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Fuzzy Logic Vehicle Parking System

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Abstract:

Interest in using intelligent systems in cars is on the rise. One of the problems that drivers face that can be addressed by these high-tech solutions is finding a place to park. The proposed approach employs fuzzy inference for vehicle management and parking in a congested area. The vehicle will follow the prescribed course thanks to two parallel embedded fuzzy controllers. In this study, we introduce a smart, autonomous parking system that can perform a number of tasks. The integrated system is made up of the Fuzzy-Based On board System and the control centre. In contrast to current auto-parking efforts, this FBOS gives the vehicle the ability to recognise slots and park in two distinct parking modes. Error rates can be kept to a minimum by the use of real-time monitoring, which is enabled by the control centre.

Keywords* — *Fuzzy Logic, Vehicle , FBOS , Car parking.

INTRODUCTION

The increasing number of cars in human cultures has generated several challenges, one of which is the shortage of suitable parking space. Parallel car parking is an issue that drivers deal with daily, demanding labour, even for expert drivers. Besides, the relatively tiny places for parking in packed streets make parking quite difficult, especially if the driver is not skillful enough. Therefore, an intelligent car parking system is needed. Smart auto parking, by boosting driver comfort, minimises traffic and parking time and prevents car collision with parked vehicles. With the increasing breakthroughs in the intelligent vehicles sectors, the demand of fully automatic and semi-automatic parking systems in cars may be recognised. So far, different strategies were applied to build a smart car park system. [1] However, in general, a parking issue may be broken into three sections,

which are as follows: environmental awareness, planning the desired course, controlling and driving the automobile on the scheduled pathway.

The car can be guided along the predetermined route in one of two ways. One method is called "path tracking," and it entails the controller moving along a predetermined course. In this method, the controller takes into account the deviation between the present position of the vehicle and the reference path in order to steer the vehicle back onto the reference path. The second method is similar to the first in that it uses the error between the car's current location and the reference path to guide its movement, but in contrast, the controller actively attempts to construct the way. [2]

Lotfi Aliasker Zadeh is widely credited as the creator of fuzzy set theory in his seminal work "Fuzzy Sets" [3]. Although it was initially viewed as a mathematical diversion, it has since found a wide range of practical uses in fields as diverse as control engineering, machine intelligence, pattern recognition, qualitative modelling, signal processing, information processing, decision making, management, medicine, finance, the automotive industry, robotics, and many others. An inventor's definition of a fuzzy set is a set of things that includes a range of degrees of belonging. When comparing to classical or crisp sets, the gradualness of a transition is one of the benefits of living in an environment with fuzzy sets.

These days, most mechanical systems can't function without an advanced control system, and fuzzy logic control is often part of that. Fuzzy control systems are currently being used for a wide range of practical applications, from water management to automatic train and crane container operation to elevator and nuclear reactor and power regulation to fully autonomous parallel parking. [4]. One of the things to think about while working with fuzzy logic is the best way to convert input into output using a fuzzy inference system. Fuzzy inference is a means to formalise the input-to-output mapping that is typically provided. A set of membership functions, logical operations, and IF-THEN rules are used in this procedure. In the end, what we'll have is something we call a "Fuzzy Inference System" (FIS). [5] There are a number of different fuzzy inference systems (FIS) in use in the field of fuzzy logic; examples include the Mamdani, Sugeno, and Tsukamoto FIS. The purpose of the fuzzy control system is to reduce or do away with any overshoot. Maximum precision is required, hence the RCPS control system must have overshoot and error minimization features. Using the Sugeno Model, this research explores how a fuzzy control system might be applied to the Rotary Car Parking system (RCPS). The system is evaluated on a scaled-down RCPS with only six parking spots. After a kinematic analysis of the envisioned RCPS, the fuzzy control system is implemented. After that, we'll evaluate how the RCPS microcontroller with Fuzzy performs in comparison to the tried-and-true conventional control method. [6]

