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Autonomous Vehicle Control Using LIDAR SLAM and ROS With VISSIM Simulator in Rainy Weather

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ABSTRACT

Car driving is a major issue in bad weather in Pakistan. There are many circumstances of weather like hot,cold and rainy or snowfall. Most of the drivers can't control this scenario. Moreover, they can't locate the area of direction.Internal combustion engines also can't produce spark due to rain. In this scenario, ROS fulfilled the engine crisis significantly. LIDAR with SLAM(simultaneous localization & mapping) has the capability to increase the efficiency of the engine by compensating with ROS and utilization of snow fall reserves with negligible effects of driving. Fuzzy logic system also discussed in paper so that it maintains the direction of ROS according to the raining data sheet. The prospects of this technology are explored in VISSIM simulator as a solution to traffic solutions and especially for the utilization of directions adjusting in rainy weather.Issues and challenges are considered for implementation of this technology and finally the roadmap for its implementation in our environment is discussed.

Keywords: LIDAR with SLAM,ROS, fuzzy logic design, engine efficiency.

INTRODUCTION

Pakistan faces so many issues of traffic jam in weather ups and down condition.We need position of robots and landmark for navigation.SLAM uses location tracking and mapping methods together with pose estimation to create a map at the same time.Given the environment map use raw data to estimate current pose of the robot.Other traffic control through VISSIM.SLAM consist of motion model which is kinematics,measure model is a sensor model(RP LIDAR) in front of robotics,vehicle state (poses) and feature location(map) in the back of roboticsLidar-based SLAM.The SLAM algorithm integrates lidar scan into a pose graph,associating each scan with a node represents the estimated pose. The algorithm matches scans to determine relative poses.Loop closure is achieved by matching scans to previously mapped areas,refining node poses in the pose graph. As figure 1.

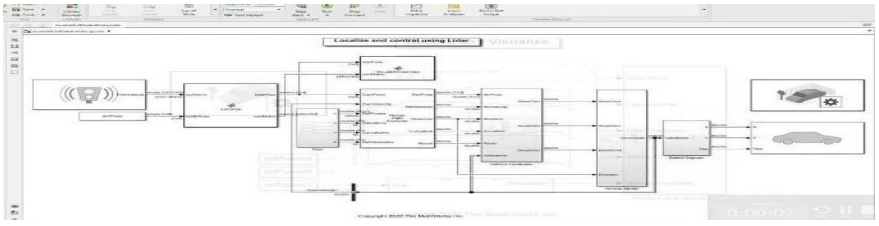

Figure 1:LIDAR SLAM implementation

Using the A* algorithm, we ensure it is *admissible* if, for any given graph, it consistently finds the optimal route from the initial state to the goal state—provided such a route exists. As discussed earlier, if

the heuristic function ‘h’ consistently provides a value that is less than or equal to the actual cost from the current state to the goal, it is guaranteed to produce an optimal result and is therefore known as an *admissible heuristic*. Consequently, we can conclude that A* will always end with the best possible path when ‘h’ is an admissible heuristic function.

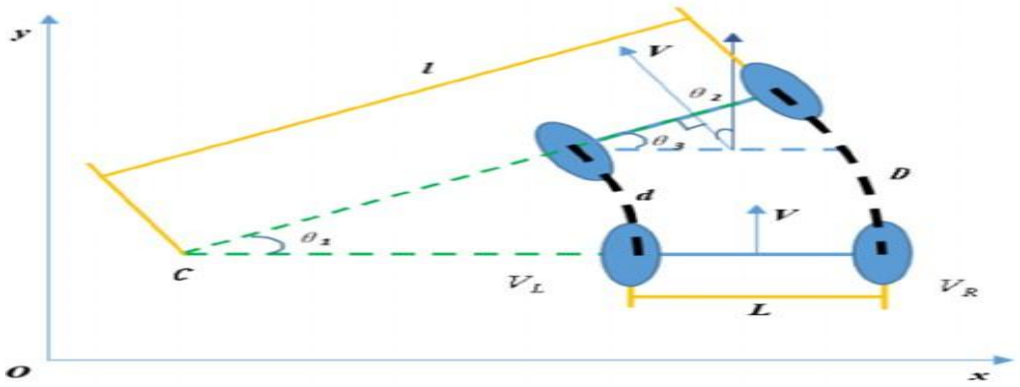

Figure 2:A* algorithm implementation

Fuzzy Logic System Design

Fuzzy logic system design made prediction of memberships values if the engine is not working due to different conditions of weather and sent to ROS too as a feedback with SLAM at poses.The design graph shown in figure 2.

