Review Paper on Automatic Braking System using fuzzy logic

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Abstract— **The use of computer assisted systems is a major step towards improving safety and performance of vehicles. Smart computers can only be achieved if they start to think and respond like humans which was made believable by Lotfi A Zadeh in 1960s with introduction of fuzzy logic. This paper investigates about how fuzzy logic helps automobiles getting safer and intelligent by which a large numbers of accidents can be avoided.**

Keywords— ***Automatic braking, Fuzzy logic, speed sensors, friction.***

I. INTRODUCTION

An Automatic braking system is an important part of safety technology for automobiles. It is an advanced system, specifically designed to either prevent possible collision, or reduce speed of the moving vehicle, prior to a collision with another vehicle, pedestrian or an obstacle of some sort.

Some automatic braking systems can prevent collisions altogether, but most of them are designed to simply reduce the speed of a vehicle before it hits something.

These systems combine sensors and a variety of computerized brake controls to prevent collisions.

Such as,
ABS (Anti-lock Braking System)
EBA (Emergency Brake Assist) and so on.

A. Fuzzy logic

Real world problems are very complex, difficult and are associated with some sort of imprecision's, uncertainties and can't determine whether the state is true or false. Fuzzy logic is based on the concept of decision making by human on vague and non-numerical information. The models developed using fuzzy logic are capable of recognize, represent, manipulate, interpret, and utilize data that is imprecise and can't be answered with truth or false only. The idea of fuzzy logic was first advanced by Dr. Lotfi A. Zadeh of the University of California at Berkeley in 1960s.

In Boolean system truth value, 1.0 represents absolute truth value and 0.0 represents absolute false value. But in the fuzzy system, there is no logic for absolute truth and absolute false value. In fuzzy logic, there is intermediate value too present which is partially true and partially false.

For example:
We can take a 4-level fuzzy logic system considering values

1. Fully True
2. Partially True
3. Partially False
4. Fully False

B.Fuzzy Inference System

It is the key unit of a fuzzy logic system having decision making as its primary work. It uses the "IF…THEN" rules along with connectors "OR" or "AND" for drawing essential decision rules. Characteristics of Fuzzy Inference System

- The output from FIS is always a fuzzy set irrespective of its input which can be fuzzy or crisp.
- It is necessary to have fuzzy output when it is used as a controller.
- A defuzzification unit would be there with FIS to convert fuzzy variables into crisp variables.

Functional Blocks of FIS: The following five functional blocks are the construction of FIS

- Rule Base − It contains fuzzy IF-THEN rules.
- Database − It defines the membership functions of fuzzy sets used in fuzzy rules.
- Decision-making Unit − It performs operation on rules.
- Fuzzification Interface Unit − It converts the crisp quantities into fuzzy quantities.

- Defuzzification Interface Unit − It converts the fuzzy quantities into crisp quantities. Following is a block diagram of fuzzy interference system.

Working of FIS

The working of the FIS consists of the following steps –A fuzzification unit supports the application of numerous fuzzification methods, and converts the crisp input into fuzzy input.

A knowledge base - collection of rule base and database is formed upon the conversion of crisp input into fuzzy input.

The defuzzification unit fuzzy input is finally converted into crisp output.

Methods of FIS

The different methods of FIS. Following are the two important methods of FIS, having different consequent of fuzzy rules –

- Mamdani Fuzzy Inference System
- Takagi-Sugeno Fuzzy Model (TS Method)

Brake assist system

BAS assists driver's by automatically increasing their braking power during an emergency brake event when the driver is unable to apply a sufficient brake force.. There are two performance requirements that BAS must fulfill in order to be employed effectively. One is the ability to activate when the driver suddenly applies brakes in an emergency while the other is the ability to provide additional assistance. Further study of BAS activation timing and degree of assistance in relation to driver acceptance is needed The driver's acceptance of BAS refers to the BAS activation only during an emergency. A study was conducted to clarify drivers' emergency braking characteristics and measure the frequency of BAS activation during normal braking.One aim of the study was to verify driver characteristics during emergency braking on a test course. Another task was to evaluate BAS with a driving simulator (DS). This study measured the frequency of BAS activation during normal braking by varying the BAS activation timing and degree of assistance. It also examined what the effects and side effects of varying these BAS parameters on the driver.[5]

B. Anti-lock Braking System

An Anti-lock Braking System (ABS) is a safety system used in automobiles which prevents wheels to slip/skid on road while applying brakes. It prevents the wheels on a motor vehicle from completely locking (cease from rotate) while braking. The aim of ABS is to minimize brake distance and allow steer ability under hard braking conditions.