FUZZY RULES

Every defining parameter of the strategy is set to the input crips. The data from the sensor used is stored in this input cache. The purpose of implementing a fuzzy logic control system is to determine the rotational speed of the motor based on the values of the distance and angle sensors that were initially set based on the input crips. Because of the frequent rotational and translational motion changes inherent in RCPS, distance and angle parameters are employed. The system's rules are derived from a set of parameters already applied to the membership function. Figure 1 displays a set of variables and fuzzy rules. [7]

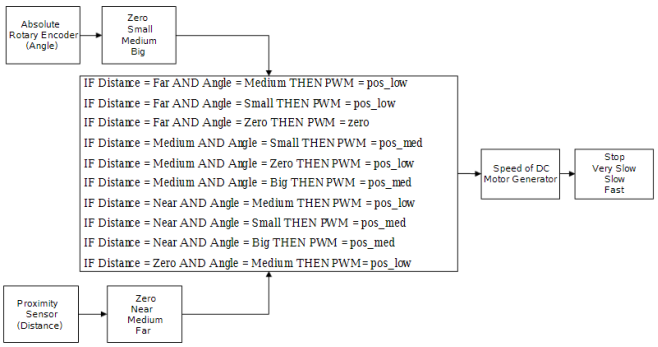

Fig.1: Variables, set and fuzzy rules

SYSTEM FUNCTIONALITY

Commercialization prospects for the intelligent autonomous parking system are high because it is a fully formed, multi-purpose system. The FBOS (Fuzzy-Based Onboard System) and the control hub are its two main components. The control room houses the computerised Graphical User Interface (GUI) and the ground station is situated in the parking garage. The automobile and the base station are in constant, two-way radio contact. Using an RS232 serial port cable, GUI may communicate with the ground station. The primary goal of the GUI is to keep an eye on the parking lot and see how things are going there. It also has the added capability of sending and receiving text messages with vehicle owners. [8]

ADVANTAGES FUZZY LOGIC:

- Firstly, the ideas behind Fuzzy Logic are simple to grasp. Fuzzy reasoning relies on some straightforward mathematical ideas. Fuzzy logic is a simplified, more intuitive alternative to traditional methods.
- Fuzzy logic can be adjusted to different situations. It's simple to add new features to any system without having to redesign it from the ground up.
- Fuzzy logic can work with less-than-perfect information. Everything has some degree of

vagueness if you look closely enough, and many things are vague even when examined thoroughly. Fuzzy reasoning incorporates this awareness throughout the procedure, rather than adding it at the very end.

- Nonlinear functions of arbitrary complexity can be modelled using fuzzy logic, according to this theory. Every possible pair of inputs and outputs can be accommodated by a custom-built fuzzy system. With the help of Fuzzy Logic Toolbox, which includes adaptive approaches like Adaptive Neuro-Fuzzy Inference Systems (ANFIS), this is a breeze.
- Expert knowledge can be layered using fuzzy logic, as shown below. Fuzzy logic allows you to rely on the expertise of people who are already familiar with your system, in contrast to neural networks, which absorb training data and build opaque, impenetrable models.
- Combining traditional control methods with fuzzy logic Traditional methods of control may not be abandoned in favour of fuzzy systems. Many fuzzy systems are used to enhance and simplify the aforementioned.
- Fuzzy logic is grounded in the study of human language. Human communication serves as the foundation for fuzzy logic. This realisation is the basis for numerous
- the remaining claims concerning fuzzy logic. As a result of its foundation in the patterns of qualitative description found in everyday language, fuzzy logic is intuitive.

REVIEW OF LITERATURE

Volkswagen's Futura Concept Car, also known as the Integrated Research Volkswagen, debuted in 1992 [9] with an innovative self-parking system (IRVW). The IRVW gave the driver enough power that they could exit the vehicle to observe its parking without getting behind the wheel. However, the proposal was never put into production because of the high cost rise associated with implementing such technology. Toyota's "Intelligent Parking Assist" self-parking system debuted in the Prius hybrid automobile of Japan in 2003; three years later, businesses in England chose to market the concept.