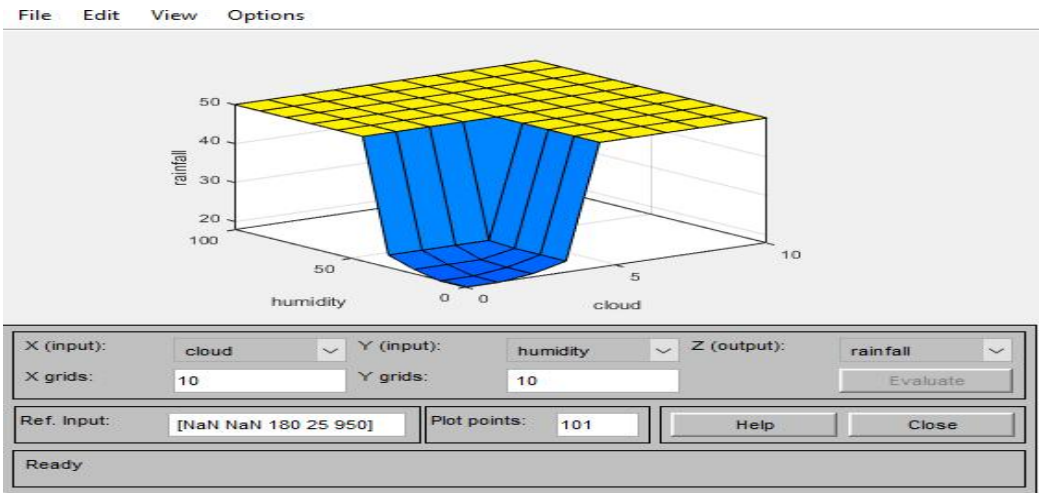

Figure 3:fuzzy logic feedback

The fuzzy based control model for LiDAR SLAM has formulated with feedback system of ROS.Design of interface architecture in robotic vehicle with Bluetooth module can be achieved on runtime comparison of estimated and real condition.This process continues until it reaches in final

destination of mapping.Fuzzy logic system can also be connected in GUI with c++ but here prefer python for sequence of flow to merge all items in one margin.It also loop the A* algorithm in every step.

The sequence will be followed by neural network in which one input detected from lidar slam and one input from fuzzy logic system(one input feedback is also consider as a fuzzy logic system when weather will instantly changed a little bit.All data collected in access system(can also connect through sql in python) will be developed in sequence to form flatten form and one output at a time.Kalman filter can be used for for blur image and connected through HDMI for video detection at real time.Weight will be updated sequentially in data collection if ups and down with respect to our requirement.All input connected through labview simulation in ROS (Arduino can also used as actuator).VISSIM through Bluetooth synthesizer also record a mapping in real time then comparison to imaginary data can produce error.Error removed in sub loop of python programming in QT creator and updated regularly.

ROBOT OPERATING SYSTEM

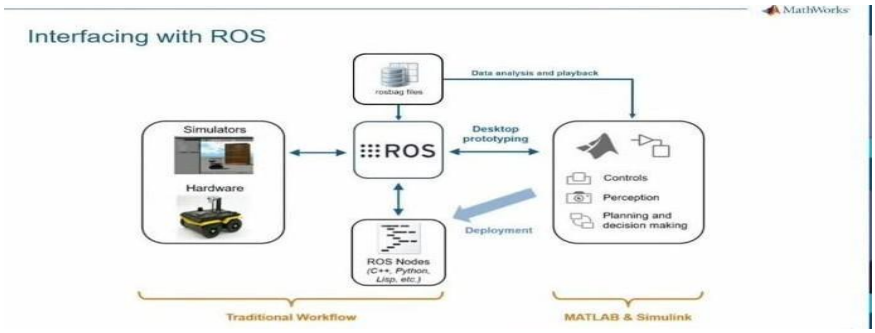

Figure 3:ROS modeling

In this case of studies we created python building GUI with QT creator which is user interface integrated development environment(IDE) and integrate with ROS.We decorate widget,slot and main windows by building application with python using agile algorithm and then interact with QT designer window.The steps included.

