

# Efficient Power Utilization in Towing Method of Electric Operated Vehicles

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## ABSTRACT

**This paper mainly focuses to utilize the efficient power consumption of battery operated electric vehicles in the industries with heavy torque low power. As quality and safety being the main concern in industrial drives, our proposed system aims even for the safety of the employees and to the vehicle, which is being implemented by fuzzification in which the speed of the vehicle is being reduced with the distance of the object and even saves power. It is ideal for use in inter-plant transportation, factories, warehouses, defense units, railways, workshops, airports, and large processing plants. In addition of solar panel to the vehicle it even charges to the industrial lights which makes it to work for more hours. The fuzzy logic collision avoidance is justified using MATLAB /SIMULINK results.**

**Keywords-** Electric Tow Vehicle, Fuzzy logic collision avoidance, High torque, Low power consumption

## I. INTRODUCTION

In today's industrial outlook, owing a number of industrial vehicles is a difficult task because the price of vehicles is going increasing according to the ton capacity and power consumption. As the capacity of vehicle increases its power rating also increases, and the maintenance also increases [5]. Thus to overcome these drawbacks our project plays a vital role in carrying out high torque approx 240Kg at 24V, 4.5AH. And due to the carelessness of the employees and their work tension, more accidents are bound to happen in industries[6]. In the past, the driver judges the distance between his/her vehicle and the vehicle in front by human vision and accordingly applies brake to stop the vehicle and to prevent from sudden accidents[1]. However these problems continue to prevail because human cannot accurately determine distance or human sometimes make careless mistakes or even pedestrians and other vehicles in front of us are also prone to some carelessness, which is the major cause of accidents. Therefore, the method of monitoring by the driver

cannot effectively avoid danger[3]. Thus our vehicle aims at overcoming this human inability. In this context we intend to develop a mechanism of fuzzy logic which reduces the accidents and also assist physically challenged individuals.

## II. LAYOUT OF THE PROPOSED SYSTEM

The vehicle is a four-wheeled electrically operated automobile to avoid collisions in conjunction with regulating its speed in accordance with the distance of the neighboring vehicles for assisting the differently-abled while driving using a fuzzy controller, to create an intelligent vehicle with automatic braking, acceleration control and a maximum load capacity of 240kgs to operate on industrial platform at a speed of 5 kmph. The proposed layout model of the electric vehicle is shown in Fig. 1. The wheels are intended to be made of vulcanized rubber in order to enable the vehicle to withstand to a certain extent and thus increase the vehicle's reliability[4]. The four wheels are connected by a shaft in order to give the vehicle the ability to take sharp and narrow turns[2]. This way, the tilt angle required to turn the steering is also reduced. Shaft and axle arrangements are present for the purpose of implementing the maneuvers of the driver[9]. The entire frame of the vehicle is made thick annealed iron in order to provide high strength to the vehicle so that it can withstand a good amount of weight (about 240 kgs approximately). One seat will be provided for the driver of the vehicle located approximately at the geometric centre of the vehicle[10]. The vehicle will have the facility of hand-held acceleration control, where the accelerator and brake are in the form of a button on the steering wheel and operated with the hands. The circuit housing is provided to the left of the seat, where the controller circuit is located. Immediately behind the motor housing, carries the PMDC motor, which is responsible for the movement of the wheels, i.e., the movement of the vehicle[8]. The motor shaft is directly connected to a chain and sprocket arrangement. The driven wheel is connected to the shaft of the hind wheels, thus controlling them[7].

