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NAVIGATION AND MAPPING FOR ROBOTIC CAR TECHNOLOGY

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Abstract- Robotic car navigation gets more importance in most of the various growing application areas. In this paper we describe a system where the car autonomously navigates to its destination. In this system using GPRS modem, it provides communication between the car and the internet. To decide the robotic car path the system interface through internet with OSRM open source map. In non-urban Domains such as deserts, villages; the problem of successful GPS-based navigation appears to be almost solved, still some challenging problems remain like navigation in urban domains particularly in the close vicinity of buildings, in thiskind of situations GPS accuracy significantly drops down due to GPS signal's unavailability. The efficiency of navigation is also improved in this project if implemented in the current robotic cars. This system not only relies on GPS but also to improve the efficiency it uses location information from inertial sensors, rotatable laser range finder for obstacle sensing. The design of the system isdone in a way thatthrough the help of internet it can be monitored from anywhere.
Keywords- Localization, Inertial Navigation System, Laser,GPS, Compass, GPRS, Navigation.

1. INTRODUCTION

Aroboticcaris also known as a self-driving car,driverless car, autonomous car.Robotic car is a vehicle capable with capabilities of a traditional carwhichfulfil the human transportation. Without the help of human inputssensing the surrounding environment and navigating is the capability ofaroboticcar.

Roboticcar's use techniques such as radar, lidar, GPS, and computer vision to sense their surroundings. To helps identify appropriate navigation paths, obstacles and relevant signage,advanced control systems interpret sensory information. The robotic cars to keep track of their position even if there is any changein conditions or when they enter uncharted environments, for which roboticcars update their maps based on sensory input. For any robotic car, the most importantcapability isthe abilityto navigate in any environment. The task of navigation can be said to be combination of 3 basic competences in general which are localization, path planning and vehicle control. The ability of robotic cars to determine the orientation (pose) within a global reference frame and its own positionis known as localization. From the current car positionto reach the desired destination a computation of an adequate sequence of motion commands are done which are defined as path planning. Path planning is done before motion dueto its planning component. The robotic car use feedback control to follow the planned path. Reactive obstacle avoidance and global path preplanning is included in this controller.

The potential application areas of the navigation and mapping for robotic car technology include automatic driving,transporting objects in factory or office environments, exploration of dangerous regions, collectinginformation ofgeographical unknown terrains like unmanned exploration of a new planetary surface, etc.

2. METHODOLOGY

The current position is taken as the source and the destination point is taken from the user by the system. The destination in the map has to be specified by the user. Theextraction of the latitude, longitude coordinates from the graph and sending it to the robotic car andthe shortest path to the destination is done by the system. Using the GPS and the compass robotic cars follow the coordinates. If GPS signal not received, then to obtain the current coordinate it usesinertial navigation system.

The car senses the obstacles around itwith the use of laser range finder. Server uploads the current location of the roboticcar using GPRS. Coordinates are taken and shown in Google map at the server for monitoring purpose, so that the car can be monitored anywhere in the world. Block diagram of the robotic car is show in Fig.1.

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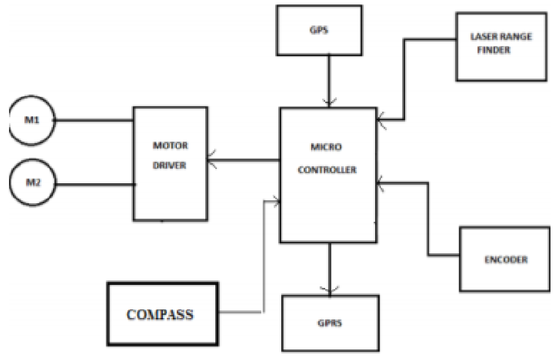

Fig.1 Block diagram

2.1 Waypoints Extraction –

The appliance of standardized geo-data by the OpenStreetMap project as an Environmental representation for robotic car navigation is used for this paper. OpenStreetMap (OSM) is a collaborative project which wasfounded in July 2004, which helps in targeting to create a free to use and editable map of the world. The OSM map is created by volunteers performing systematic surveys with a handheld GPS receiver and publicdomain.The OSM mapis different from other commercial map distributors such as Navteq and Google.

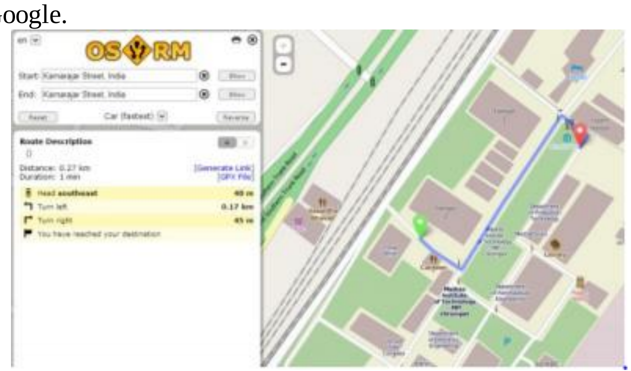

Fig.3 Path selected from OSM map

OSM map allows the user to select the car's navigation path. Waypoints are extracted which are along the path and are send to the carusing the help of internet. To perform this task a visual basic application is designed and developed.