Mamta Gahlan et al. [10] detail a GPS-based method for parking lot administration (Global Positioning System). This GPS-based technology can identify and designate the open parking spot. Using coordinates, we can find the free spot. Modules like the "drivermodule," "communication module," and "function module" are a part of the architecture. When the GPS is activated, the in-car module will determine where the driver currently is and relay that information to the car's communication system. The database already has the coordinates for the parking system. The distance between the two points can be determined by using the module for communication. The Haversine formula is used to determine the spatial separation between two points. The parking system's current location will be compared to the driver's current location by the server.

D. J. Bonde et al. [11] offer a system that may be operated from a mobile device using an Androidapp. This system introduces an automated vehicle parking solution that can control the number of cars parked in a given location in response to vacancies. Using a variety of sensors, this automated system can park and release a vehicle. An Android app handles the process of entering and leaving the parking spot. Using an Android app, the driver can trigger the device with the command "Park My Car." That's why it'll be sent in code. The GSM module in the parking garage will retrieve the message and relay it to the microcontroller. A response will be delivered to the driver based on the data in the controller. A car can pull into a vacant parking spot if one is nearby.

Automatic user parking behaviour identification was developed by Rosario Salpietro et al. [12] by analysing data from sensors built into smartphones and Bluetooth connections. After a parking incident is identified, the data may be disseminated across the intended scenario with the use of an adaptive strategy that takes advantage of both internet access to a remote server and device-to-device connectivity via wifi direct links.

An Adaptive Fuzzy Fractional-Order Sliding Mode Controller Design Strategy for ABS was proposed by Tang et al. [13]. The suggested strategy incorporated both the fractional-order sliding mode controller and the FLC. In order to mitigate the negative consequences of ABS parameter changes, the FLC was developed. The Lyapunov method of analysing stability was used to fine-tune the controller. While research on ABS control continues for the goal of improved performance and reduced costs, electric vehicle technology has provided a fresh impetus for development studies due to its unique requirements on certain system elements.

OBJECTIVES

- To study fuzzy logic and its System functionality
- To study how to get posture stabilization
- To study how to measure disatnce
- To study features of a membership function

RESEARCH METHODOLOGY

A research technique is a standard approach to a research problem that includes steps like gathering relevant data, analysing it, and drawing conclusions. A research methodology is a game plan for doing a study. Research can be defined as the systematic pursuit of knowledge via the collection and examination of data from a variety of sources. The purpose of this research is to employ methodical approaches to the resolution of intellectual and practical challenges. Research is defined as "scholarly inquiry or investigation," with a focus on "inquiry or experimentation directed at the exploration and clarification of data, modification of existing techniques or laws in light of new facts, or practical application of such new or updated theories or laws" by Webster's Collegiate Dictionary. In the eyes of these folks, study is a trip from the familiar to the strange. The data used in this descriptive study came from a wide range of secondary resources, such as books, journals, scholarly papers, government publications, printed and online reference materials, and encyclopaedias.

RESULT AND DISCUSSION

In order to achieve truly autonomous parking, posture stability is a must. It aids in the prevention of accidents and guarantees precise measuring of the parking space. The vehicle's front wheels demonstrate wall-following behaviour. An on-board fuzzy logic controller monitors data from the FR and BR sensors in real-time to maintain stability (Fig.2). [14]

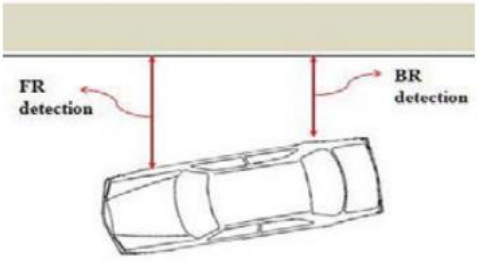

Fig.2: Posture Stabilization

The ground station, situated in the parking lot, and the Graphical User Interface, installed in the control room, make up the control centre. It's possible to have two-way conversations in real time. The intelligent vehicle and the ground station communicate with each other using radio frequency signals. The car's current condition is relayed from the ground station to the GUI, and the ground station in turn relays commands from the control room to the vehicle. Cable connections through RS232 ports are used to link the ground station to the GUI. [15] Using Bluetooth technology, the GUI also has the ability to send and receive text messages with car owners. The channels of interaction between these subsystems are shown in Fig. 3.

