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Integration of Artificial Intelligence in Autonomous Vehicles for Efficient Path Planning

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Abstract - Artificial Intelligence is basically the simulation of Human Intelligence processes by Machine, particularly Computers. These processes will accept the learning through these rules to succeed in definite and self-correction such as acquisition of data and rules for victimization of the information, reasoning. Explicit applications of Artificial Intelligence include skilled systems, speech recognition and machine vision. Automation with inherent is progressively rising in various applications such as autonomous vehicles. Drawing associate analogy from human social interaction, the conception of trust provides a legitimate foundation for describing the connection between humans and automation. Main Purpose of Artificial Intelligence is to Implement Human Intelligence in Machines – Making systems that Perceive, Cogntive, Think, Learn, and Behave like Humans and to Create Expert Systems. Expert Systems that exhibit intelligent behavior, learn, demonstrate, explain, and gives recommendations to its users. This paper is about implementation of Autonomous Vehicles through Artificial Intelligence. This includes the Path Planning, Travel Patterns, and the ability of these vehicles to assess their environments, which are treated as problems in inefficient autonomous vehicles. In addition, this paper includes the evaluation of these problems. Path Planning involves selection of the optimal path for which the autonomous vehicle has to travel by following a certain planning algorithm and the ability to sense the environment and obstacles in autonomous vehicles is also enhanced through particular methods. Research methods that are addressed include Motion Planning to enhance the planning algorithm and also Trajectory Planning to assess the uncertain environment in order to avoid certain obstacles for the automated vehicle to move in a safe path. Hence, with the implementation of the following research methods Such as Voronoi diagrams and Evidential Occupancy Grid, we were able to derive results for an Efficient Autonomous Vehicle.

Keywords - Artificial Intelligence, Autonomous Vehicles, Real-Time Motion Planning, Trajectory Planning, Voronoi diagrams, Evidential Grid.

1. Introduction

While exploiting the power of the computer machines , the curiosity of human, lead him to think and get surprised, *"Can a machine think and behave like humans do?"* Thus, the progress of Artificial Intelligence begun, it started with the intention of making similar intelligence in machines that we discover and adjudge high in humans. Since the invention of computers or machines, their capability to perform numerous tasks went on growing exponentially. Humans have developed the ability of laptop systems in terms of their numerous operating domains, their increasing speed, and reducing the size with regard to time. A branch of engineering science named computing pursues making the computers or machines as intelligent as mortals [2]. Artificial Intelligence is basically the simulation of human intelligence processes by machines (particularly computers) . These processes embrace learning (the acquisition of data and rules for victimization of the information), reasoning (using rules to succeed in approximate or definite conclusions) and self-correction. Explicit applications of AI include skilled systems, speech recognition and machine vision.

1.1 Philosophy of Artificial Intelligence

Automation with inherent (AI) is progressively rising in various applications, as an example, autonomous vehicles. Drawing associate analogy from human social interaction, the conception of trust provides a legitimate foundation for describing the connection between humans and automation. However, despite their growing use, there is still noticeable scepticism in society regarding these applications [2].

1.2 Goals of Artificial Intelligence

- **To Implement Human Intelligence in Machines** – Making systems that perceive, think, learn, and behave like humans.
- **To Create Expert Systems** – Systems that exhibit intelligent behavior, learn, demonstrate, explain, and gives recommendations to its users.

2. Applications of Artificial Intelligence

Artificial Intelligence contains various Applications such as Application of Artificial Intelligent Techniques in Power System Stabilizers (PSSs)**,** Application of Artificial Intelligence Techniques in Network Intrusion Detection Intrusion , Application of Artificial Intelligence Techniques in Medical Area (medicine and Hospital Inpatient Care, Application of Artificial Intelligence in Accounting Databases, Application of Artificial Intelligence Techniques in the Computer Games

2.1 Application of Artificial Intelligent Techniques in Power System Stabilizers (PSSs)

Since the 19th century, PSSs have been used to add damping to electromechanical oscillations. The basic function of the PSS is to apply a signal to the excitation system, hence producing electrical torques to the rotor in phase with speed differences that damp out power oscillations. They perform among the generator's excitation system to make an area of electrical torsion, called damping torque.A CPSS can be modeled by a two stage (identical), lead-lag network which is represented by a gain K and two time constants T1 and T2.This network is connected with a washout circuit of a time constant Tw. The signal washout block acts as a high-pass filter with the time constant Tw that enables the signal related to the oscillations in rotor speed to pass unchanged. Furthermore, it does not permit the steady state changes to change the terminal voltages. The commonly used structure of the PSS Structure of PSS In the field of power system operation computer programs are executed and modified frequently according to any variations. Artificial intelligence (AI) has the power to affect the high nonlinearity of sensible Systems. Various technologies that are used in PSSs optimization problems are ANN, FL, ES etc.[8]
Few of its techniques are:

