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An Autonomous Braking System of Cars Using Artificial Neural Network

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ABSTRACT

The main aim is to develop the system to distribute proper braking force to each wheel of the vehicle by using Artificial Neural Network framework. However Artificial Neural Network facilitates the system to design and improve turning abilities. The underlying control philosophy takes into a consideration steering angle and obstacle detection. This system is designed to avoid skidding under sudden turning conditions. Simulations and hardware prototype demonstrate the effectiveness of the proposed braking system. The neural network framework takes decision on braking in each wheel that depends upon environmental conditions.

Keywords: Artificial Neural Network, Ultrasonic sensor, Arduino Uno

1. INTRODUCTION

Braking takes an important role in maintaining stability of any autonomous vehicle. Stability can be decreased during certain conditions such as sharp turnings and sudden obstacle detection. The researcher designs many braking system to avoid those certain conditions in vehicles. This proposed braking system can be improved from earlier systems like Antilock Braking system and Electronic stability program or control. Antilock braking system stops a vehicle wheel without locking while decreasing the stopping distance. Wheel locking will result in skidding of vehicle. An addition of yaw rate sensor to the Antilock Braking system, it applies a distributed brake force to the individual wheel of the vehicle that prevents the vehicle from skidding.

Another factor that occurs skidding of vehicle is sudden obstacle detection of the driver. This can be avoided by using an Automatic braking system that works with the help of GPS transmitters and receivers which are attached to the vehicle. Automatic Braking system will not detect sudden obstacle occurrence infront of the vehicle results in skidding of the vehicle. The researcher proposed system that will avoid the difficulties that occur in both Electronic Stability Control and Automatic Braking system. In this system ultrasonic sensor and yaw rate sensor are attached to the control unit of the vehicle. Artificial Neural Network methodology is used to develop an algorithm to avoid skidding. The main reason for using Artificial Neural Network is to create the system which process with the continuous sensor readings in multilayered architecture that applies distributed brake force to the individual of the vehicle.

2. LITERATURE SURVEY

Abhinav Kant, Mukesh Kumar, Varun, Shimi [1] has proposed the paper Enhanced braking system in 2013. In which braking mechanism play a vital role in vehicle to improve turning abilities in different road conditions. This system takes into consideration in wheel acceleration as well as wheel slip factor.

K. Subhulakshmi [2] has proposed the paper antilock braking system using fuzzy logic in 2014–to detect vehicle wheel locking in vehicles. This paper tests on an experimental car with antilock-braking

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system (ABS) and vehicle speed estimation using fuzzy logic. This detector takes consideration in wheel slip, vehicle and wheel velocity as well as the tire and road adhesion coefficient in order to recognize braking tendencies.

Chun-Fei Hsu [3] has proposed the paper neurocontroller design and stability analysis in the year 2008 control an antilock braking system (ABS) based on the concept of Neurocontroller with RBF neural network observer. This system demonstrates that the neurocontroller can achieve tracking and robust performance for various road conditions.

The controller that work based on FUZZY LOGIC and ABS system are mainly used in transportation and motors which was proposed in paper [4]. This hybrid controller works with the combination of a sliding mode controller (SMC) and a novel fuzzy controller which inturn improves the sliding mode controller efficiency.

Eneh I.I. and Oka [5] has proposed the paper automatic brake control system using artificial neural network in the year 2014 which is mainly designed to reduce acceleration once it detects an obstacle of 250m ahead. This controller takes two inputs and one output parameters; position, velocity and brake. Neural Network based on back propagation training algorithm was implemented in neural network controller drive system.

3. PROPOSED SYSTEM

3.1. Autonomous Braking System

This section describes the braking system and all the requirements both software and hardware briefly in this section. It consists of three layers. First one is Input layer where all the real time inputs are collected with the help of ultrasonic sensor and yaw rate sensor. Second one is decision layer, here all