Fig. 3: Communication between Subsystems

The slot-shaped object's distance from the reference point is read using an ultrasonic sensor of type HC SR04. In the diagram of Fig. 4, position B of the slot serves as the x-reference axis's point. This sensor can roughly determine how far away the object (slot) is from the x-axis. [16-18] In order to detect an item, an ultrasonic sensor sends out a signal that is reflected back to the sensor. Fig.4 depicts the sensor's distance-reading mechanism.

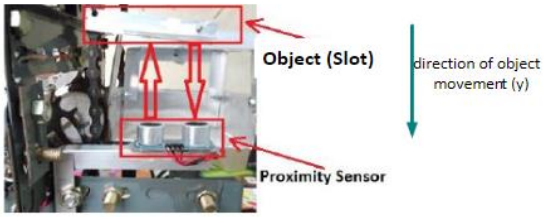

Fig. 4: Distance reading mechanism by using ultrasonic sensors

Fig 5 shows the configuration of fuzzy logic, which accepts imprecise data and vague statements such as low, medium, high and provides decisions

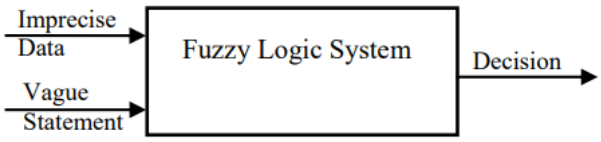

Fig. 5: Configuration of fuzzy logic system

Using a graphic representation called the membership function, we can see how much weight each input carries in the overall model [19]. Each processed input is given a relative importance, inputs are compared for functional overlap, and a final response is calculated based on all of these factors. The rules employ the membership values as weights to decide how much the fuzzy output sets contribute to the final output conclusion. Inferred, scaled, and combined functions are defuzzified into a clean output that controls the system. [20] The membership functions connected to the various possible inputs and outputs vary. The characteristics of the triangles are shown in fig. 6.

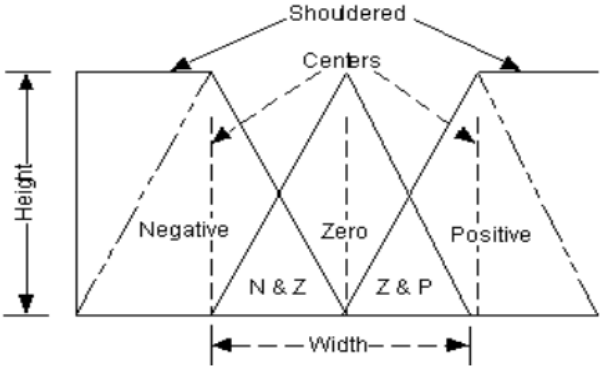

Fig. 6: Features of a membership function

CONCLUSION

In this study, we present an autonomous parking system that is both smart and efficient. Fuzzy Based Onboard System (FBOS) and the command hub are the two main components. Slot recognition and autonomous parking are both under FBOS's control, with the help of peripherals like infrared sensors and ArduIMU. The FBOS coordinates auxiliary operations like navigating around obstacles and talking to the control room. The ground station and graphical user interface that make up the control centre were built with real-time tracking in mind. The goal is to build channels of communication using RF signal, serial port, and Bluetooth to complete the mission. The typical parking operations can be completed dependably using this method. However, a lengthy distance to the sidewalk, a lengthy or plentiful vehicle, a large number of obstructions, etc. could all cause this method to fail. This system's inability to monitor additional targets means that the vehicle will inevitably run over anything that isn't specifically taken into account here.

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