1. Artificial Neural Network (ANN) in PSS
2. Fuzzy Logic (FL) in PSS

2.2 Application of Artificial Intelligence Techniques in Network Intrusion Detection Intrusion

Intrusion Detection Systems (IDS) uses the various Artificial Intelligence techniques for protecting computer and communication networks from intruders. Intrusion Detection System (IDS) is the process of monitoring the events occurring in network and detecting the signs of intrusion [8]. Few of its techniques are:

1.Artificial Neural Network in IDS
2.Fuzzy Inference Systems (FIS) in IDS

2.3 Application of Artificial Intelligence Techniques in Medical Area (medicine and Hospital Inpatient Care)

Artificial intelligence techniques have the potential that can be applied in almost every field of medical science. AI has conjointly been helpful for computer-aided detection of tumors in medical pictures. Such approaches help in the diagnosis of various forms of cancer, and congenital heart defects. Primarily on the diagnosing of a patient's condition given his symptoms and demographic data .Mycin a rule-based professional system for characteristic micro-organism inflicting infections and recommending antibiotics to treat these infections was dealt underneath the work of CDSS for diagnosing. Pathfinder, which used Bayesian networks to help pathologists more accurately diagnose lymph-node diseases.[8] Few of its techniques are:

1.Fuzzy Expert Systems in Medicine
2.Evolutionary Computation in Medicine

2.4 Application of Artificial Intelligence in Accounting Databases

The use of Artificial Intelligence is investigated because the basis to mitigate the issues of accounting databases. The difficulties with existing accounting info systems could be, the needs of call manufacturers are not met by accounting info. Humans do not perceive or cannot figure the processed accounting databases. Systems are not easy to use. Hence, there is focus on the numeric data. Integrating intelligent systems with accounting databases is done by direct participation of the decision maker. Thus, the systems will analyse the info and assist the users

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understanding or decoding transactions to see what accounting events are captured by the system, with the artificial intelligence we store and retrieve knowledge in natural language. There are some AI tools or techniques that facilitate within the broader understanding of events captured by the method of accounting. There is a lot of stress on symbolic or text information instead of simply numeric information to capture context. The artificial intelligence and knowledgeable system builds intelligence into the info to help the users. Without users direct participation such models facilitate the users by sorting through giant quantities of knowledge. Such models conjointly assist the choice manufacturers below time constraints; counsel alternatives within the looking and analysis of knowledge [8].

2.5 Application of Artificial Intelligence Techniques in the Computer Games

In the evolution of pc games, they need fully grown from modest text primarily based to the three dimensional graphical games with advanced and enormous worlds. The systems as graphics rendering, playing audio, user input and game artificial intelligence (AI) when put together provide the expected entertainment and make a worthwhile computer game. If we have tendency to take away AI from pc games, the games will be so simple that nobody will be interested in playing the computer games anymore!! There are many ways in which AI contributes to fashionable pc games, simulated perception, spatial reasoning, learning, unit movement , group coordination,steering,target selection and resource allocation.

Artificial intelligence is employed to resolve common issues within the pc games and supply the options to the games. Specifically, non-playing character (NPC) path finding, decision making and learning are examined.
Few of its techniques are:

1.NPC Movement Using Path-Finding
2.NPC Decision Making Using Bayesian Networks
3.NPC Learning[8]

- An Autonomous Agent

An Autonomous Agent usually exists in isolation, or it is often located exceedingly in the world shared by various entities. An autonomous agent can deal exclusively with abstract information or it can be embodied in a physical manifestation. A located agent is often reactive (instinctive, driven by stimulus) or it is often intellectual (in the terms of AI) Combinations of located, reactive, and embodied outline many distinct categories of autonomous agents [1].

This document is set in 10-point Times New Roman. If absolutely necessary, we suggest the use of condensed line spacing rather than smaller point sizes. Some technical formatting software print mathematical formulas in italic type, with subscripts and superscripts in a slightly smaller font size. This is acceptable.

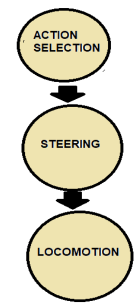

Fig.1. Autonomous Agent

The behaviour of an autonomous character can be better understood by dividing it into several layers. These layers are meant just for clarity and specificity within the discussion will follow the above figure ; shows a division of motion behaviour for autonomous characters into a hierarchy of three layers: action selection(strategy), steering(determination of the path) , and locomotion (articulation and animation) [1]. An analogy might be used to compare the written driving instructions to get from one place to another with the act of driving the car along with that route*]*[1].