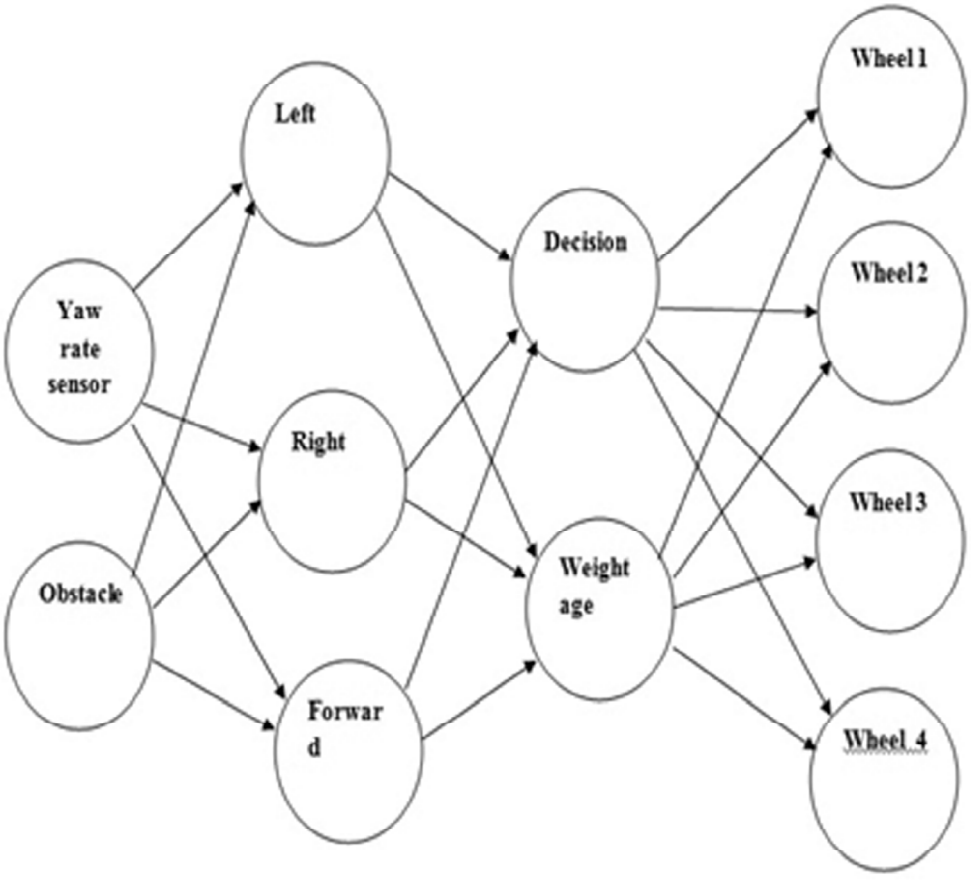

Figure 1: Multi Layered Architecture of Autonomous Braking System In Neural Network

those input values are processed with the help of Artificial Neural Network multilayered algorithm, which inturn takes decision based on the weightage values given by the user. Third one is output layer, where distributed brake force is applied to the each wheel of the vehicle based upon the decision values from the decision layer.

The proposed solution block diagram is shown below:

3.2. Architecture of environment side system

As shown in figure 1 all the sensors are connected to the Arduino UNO. This Arduino UNO is responsible for transferring the data from the sensors to the Raspberry pi. It provides real time data gathering. The ultrasonic sensor is attached to the front of the vehicle and it detects the occurrence of obstacle infront of the vehicle thereby sending and receiving ultrasonic waves from the sensor. The yaw rate sensor is connected to the steering of the vehicle which inturn measures the steering angle. The readings from both the sensors are automatically updated to the database and sent to the raspberry pi for decision making. This is mainly used to avoid skidding under sudden turning that occurs due to sudden obstacle occurrence conditions. Data transfer from Input layer to Decision layer with the help of serial communication.

3.3. Decision layer

The main heart of the proposed system is to take decision from the input layer and sends result to the output layer with the help of neural network. Neural network is able to check whether the obstacle is available infront of the vehicle or not. It also able to detect the vehicle moving in which direction it may be left, right or forward movement. All the data will be stored in the database. Decision making in neural network plays a major role in Autonomous braking system. Data mining is responsible for this process. It is normally of two type's Safe, unsafe. When the data from the ultrasonic sensor is zero then it will be considered as a safe mode. In the safe mode neural network take decision based upon the low weightage values. Suppose a value get from the ultrasonic sensor is one then it will be considered as an unsafe mode. In unsafe mode neural network take decision upon the high weightage values. It also intimates the user via message displayed in the screen.

This result are stored in the database. The database entities are indication of the obstacle and turning directions like left, right or forward movement.

3.4. Output layer

The third layer in this system is output layer. Output layer is processed in Ardunio Uno. In case of safe mode, brake force applied to the individual wheel of the vehicle is equal to the normal brake force. In case of unsafe mode, new brake force values are applied to the individual wheel of the vehicle and also results in smooth turns and system stability without skidding.

4. IMPLEMENTATION

The researcher tests the system with both simulation and Hardware prototype.