1)Introduce

2Add prerequisites

3) Produce static GUI layout
4) Perform widget naming convention
5) Connect vs autonomic convention
6) Define widget functions
7) Create Qt docs
8) Handling user errors
9) Develop Q message box
10) Close & close event
11) Wrap up

The connection of software and hardware is undertaken by our requirement of compatibility of system used and pins connector.Agile algorithm maintain the flow of cost and performance in each step and save in memory and will give a continuous set of data sheet.I did not mention here a perfect calculation of amount of data as it is built in or normalize through access or sql automatically.The raspberry pi show the output and can be monitor through any android application(raspberry pi monitor).FPGA can also be used so that it provide better memory system.The slope of vehicle can be monitor through equations by initial and final velocities or you can say thirst velocities of gradients and can be resemble to pyfirmata.Tkinter can also be used a library of python except QT creator but Its normally used with ubuntu.

VISSIM Simulator with Bluetooth Detectors

We used a blue synthesizer application in which wifi,3D GPRS and Bluetooth combine together to collect data using the VISSIM simulator.

The software operates with two execution nodes.The offline mode can replay a trajectory and generate Bluetooth hits and detection records similar to actual events. The online mode enables real time traffic analysis,Bluetooth stimulation,and traffic signal control integration with the VISSIM stimulation.This will facilitate the testing and verification of the proposed adaptive signal control model in a variety of traffic conditions. This simulation provides a test environment for validating advanced trafficmanagement strategies reliant on Bluetooth technology.Field measurements from a custom developed hardware and software system were used to validate the proposed Bluetooth stimulation model.

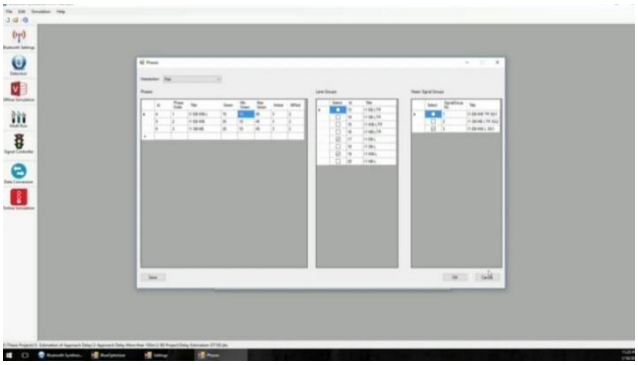

Figure 4: Bluetooth Synthesizer

I converted VISSIM Vehicle Trajectory (FZP) files to the ACCESS database from where I can use the output of this process as an input to the Bluetooth Synthesizer.

The detail process of VISSIM simulator contains set parameters,units,vehicle types and composition,loading project area,drawing links and connectors,reduced speed areas,vehicle input,static routes,vehicle composition,adding signal head and signal controller,adding 3D model and running simulations.

The proximity of two major intersections increased the complexity,necessitating a microsimulation study was crucial for achieving accurate results in vehicle actuated signalization. Testing it in the safe environment of a micro-simulation tool allows the traffic engineer to design an optimized and fault-proof signalization. This optimizes the use use of available road space ,minimizes maintenance

dowmntime,and maximizes capacity for all users. This can be controlled using timing optimization or traffic signal coordination ensuring a smooth and sequential traffic flow.

Interfacing Platform

The interfacing technique we used in our research is lab view where we connected ROS,fuzzy logic system,LIDAR SLAM.VISSIM is connected through bluetooth application and send it to raspberry pi.Python code also connected to raspberry pi to control ROS.fuzzy logic system and lidar SLAM.