3. Autonomous Vehicles

These vehicles have the potential to reduce/avoid crashes and improve route potency considerably by automating the responsibilities of the driving force. If a driver is unable to require management in time, a computer blames for pre-crash behaviour. Unlike alternative automatic vehicles, such as aircraft, in which every collision is catastrophic, and unlike guided track systems, which can avoid collisions only in one-dimension, automated roadway vehicles can predict numerous crash mechanical phenomenon alternatives and choose a path with all-time low the injury or probability of collision.

An Autonomous vehicles have gained more focus recently on Google's self-driving cars, auto manufacturers, Defence Advanced Research Projects Agency Urban Challenge vehicles [4].

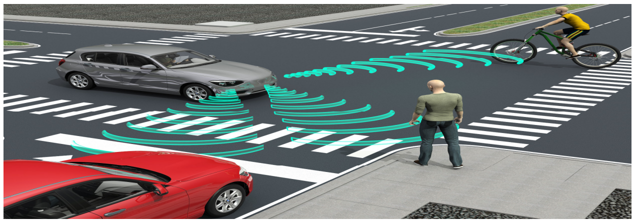

Figure 2

4. Role of Artificial Intelligence in Autonomous Vehicles

Consider the human perspective of driving an automobile which includes sensory functions like vision and sound to observe the road and the other cars on the road. When we stop at a red traffic light, we have our ability to measure our memory to create these quick decisions. Over The years of driving experience habituate us to look for the little things that we encounter often on the roads it could be a better route to the office. Now, we are building autonomous vehicles that drive themselves, similar to the way how human drivers drive. That means we induce these vehicles with the sensory functions, psychological feature functions like (memory, intelligence, decision-making and learning) and independent capabilities that humans use to drive vehicles. By the end of 2020 there could be a massive progress in Autonomous vehicles as they are being fitted with cameras, sensors and communication systems to enable the vehicle to generate large amounts of knowledge that, once applied with AI, allows the vehicle to envision, hear, suppose and build choices a bit like human drivers do.

5. Role of Artificial Intelligence in Autonomous Vehicles

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6. Motivation

To ensure efficiency of Autonomous Vehicles by addressing the issues of uncertainty in sensing the environment, making decisions, and enhancing the performance of motion planning algorithms.

6.1. To enhance performance of planning algorithm (Real-Time Motion Problem)

Path-planning is therefore the problem of finding a geometric path from an initial configuration to a given terminating configuration such that each configuration and state (if time is taken into account) on the path is convenient. A feasible configuration/state does not result in a collision and executes to a set of motion constraints such as road and lane boundaries. In this, for the path planning we need to the best and safest geometric trace under the constraints [3]. Currently autonomous or self-driving vehicles are of domain research, its multifaceted advancements has improved safety, reduced congestion, lower emissions with great quality. Software is that the key driving issue underpinning autonomy among the designing of algorithms that are accountable for critical decision making hold an important position. Passengers while travelling from source to destination by incorporating a path to follow, it generates the most feasible path by avoiding the obstacles to ensure the safety ,efficiency and comfort.

6.2. Environment Sensing and Predictability (Trajectory Planning Problem)

Whether driving on highways or exploring in the middle of a war zone, autonomous vehicles must have the capacity to rapidly and robustly plan a trajectory in uncertain environment. The uncertainty comes from : imperfect knowledge of the vehicle model, environment sensing and predictability.To solve environmental predictability, Partially Observable Markov Decision Process (POMDP) offers a framework for autonomous robot navigation in dynamic environments. With this approach, the state of a car's environment can be estimated and the development of traffic situations can be predicted. A system is developed based on the manualy constructed decision tree, it is able to predict the future behaviour of the ego-vehicle

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in an inner-city environment and notices the class of the situation that a traffic participant is facing. This approach does not predict the position and future direction of other vehicles which is essential in motion planning.nThis paper addresses problems involving uncertainty in sensing and how to integrate this uncertainty in trajectory planning. [5]

7. Path-Planning Techniques for Autonomous Vehicles

7.1. Dirichlet tessellation technique for Real-time Motion Planning

Voronoi Diagrams or Dirichlet tessellation techniques, generally generate ways that maximise the space between the vehicle and its surrounding obstacles.(Here we are using this as for our application)There are various algorithms that can be used for looking on Voronoi Diagrams as complete, if a path exists in free manner , in the voronoi diagram. As depicted in figure below, grey lines represent Voronoi edges (i.e. edges with maximum distance from detected obstacles),and produce a space where the vehicle can perform its action . Voronoi Diagrams for path-planning of autonomous vehicles in parking is done by combining Voronoi Diagrams with potential fields; obstacle turning away formula derived from mobile robotics. Voronoi Diagrams are usually used for designing in static environments, like parking vehicles. Furthermore, Voronoi diagrams on their own do not seem to be appropriate for on-road path-planning, since Voronoi edges,on that a vehicle navigates, will probably be discontinuous and unsuitable for non-holonomic vehicle. In this method, let us come up with a mathematical approach for solving the problems faced by the voronoi diagrams when used in autonomous vehicles [10].