4.1. Simulation Result

Simulations are carried out with the help of Matlab. Input values that consist of both ultrasonic sensor and yaw rate sensor readings are tabulated below diagram:

Based upon the above input values algorithm is processed and output will be shown in below diagram:

YAWRATE SENSORVALUE	OBSTACLE DETECTION SENSOR
45	0
45	1
96	0
96	1
90	0
90	1
49	0
49	1
100	0
100	1

Figure 2: Input Values

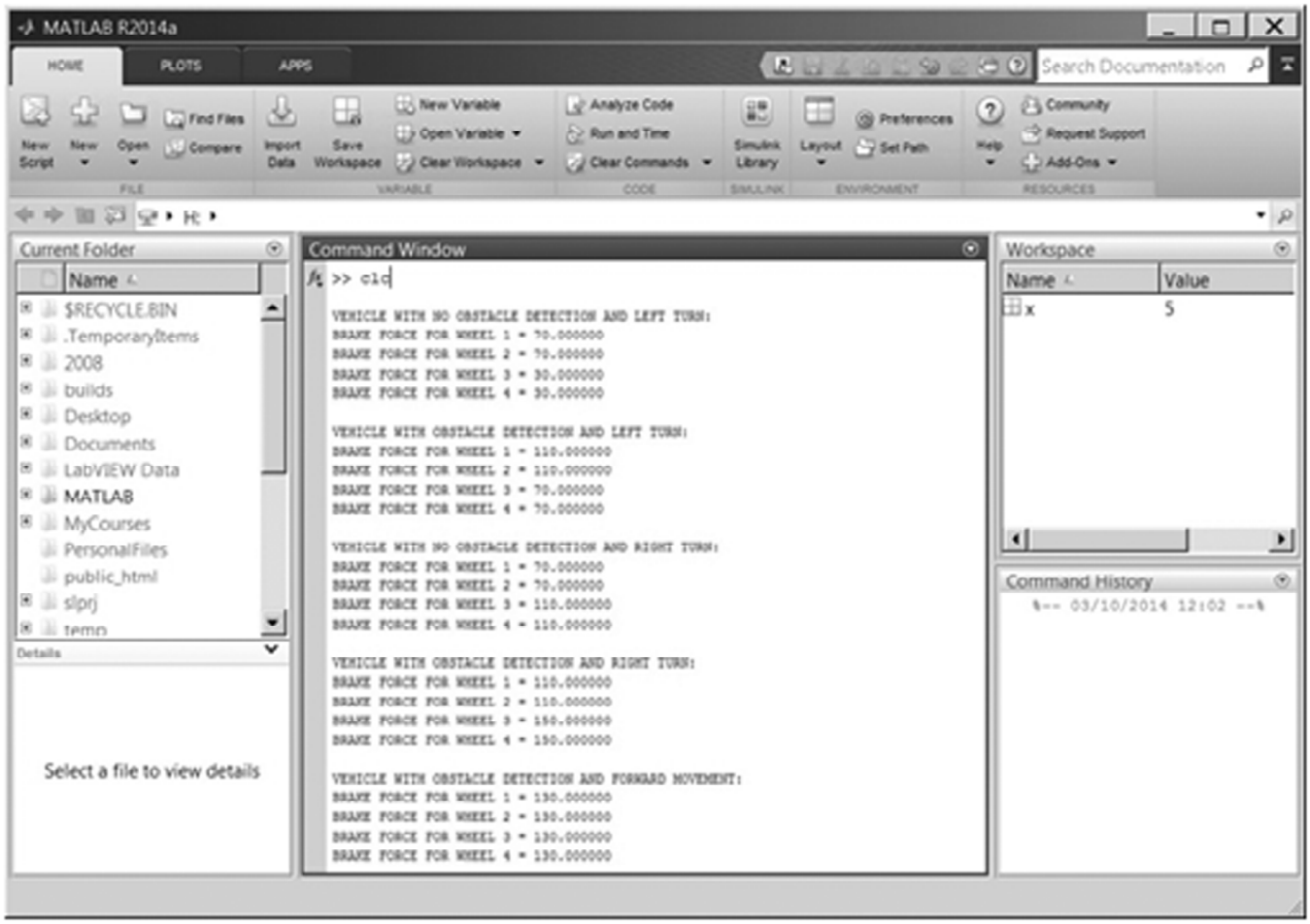

Figure 3: Simulation Output

4.2. Prototype

Sensors are used for measuring the environmental side condition of the vehicle. Raspberry pi model B2 is used in this prototype.