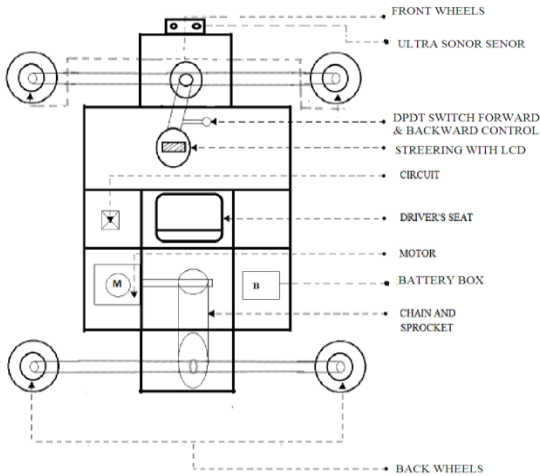


Fig. 1 Physical layout of our proposed model

### III. PROCESS FLOW CONTROLLER UNIT

The PIC microcontroller is used to implement Fuzzy Logic and is programmed using embedded C. The various parameters- distance of the neighboring vehicle from our vehicle and the relative velocity of the neighboring vehicle, are measured using a logic ultrasonic sensor and are given as the inputs to the microcontroller through an analog to digital converter. Based on the inputs, the microcontroller generates an output, using the decision made by the fuzzy controller. The digital output obtained is converted into an analog signal and provided to the motor in order to control the speed of the vehicle. In case of a situation of danger of collision, the vehicle can also automatically come to a halt. In this manner, the vehicle is capable of differentiating a situation of actual danger from one that can be handled without the requirement of stopping the vehicle. The process flow in the PIC controller is shown in Fig. 2.

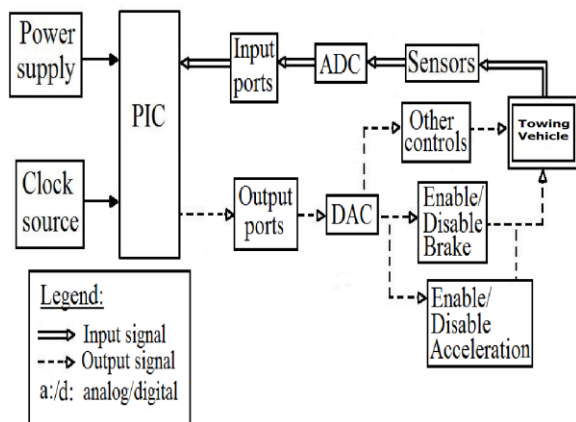


Fig. 2 Process flow in the controller

### IV. VEHICLE CONTROLLER

The circuit required for the process is clearly specified in fig.3. The microcontroller receives input from the ultra sonic sensor, brake switch, battery voltage detector circuit and motor speed at its analog ports and produces a corresponding output, which are inherently digital.

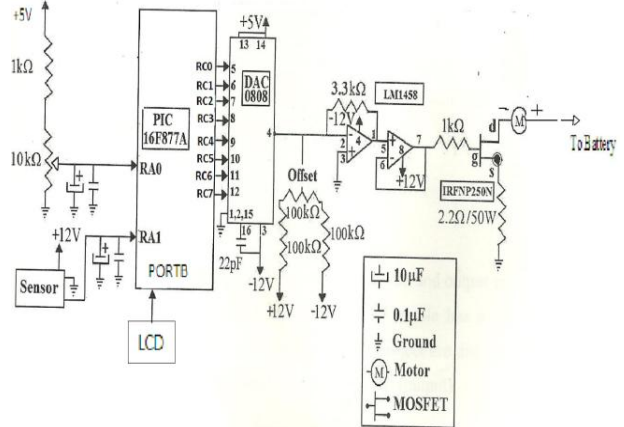


Fig. 3 Circuit diagram for the controller of the vehicle

This is converted to an analog value using a DAC, which is used to control a motor. It has been attempted to select the most efficient components to form the circuit keeping in mind the economic constraints. The flow of action through the entire process of driving the vehicle and simultaneously checking for an obstacle continuously and also providing a mechanism to avoid it has been provided in the flowchart in Fig.4.