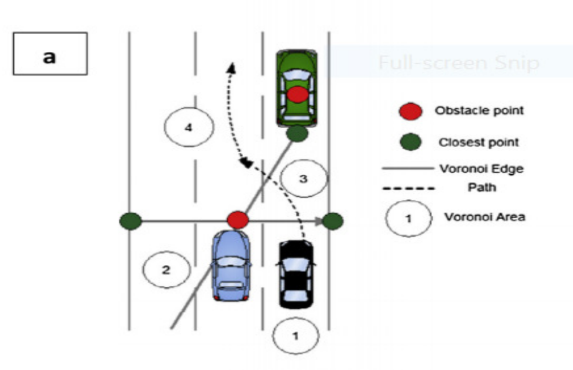

Fig.3. Voronoi Diagram

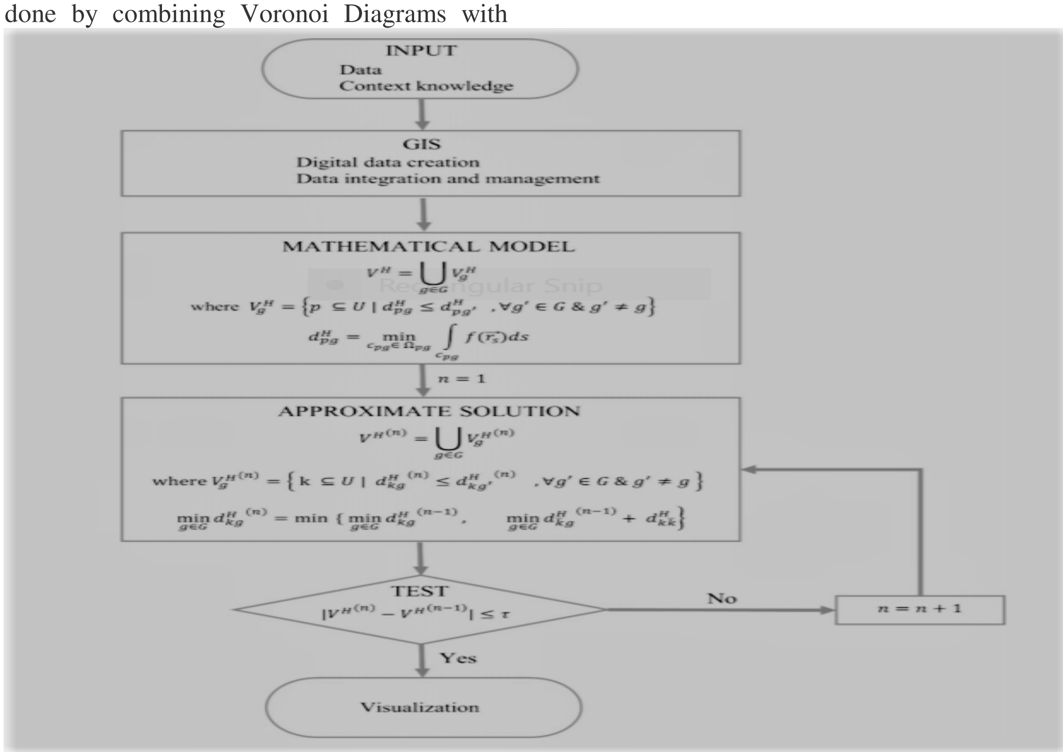

Fig.4. Process for Deriving a Heterogeneous Voronoi Diagram in Real-Time Planning

A flowchart representing the above process for deriving a heterogeneous Voronoi diagram in real-time planning and analysis is detailed in the above figure . The process highlights the interaction of decision making, geographic information, and spatial analytics. Specifically, GIS provides the ability to capture, store, manipulate, analyze, and display all types of spatial data [11]. An autonomous vehicle requires manoeuvre search, which determines the speed and path prediction of the vehicle, and then comes the trajectory planning.

Fig.5. Transition from real-time motion planning to trajectory planning.

The above figure gives an outline of the transition from real-time motion planning to trajectory planning.