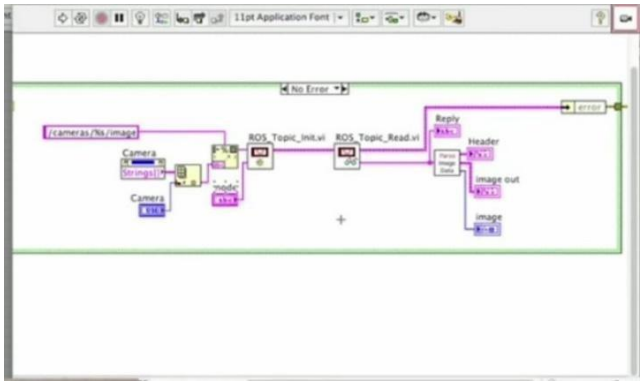

Figure 5:Labview platform

If the weather is hot or cold or rainy then it produce feedback loop to input where lidar produce comparison of data for autonomous detection of recorded and capturing manners with error handling.ROSmove actuator forward or reverse after VISSIM map object detection to make a decision either object may be pedestrian,tree,vehicle,bike, Traffic signal or any non materialistic object.Brakes may also produce some resistance in gear that slow down the car automatically.QT creator in python creating a subloop for all systems before rotating the ROS.

Current Research

The Robot Operating System (ROS) is a collection of software framneworks and tools that enables the development of robotic systems and applications. The latest long term support version of ROS is ROS Noetic. It is the 13th and and most recent Robot Operating System (ROS1) distribution release.ROS Noetic was launched on May 23,2020 by open Robotics,the organization behind ROS.It has 5 year support lifecycle,ending in May 2025. In the future, all the official effort will be put into developing ROS 2, which is a major rewrite of the ROS framework.

ROS Noetic is primarily designed for Ubuntu 20.04,making Ubuntu the preferred Linux distribution for installation. This tutorial describe how to deploy the software ROS Noetic from source on the Raspberry data Pi OS and how to link your LiDAR to maker board Pi 4 Model B using ROS Noetic middleware. It's not difficult,but compilation will take a while.

In the upcoming days, a study aims to explore the application of GPS technology for estimating stream travel time under Turkish traffic conditions. In this context, certain similarities and distinctions may emerge between technologies like Bluetooth and GPS. Notably, companies such as Waze, TomTom, and

Google already deliver real-time traffic data at both city and national levels using GPS and various other data sources. Therefore, a comparative analysis of these technologies will be conducted to assess travel time estimation performance under varying conditions.
Currently, the LabVIEW platform provides a versatile, efficient, user-friendly, and comprehensive framework for image analysis.
With several valuable modules available, this study presents a method for analyzing color perception using a basic USB webcam and custom-developed software for real-time color detection on the LabVIEW platform. The effectiveness of this approach in performing fundamental color analysis is evaluated. The application was developed in LabVIEW 2019 utilizing the NI Vision Development Module v19 and NI IMAQ v19 components.

CONCLUSION

The mentioned algorithm is little bit difficult to design but Its gives perfect output and simulation for self driving system.Moreover researches are not so much established regarding to that so its new idea to control robotics in the field of information technology.Models number can be change with respect to need of technologies but main phenomena is defined here.

REFERENCES

L. Yang and W. Lan, "On Secondary Development of PTV-VISSIM for Traffic Optimization," *2018 13th International Conference on Computer Science & Education (ICCSE)*, Colombo, Sri Lanka, 2018, pp. 1-5, doi: 10.1109/ICCSE.2018.8468743.

K. B. Swain, S. Dash and S. S. Gouda, "Raspberry PI based Integrated Autonomous Vehicle using LabVIEW," *2017 Third International Conference on Sensing, Signal Processing and Security (ICSSS)*, Chennai, India, 2017, pp. 69-73, doi: 10.1109/SSPS.2017.8071567.

S. Gatesichapakorn, J. Takamatsu and M. Ruchanurucks, "ROS based Autonomous Mobile Robot Navigation using 2D LiDAR and RGB-D Camera," *2019 First International Symposium on Instrumentation, Control, Artificial Intelligence, and Robotics (ICA-SYMP)*, Bangkok, Thailand, 2019, pp. 151-154, doi: 10.1109/ICA-SYMP.2019.8645984. https://www.researchgate.net/publication/3454 431_Using_Fuzzy_Logic_in_Automated_Vehicl e_Control/link/0a85e530756b3bb25e000000/do wnload

B. Cao, R. C. Mendoza, A. Philipp and D. Göhring, "LiDAR-Based Object-Level SLAM for Autonomous Vehicles," *2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Prague, Czech Republic, 2021, pp. 4397-4404, doi: 10.1109/IROS51168.2021.9636299.

https://www.youtube.com/watch?v=T588klKB PNo