2.2 Perception –

The motion planning and behaviouralsubsystems are provided with a model of the world which is the responsibility of theperception system. The model includes the moving cars and static obstacles and localizing the car relative to, and estimating the shape of, the roads it is driving on. The obstacles around the car are sensed using arotatable laser range finder.

2.3 Localization –

The car's pose relative to the environment from sensor observations is the estimated problem which is localization. Forsuccessful robotic carslocalization is a necessity, it has been referred to as "the most fundamental problem to providing a car with robotic and autonomous capabilities". For getting autonomous navigation, the car must maintain acorrect knowledge of its orientation and position. The car's ability to know its orientation andposition correctly helps in successful achievement of all other navigation tasks.For localization GPS and inertial sensors are used by this system.The signals sent by GPS satellites high above the earth is precisely timed to calculate the position byGPS receiver. The messagestransmittedcontinually by everysatelliteincludes:

1. When the message was transmitted at that time.
2. Position of the satellite when the message was transmitted.

The messages receiver receives is used to determine the time of transitof each message and using the speed of light tocompute the distance to each satellite, a sphere is defined by each of this distances and satellites locations. On the surface of every of these spheres there is a receiver, when locations are correct ofthe distances and the satellites. The location of the receiver is computed using the navigation equations with the help of these distances and satellites locations. This location is then shown, perhaps with latitude and longitude ora moving map display. Information of elevation may be included. Calculated from position changes, many GPS units showinformation such as speedanddirectionwhich is derived.

On the NMEA Standards, GPS receivers also work.'$' sign is used for beginning everysentence, has about 80 characters and a carriage return/line feed been used at end.Single lines sentences are mostly framed (sometimesmay work over multiple lines) and each sentencethe data items are separated by commas.ASCII text and varies in precision is the data received.Checksum

which contains a '*'and two hexadecimal digits is end of a sentence. An 8-bit exclusive OR of all the characters between, but not '*' and '$' is represented by checksum digits.
The GPS data is extracted fromlatitude, longitude and number of satellites in view. Accuracy of the information is based on number of satellites in view. Localization is got from inertial sensors, if the data is not correct. Keeping the track of position that thecar has moved till the current position is the work called inertial localization. Car's movementsare sensed by usingcompass and wheel encoder.

2.4 Navigation –

Algorithm for navigation of robotic car is shown in the Fig.6. The current position is taken from GPS and destination coordinate are taken from user by this system. The shortest path is found by this system using the current position and destination. Then takes the shortest path. If any obstacles are sensed in the path that time it selects the new path using the next shortest path. This process is done till the destination is reached and when the destination is reached the car gets stopped and at the same time it sends its current position coordinates to monitoring part.

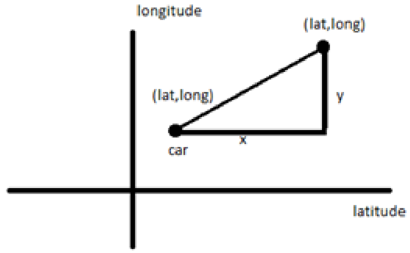

Fig.5 Distance and angle calculation

X = longitude $_{destination}$ – longitude $_{car}$
Y = latitude $_{destination}$ – latitude $_{car}$
$\Theta_{destination} = \tan^{-1}(Y/X)$
Angle (Ɵ) = Destination angle – Car angle
Where,

X-Distance to be travelled in latitude.
Y- Distance to be travelled in longitude.

If the path between goal and vehicle is not straight line, small goal points are considered at the corners along the path.

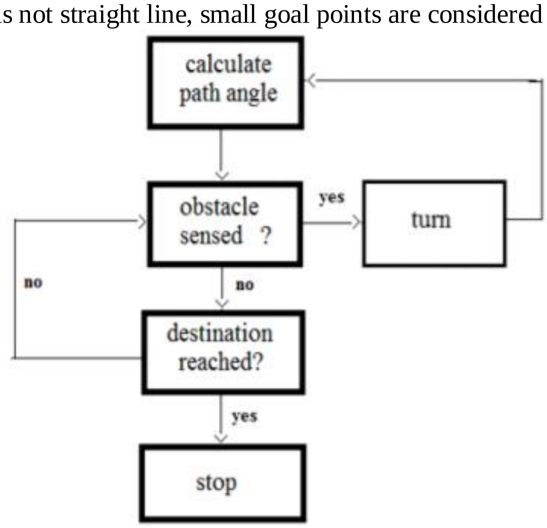

Fig.6 Navigation algorithm

2.5 Mapping –

The system allows a user to view the past and the present positions recorded of the object on Google Map using the internet.The currentposition of the object is read by the system using GPS, GPRS service sends this data from the GSM network to a webserver using the HTTP protocol POST method.The object's position data for live and past tracking which is stored in the database. A web application with the GoogleMap embedded is developedusing PHP, JavaScript, Ajax and MySQL.

3. CONCLUSION

The aim of this work is to navigate the car autonomously to the destination. The accuracy in localization is improved when IMU is added with GPS. The designed car interfaced with open source OSRM map using GPRS. This makes easy to feed path to the robotic car by the user, this also saves the time by avoiding manual collection of waypoints which are along the path.

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