When the driver presses the brake pedal in an ABS-equipped car, the computer reads values through specialized sensors and determines whether the wheel is rotating (at what speed) or stopped. If the computer senses a lock-up even at fast acceleration, it can pulse the brakes, helping the driver to maintain control.[2]

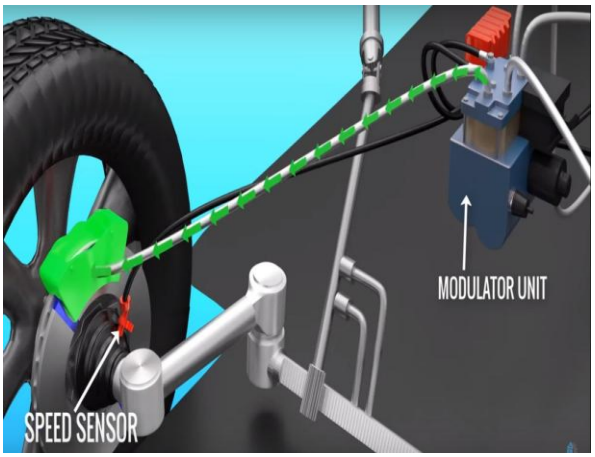

Fig no. 1:components of ABS

Components of ABS

1. Regular brake parts (such as the brake pedal, hydraulic cylinders and lines)
2. Wheel speed sensors

Wheel Speed Sensors are attached to wheels of vehicle to measure speed of wheels and sense whether wheels are turning or not. As sensors detect that a wheel is about to lock-up, a modulator unit partially releases brake pad on the wheel.

3. A hydraulic modulator operated by an electronic control unit (ecu).

Modulator unit act as actuator and partially releases and presses the brake pad on wheels and this way wheels are allowed to spin intermittently during braking.

C. Fuzzy Logic in ABS

- By using traditional logic only two values can be interpreted, either moving or stop. The sensors will then be of no use as no input of speed will be detected, instead state of wheel will be detected.

- With Introduction of fuzzy logic in ABS, different speeds of vehicle can be sensed and thus can be reacted accordingly. This prevents immediate brake application and moving of car

causing unstable and harmful behavior for passenger.

- With fuzzy ABS controller activated, steer ability is not only retained during the whole braking maneuver, but the slowing down length is considerably shortened as well.

- ABS reduces braking length:Coefficient of friction[4] between the wheel and the road varies with respect to slip. In perfect rolling conditions the value of the frictional coefficient is nearly zero. However when the wheel is 100% slipping, sliding friction comes into play. We can expect the frictional values for other levels of slippage to vary but since rubber is a complex material which has strange behaviors during braking, the frictional coefficient between the wheel and the road varies.

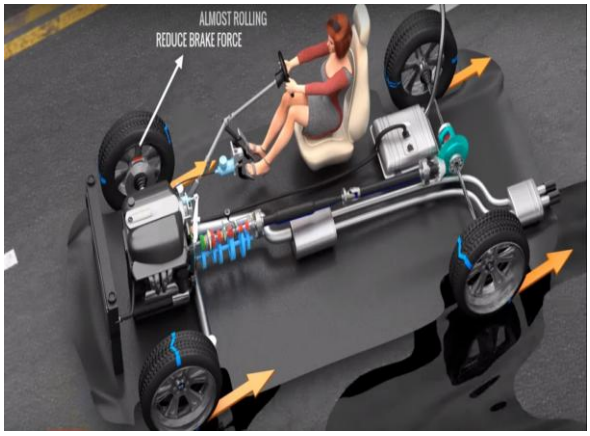

Fig no. 2:use of fuzzy logic in ABS

During breaking without ABS the frictional coefficient which comes into effect is predominantly sliding friction. However in ABS braking, the break pressure is adjusted to keep the ideal slip ratio of 0.10 to 0.30 where the frictional value is at the maximum significantly reduces the braking distance.

II. CONCLUSION

Fuzzy Logic is a very powerful concept that helps machines think and respond like humans. Implementation of this logic is making machines smart and intelligent and is helping humans getting solution to their real life problems faster and almost error-free. The Braking System, if implemented can prevent lots of accidents and can save invaluable human lives and property. Implementation of such system should be made compulsory similar to wearing helmet and seat belts so that accidents can be avoided to large extent. The future of automotive safety is more than just developing new technology; it is shifting the approach to safety.

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