Raspberry pi is used as a Linux based microcomputer. Raspbian OS is used. It consists of 4 USB ports, Ethernet LAN cable, HDMI port, 40 GPIO pins, and Memory card support. It acts as mini CPU. Ultrasonic sensor is used (HC-SR04), four DC motors are used for moving the vehicle. The above items are all hardware requirements. Software requirements are described below python language is preferred for raspberry pi processor. It has processing speed 900MHz, 1GB RAM, ARM V7 Quad core processor are used. Python language is used to build a decision making algorithm. Raspberry pi kit is more flexible for working a more complex algorithm and gives an instant result. Arduino UNO will read any type of sensor values and it will be safer to run four DC motors. WIFI module is used to send data to the computer for user reference. Hardware prototype will be moved through the Given pathway and it is shown in below diagram

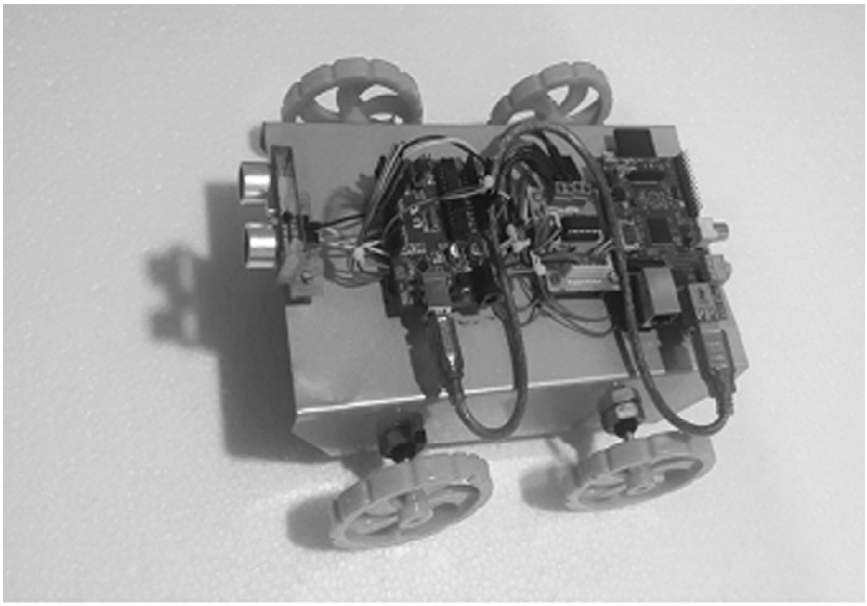

Figure 4: Hardware Prototype

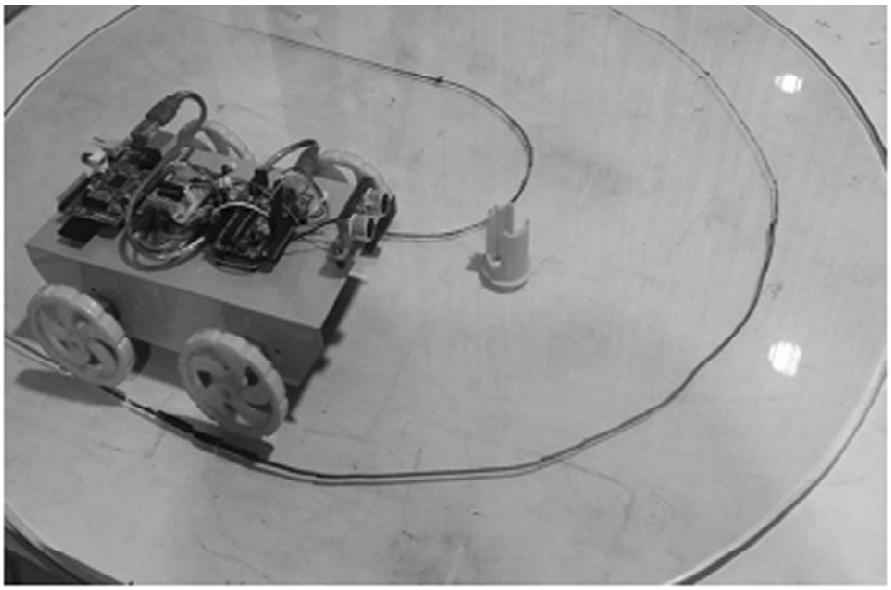

Figure 5: Prototype Moving In a Maze

5. CONCLUSION AND FUTURE SCOPE

Artificial Neural Network methodology is applied to the autonomous braking system to avoid skidding that occurs due to sharp turns and sudden obstacle detection. The Autonomous braking system improves vehicle stability by applying distributed brake force to individual wheel in the vehicle. Due to the yaw rate sensor and ultrasonic sensor, the proposed braking system can further improve the performance of braking system when compared with the earlier braking system. The performance of the proposed system is verified by using MATLAB simulation tool and Hardware prototype. In future, the implementation of this research would more efficient autonomous vehicle with new technology.

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