In order to settle on the most effective tentacle to execute, we use the knowledge provided by the occupancy grid. First we classify tentacles as navigable or not navigable. We define a security area as the distance over one second with the ego- vehicle speed. If a tentacle is obstacle free in this security area, we classify as a navigable one, otherwise it's not navigable . Secondly, we need to choose from the navigable tentacles one to execute using different criteria. As it was presented in [Mouhagir et al. 2016b], we modeled the decision problem as a MDP-like problem. We attribute

7.2. Evidential Occupancy Grid for Trajectory Planning

The evidential occupancy grids gather more and more attention in the literature. Another interesting point is that different sensors are used in these works, sonars, lidars, etc, proving the efficiency and effectiveness of the evidential occupancy mapping approach. A mass function is defined which is represented by each cell in the evidential occupancy grid which gives the state of occupancy [9]. The left grid is a significant occupancy grid where, the inexperienced color shows the free cells (navigable), the red shows the occupied cells, whereas, the blue represents conflicting cells and the black represents unexplored cells (unknown). The color intensity reflects the certainty degree. The right grid is a binary grid computed from evidential one, with the value '0' for free cells and '1' for occupied cells . We consider that the cell is Occupied if the m(O) > 0.5, otherwise it is considered as a free cell. Instead of binary grid, we propose to use evidential grid as perception information for trajectory planning [9].

(1) Occupancy criterion: Since we want to guage each tentacle regarding its occupancy, we discretize each tentacle by using circles (their diameter represent the width of the vehicle with a margin of security). Then, we provide positive reward to circles (states) free from obstacles, and negative reward for the occupied circles.

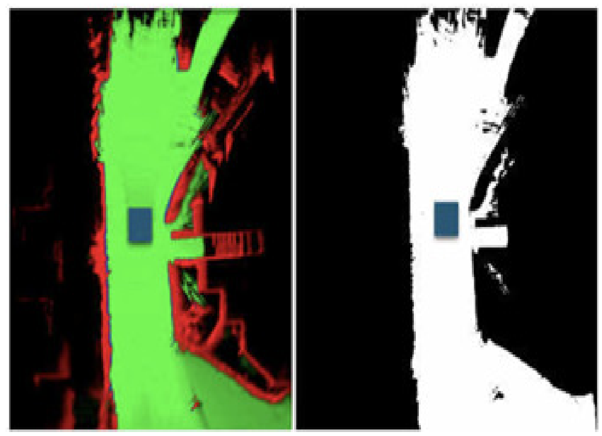

Fig.6. Concept of Evidential Grid

8. Clothoid tentacles in Trajectory planning

This Trajectory approach is based on a collection of Virtual Antennas referred as Tentacles in the vehicles. Tentacles are geometrical forms that model the dynamic possible trajectories of the vehicle. In our work, we use clothoid tentacles. As a result of this technique, the present steering angle of the vehicle and sleek variations within the vehicle dynamic variables like the yaw rate, the sideslip angle and the steering angle are considered. After generating all tentacles within the egocentric occupancy grid associated with the vehicle, future step is to settle on the simplest tentacle to execute victimization totally different criteria. After generating all tentacles in the egocentric occupancy grid related to the vehicle, the next step is to choose the best tentacle to execute using different criteria [9].

8.1. Choosing the Best Tentacle

In order to settle on the most effective tentacle to execute, we use the knowledge provided by the occupancy grid. First we classify tentacles as navigable or not navigable.

We define a security area as the distance over one second with the ego- vehicle speed. If a tentacle is obstacle free in this security area, we classify as a navigable one, otherwise it's not navigable . Secondly, we need to choose from the navigable tentacles one to execute using different criteria. As it was presented in [Mouhagir et al. 2016b], we modeled the decision problem as a MDP-like problem. We attribute reward regarding three criteria [9]:

(1) Occupancy criterion: Since we want to guage each tentacle regarding its occupancy, we discretize each tentacle by using circles (their diameter represent the width of the vehicle with a margin of security). Then, we provide positive reward to circles (states) free from obstacles, and negative reward for the occupied circles.

(2) Trajectory criterion: To calculate the reward to be attributed to states with regard to their closeness to the global reference trajectory, defined for example by GPS waypoints and a global map, we calculate the lateral displacement between the tentacles and the reference trajectory at different points of the tentacle. These points are chosen using the crash distance. The crash distance lc is the distance needed to stop a vehicle traveling with a speed Vx , with a maximum longitudinal deceleration am = 1.5 m/s2 that maintains passenger comfort; it is calculated by the following equation (where l_s is the security margin).

$$l_c = v_x^2 / 2a_m + l_s$$

(3) Overtaking criterion :

With the presence of associate obstacle ahead of the vehicle, the tentacles of the left receive an extra reward since overtaking is done by the left. For occupancy criterion, we use evidential grid where the mass is assigned to all subset of the domain which able this theory to represent uncertainty and conflict. The states definition in our MDP-like model helps us to discretize the environment ahead the vehicle. To use information provided by the evidential grid, we superimpose the states on the grid (the state is a circle). This superimposing is approximated by a matrix which contains several cells. Each cell contains 4 beliefs. We dispose of matrix englobing each state (circles around the vehicle), each cell of the matrix provides mass about the occupancy. In order to define a reward regarding the occupancy of the state, we process the cells information using four different rules. We must take into account that that every cell may be a supply of data about the occupancy of the state [9].