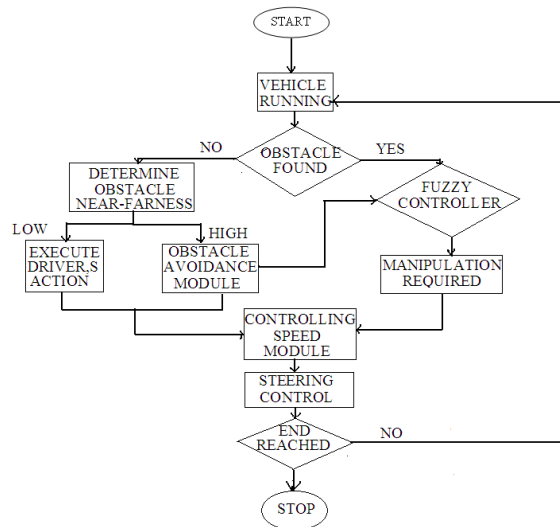


Fig. 4 The flowchart for starting, stopping and collision avoidance

- IF DISTANCE IS SHORT AND VELOCITY IS HIGH THEN ELECTROMAGNETIC BRAKING IS HARD
- IF DISTANCE IS SHORT AND VELOCITY IS MEDIUM THEN ELECTROMAGNETIC BRAKING IS MEDIUM
- IF DISTANCE IS SHORT AND VELOCITY IS SLOW THEN ELECTROMAGNETIC BRAKING IS SMALL
- IF DISTANCE IS MEDIUM AND VELOCITY IS HIGH THEN ELECTROMAGNETIC BRAKING IS MEDIUM
- IF DISTANCE IS MEDIUM AND VELOCITY IS MEDIUM THEN ELECTROMAGNETIC BRAKING IS SMALL
- IF DISTANCE IS MEDIUM AND VELOCITY IS SLOW THEN ELECTROMAGNETIC BRAKING IS SMALL
- IF DISTANCE IS LONG AND VELOCITY IS HIGH THEN ELECTROMAGNETIC BRAKING IS SMALL
- IF DISTANCE IS LONG AND VELOCITY IS MEDIUM THEN ELECTROMAGNETIC BRAKING IS SMALL
- IF DISTANCE IS LONG AND VELOCITY IS SLOW THEN ELECTROMAGNETIC BRAKING IS SMALL

A minimum braking percentage required to slow the vehicle is 40-60. The maximum braking percentage required to stop the vehicle is 70-80.

## V. PER KG POWER CALCULATION OF PROPOSED MODEL

Fuzzy logic provide accurate results when compared to conventional method like binary logic and PID controller so fuzzy logic is implemented to control the speed of the towing vehicle to avoid collision with a human and obstacles. There are mainly two inputs, namely distance and velocity of the vehicle and based on the combination of these inputs the output electromagnetic braking is obtained using a fuzzy controller. The adaptive module is responsible for modifying the multiplier which corrects the fuzzy output by manipulating the multiplier that is to be multiplied with the output to produce the required result. The inference module uses the fuzzy rule base to cause the required action. It works based on the Mamdani method of implication. Any case of danger, the fuzzy controller the vehicle is aimed to be brought to a condition of safety. The table shows the comparative analysis of proposed system and the existing system.

TOWING VEHICLES	V	AH	MAX CAPACITY	TOTAL POWER= VOLT*AH	POWER PER KG =TOTALPOWER/MAX.CAPACITY
JOTRUCK TOW VEHICLE	36 V	299AH	2000 KG	10764 W	5.38 W
JUMBO ELECTRIC TOW TRUCK	30 V	289AH	2000 KG	8670 W	4.33 W
STILL TOW TRUCK	30 V	289AH	2000 KG	8670 W	4.33 W
TOYOTA TOW TRUCK	24 V	465AH	3000 KG	11160 W	3.72 W
PROPOSED MODEL	24 V	4.5AH	240 KG	108 W	0.45 W

Membership functions are numerical functions corresponding to linguistic terms. A membership function represents the degree of membership of linguistic variables within their linguistic terms. The degree of membership is continuous between 0 and 1, where 0 is equal to 0% membership and 1 is equal to 100% membership. There are several types of membership functions available, namely, sigmoid, singleton, triangular, Gaussian, trapezoidal etc. The membership function used in this project is the triangular membership function. The triangular membership function is shown below in Fig.5.

