780.

[3] De Silva, V.; Roche, J.; Kondoz, A. Robust Fusion of LiDAR and Wide-Angle Camera Data for Autonomous Mobile Robots. Sensors 2018, 18(8), 2730; https://doi.org/10.3390/s18082730.

[4] Papoutsidakis, Michail & Kalovrektis, Konstantinos & Drosos, Christos & Stamoulis, Georgios. (2017). Design of an Autonomous Robotic Vehicle for Area Mapping and Remote Monitoring. International Journal of Computer Applications. 167. 36-41. 10.5120/ijca2017914496.

[5]<https://www.ingentaconnect.com/content/asprs/pers/2007/00000073/00000004/art00004;jsessionid=4cam8541dpaun.x-ic-live-01> Number 4 / April 2007, pp. 385-396(12) [Csanyi, Nora](https://www.ingentaconnect.com/search?option2=author&value2=Csanyi,+Nora); [Toth,CharlesK.](https://www.ingentaconnect.com/search?option2=author&value2=Toth,+Charles+K." \o "Search for articles by this author)

[6] N. Baras, G. Nantzios, D. Ziouzios and M. Dasygenis, "Autonomous Obstacle Avoidance Vehicle Using LIDAR and an Embedded System," 2019 8th International Conference on Modern Circuits and Systems Technologies (MOCAST), Thessaloniki, Greece, 2019, pp. 1-4, doi: 10.1109/MOCAST.2019.8742065.

[7] Milstein, Adam. (2005). Dynamic Maps in Monte Carlo Localization. 1-12. 10.1007/11424918\_1.

[8] Frese, Udo & Wagner, René & Röfer, Thomas. (2010). A SLAM overview from a users perspective. KI. 24. 191-198. 10.1007/s13218-010-0040-4.

[9] Zoltan Rozsa, Tamas Sziranyi https://ieeexplore.ieee.org/document/8283563