The main advantage of the proposed algorithm is to plan a trajectory while taking into consideration the uncertainty of the environment. The use of evidential grid provides information about the unknown which enables us to process it differently from the occupied space. In this work, our purpose is to address the issue of uncertainty of environment in trajectory planning using evidential grid.The simulation results show good performance of our algorithm in avoiding obstacles under uncertainty and underline the difference between using an evidential grid instead of a binary grid. Among the views, we tend to aim to check the algorithm in completely different situations and implement it in an exceedingly robotized vehicle. We also aim to use a control approach to execute the selected tentacle [9].

9. Literature Review

Boss is an Autonomous vehicle. It contains many sensors such as global positioning system (GPS), dash cameras, lasers and radars. The boss follows a three-layer planning system when driving in Urban environments. This planning system was developed from to handle the wants of the DARPA Urban Challenge employing a spiral system development method with an important stress on regular, regressive system testing. The three-layer planning system contains mission, behavioural and motion planning. Firstly, the mission planning layer decides which route to take in order achieve the goal. Whenever we want to change the lanes and Intersections ,behavioral layers guides by performing the error recovery maneuvers.

The motion planning layer deals with what actions to perform to avoid obstacles while creating progress towards native goals. During the 85 km Urban Challenge Final Event, Boss showcased some of its capabilities by coming first and winning the challenge. DARPA's reasoning for selecting only 11 teams was mainly safety-related. Safety was a paramount.[12]

The figure below represents the working of the Boss vehicle.

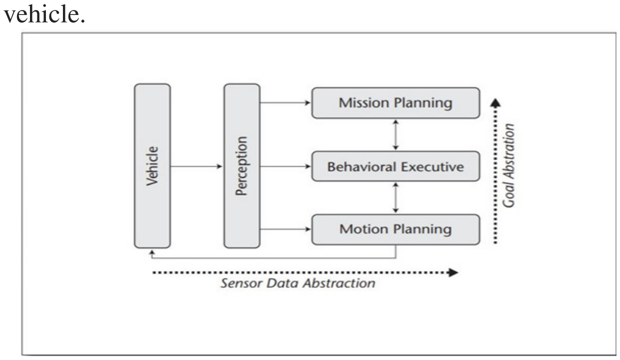

Fig.7. Working of Boss Vehicle

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9.1 Sampling-based threat assessment algorithms for intersection collisions

The field of road safety and safe driving has undergone rapid advancements due to continuous improvements in sensing and computation technologies. Efforts are currently underway to use more advanced concepts like car-to-car communications and intelligent vehicle highway systems for improving the safety and efficiency of human-driven ground transportation systems. Negotiating a traffic intersection safely is one of the most challenging driving tasks. An estimated 45 percent of injury crashes are intersection-related, and result in approximately 22 percent of roadway fatalities. Most of them occur at traffic signals. A main cause of these accidents is the driver's inability to correctly assess and/or observe the danger involved in such situations. These facts suggest that driver assistance or warning systems may have an opportunity in reducing the number of accidents.

Talos, the MIT autonomous Land Rover LR3 that participated in in the 2007 DARPA Grand Challenge (DGC): negotiating intersection traffic. If a threat assessment module was embedded in the motion planner of autonomous systems, it could improve its safety during trajectory generation and the risks caused by the different behaviors of other vehicles. To portray the threat level of dynamic road situations, various measures have been introduced. These approaches typically measure collision risk by time-to-collision and its variants, headway time, or required deceleration. However, these measures are mainly created to frontal collision warning systems where the unexpected dangerous driver is leading the host driver, and cannot be applied to intersection scenarios where the dangerous driver can come from different angle. However, it is assumed that a prediction model of the opposite vehicle's future motion is offered, which is unlikely for a driver behaving unpredictably and thus erratically [13].

9.2. Enabling safe autonomous driving in real-world city traffic using multiple criteria decision making

The autonomous vehicles impressively demonstrated that it was possible to successfully complete DARPA Urban Challenge test track, it is important to note that this race took place in a simplified environment, and not in real world traffic. The developed decision making solutions for the DARPA Urban Challenge were mainly focused on satisfying the race requirements to win the race, and not on making driverless vehicles to safely cope up with the real-world traffic. For example, the developers of "Knight Rider" let their vehicle to perform illegal U-turns to save time, while team "Talos" released safety constraints by minimizing safety distances around the obstacles, neglecting traffic lanes, "ignoring" the part of the vehicle behind its rear axle, or skipping checkpoints. Driverless vehicles for civilians are not likely to gain public acceptance unless they are proved to be safer than human-driven vehicles. Therefore, the decision making subsystem plays a crucial role toward reaching this goal [14]. The decision making process consisting of two consecutive stages:

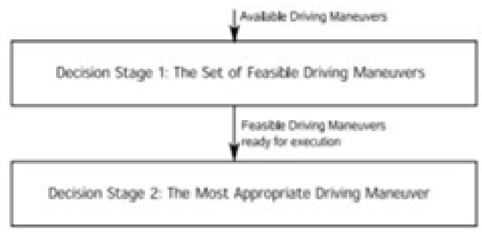

Fig.8. Decision Making Process Stages

The main drawback for this approach is that you need precise information and manually specified weight for each criterion.

9.3. Intention-Aware Motion Planning

Motion planning is an important capability for autonomous robots. The key issues of motion planning—geometry, kinematics, dynamics, uncertainties in autonomous control and sensing, etc. were identified many years ago. At the time, autonomous vehicles were mostly confined to tightly controlled environments, where they seldom actively interact with humans. For example, a robot golf cart, during an encounter with pedestrians in a parking lot. Each pedestrian walks towards one of the several goals, some may lead him to go across the road. The robot doesn't know the pedestrian's intention, so, in this case, the goal must be known in advance and must be inferred based on observed pedestrian behavior. The robot then acts accordingly. By modeling the encounter as a MOMDP and solving it, we obtain a conditional plan that enables the robot to act optimally (with respect to the model) despite uncertainty on the pedestrians' intentions. Therefore, unaware of the pedestrians' intentions in advance, the vehicle must pass over them as quickly as possible and avoid accidents [15].

9.4. Probabilistic decision-making under uncertainty for autonomous driving using continuous POMDPs

This is a generic approach for tactical decision-making under uncertainty in the context of driving. The complexity of this task mainly comes from the fact that rational decision-making must consider several sources of uncertainty: The temporary evolution of situations can't be predicted without uncertainty because, the other road users behave randomly and their goals cannot be measured. Even more important, road users are only able to interpret a tiny part of the current situation with their sensors because measurements are noisy and most of the environment is closed. In order to anticipate the results of decisions a probabilistic approach, considering each type of uncertainty, is important. We address this by making the task of driving as a continuous Partially Observable Markov Decision Process (POMDP) which can be optimized for different scenarios. We do not use a symbolic representation or illustrate the state space apriori since there is no representation of the state space that is optimal for each and every situation. Instead, we embed a continuous POMDP solver that tells a good representation of the specific situation [16].

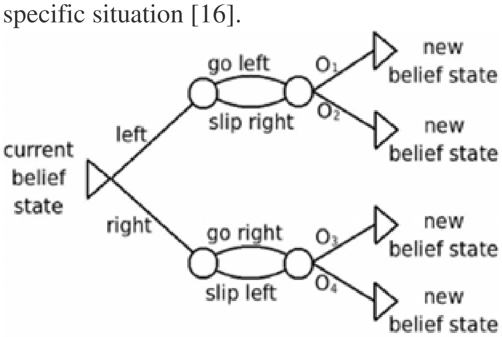

Fig.9. Belief Space states

The drawbacks of this approach are that the continuous belief space may lead to large number of samples and large computational effort.

9.5. Google's self-driving car really be ready

There's a slight chance that once if you get behind the first commercial version of the Google car, it may not be possible to take you where you want to go. Any shift by Google in its self-driving car plans would be worthy of attention, because while there

10. Conclusions

The better your paper looks, the better the Journal looks. Thanks for your cooperation and contribution.

Appendix

Appendixes, if needed, appear before the acknowledgment.

have been skeptics, much of the world has taken it for granted that major technology challenges of fully computer-controlled vehicles have been worked out, and that Google was to deliver them in the near future. The expectations are very high that the lawmakers are now being impulsed to scrap support for mass transit programs, which won't be needed in an era of ubiquitous self-driving cars. The Google Car is a sophisticated system that integrates proprietary hardware and software, using video cameras, radar sensors, and a laser range finder to visualize traffic and detailed maps taken from Google Maps to enable navigation between destinations. Google's data centers process the incoming data passed on from the sensors and cameras mounted on the Google Car in order to provide the car with useful information about its environment that is later used in translating into the physical operation of the vehicle [17].

Fig.10.Google Car

Google stated their ambition to develop a fully computerized car without either a steering wheel or brake pedal.

9.6. Evaluation of vehicle-to-pedestrian communication displays for autonomous vehicles

Previous works on humanistic style includes development of interfaces that helped in rising driver's effectiveness; but, interfaces designed associate with pedestrians based on a vehicle's perceived intention is minor. For this work, the authors investigated intent communication for autonomous vehicles by comparing the efficiency of different methods of presenting vehicle-to-pedestrian street crossing information.

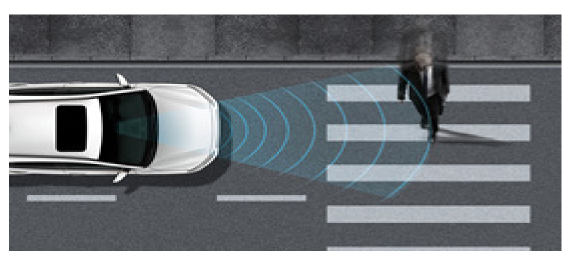

Fig.11. Vehicle-to-pedestrian street crossing information.

In an experiment, a van representing an autonomous vehicle presents information to pedestrians telling them when to cross a street. Participants made crossing decisions from two locations, a marked crosswalk and an unmarked midblock location. Differences among individuals such as age, gender, crossing location and conscientiousness were predictive of safe crossing decisions. Participant response times were analyzed to tell which display types gave the fastest and safest decisions. The results suggest pedestrians will depend on legacy behaviors rather than the information on an external display. A large number of participants, believe more additional displays will be needed on autonomous vehicles. The results of the experiment can be used to help inform future designs for vehicle-to-pedestrian communication [18].

9.7. Autonomous vehicle control at the limits of handling

First autonomous vehicles are being introduced into the market right now. In the research first highly integrated dynamic vision system has become operational recently and is discussed as reference for future developments. Initially, assistance systems will be available for getting experience while the human operator carries all responsibility. Since the autonomous vehicle is created to simulate a human driver's behaviour, it is necessary to introduce a driver model to the design of the autonomous vehicle controller. In the long run, phases of fully autonomous driving may become affordable of the legal implications. The driver will have a choice to use these capabilities or not. Also manual driving will remain an option for enjoying own skills. However, the autonomous system may intercede in order to prevent clearly dangerous situations. Race Car drivers have the ability to operate a vehicle at its friction limit without losing control. If autonomous vehicles or driver assistance systems had same capabilities, many accidents can be avoided. To advance this goal, an autonomous racing controller is designed to increase insights into vehicle control at the friction limits.

A bicycle model and a ‘ *g-g* ’ diagram are used to imitate race car drivers’ internal vehicle model. Lane Keeping steering feedback and wheel slip feedback controllers are used to steer and throttle corrections according to the vehicle responses. Experimental results on a low friction surface indicated that the controller can strongly track a path during tyre adhesion and provide an accurate understanding for the future development of vehicle safety systems [19].

Google stated their ambition to develop a fully computerized car without either a steering wheel or brake pedal.

11. Inference

This paper focuses on spatial heterogeneity in constructing the Voronoi diagram in order to support appropriate allocation. Therefore, detailed spatial information is required, including road network, travel patterns, population density, behavioral characteristics, boundary of restriction area, etc. Further, realtime context knowledge, such as traffic conditions, weather, accidents, constructions, is also essential since it may influence travel behavior in certain conditions. GIS facilitates creation, integration, and management of these different kinds of data as well as transfer of attribute values. After specification of the heterogeneous Voronoi diagram model, the solution approach is detailed. This approach is based on iterative approximation using deterministic dynamic programming. Visualization and display of allocation is a straightforward task in GIS. In addition, We have also integrated uncertainty of the environment in the planning trajectory using evidential grid. The simulation results show good performance of our algorithm in avoiding obstacles under uncertainty and underline the difference between using an evidential grid instead of a binary grid. Consequently, we have introduced techniques to improve the problems of path planning with the help of processes that include decision making to choose the optimal path, and also detection of safe environments for travel of autonomous vehicles , and also we could derive results for an efficient autonomous vehicle.

12. Future of Artificial Intelligence and its Scope

The automotive AI market reported that it's expected to be valued at $783 million in 2017 and expected to succeed in about to $11k million by 2025, at a CAGR of about 38.5%. IHS Markit expected that the installation rate of AI-based systems of latest vehicles would rise by 109% in 2025, compared to the adoption rate of 8% in 2015. Artificial Intelligence-based systems can become a customary in new vehicles particularly in these 2 categories: Infotainment human-machine interface, including speech recognition and gesture recognition, eye tracking and driver monitoring, virtual assistance and natural language interfaces and Advanced Driver Aid Systems (ADAS) such as autonomous vehicles, driver condition evaluation, camera-based machine vision systems, radar-based detection units, sensor fusion engine control units (ECUs), driver condition evaluation. To implement the Machine Learning approach,Deep Learning Technology is used. Machine Learning is the fastest –growing technology in an Automative Artificial Intelligence Market. It is used in various areas like voice search,sentiment analysis, voice recogntition,image recogntition and Motion detection in autonomous vehicles.

Insert acknowledgment, if any. The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments. Avoid expressions such as "One of us (S.B.A.) would like to thank ... ." Instead, write "F. A. Author thanks ... ." Sponsor and financial support acknowledgments are also placed here.

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