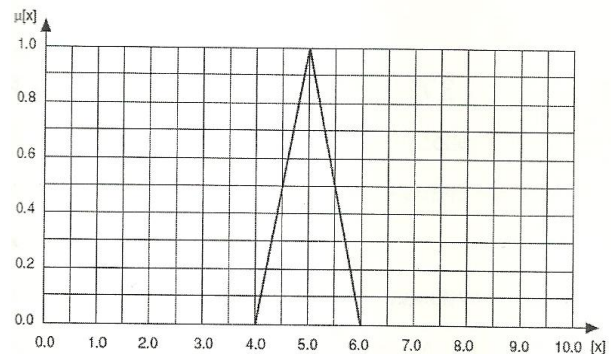


Fig. 5 Triangular membership function

It is a collection of linkages which are used to aid the driver to cause the vehicle to follow the desired course. It is based on the concept of potentiometric acceleration using a hand held accelerator. Using potentiometer, the amount of voltage available to the motor, consequently the speed of the motor can be linearly varied. An emergency brake facility is also available on the steering in the form of a push button for the purpose of manual breaking .Its main purpose is to cause a braking action whenever required , i.e., the vehicle should come to a halt. A brake reduces the on-going speed or

completely stops the vehicle as per the requirement. Electromagnetic braking is used to overcome the disadvantages of frictional, hydraulic or pneumatic braking – movable components causing wear and tear. In electromagnetic brakes, a reverse magnetic field is applied to the axle which avoids the vehicle from moving any further (the wheels are locked).

## VI. RESULTS AND DISCUSSION

The two input to the fuzzy logic input is distance velocity and the output is electromagnetic braking.

**Case 1:** When distance is 100 cm and velocity is 0 kmph the electromagnetic braking is 16.3% therefore the towing vehicle will not move

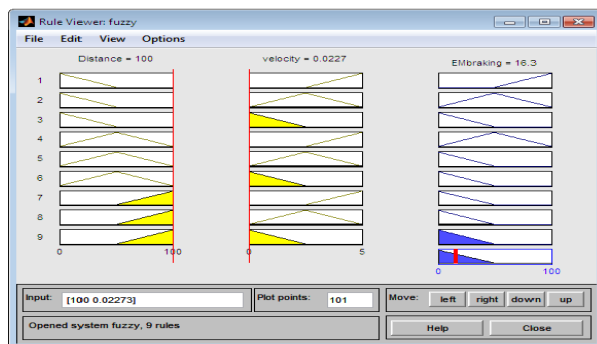


Fig. 6 Rule viewer converting fuzzy values into crisp value

**Case 2:** When distance is 100 cm and velocity is 5 kmph the electromagnetic braking is 16.3% therefore the towing vehicle will move fast

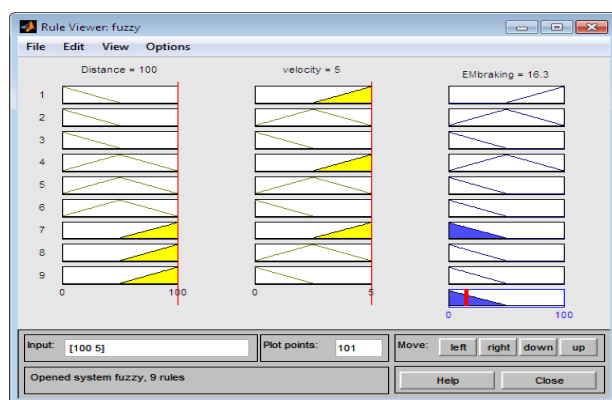


Fig 7. Variation in velocity input and electromagnetic braking output values

**Case 3:** When distance is 50 cm and velocity is 5 kmph the electromagnetic braking is 50% therefore the towing vehicle will move at a medium speed

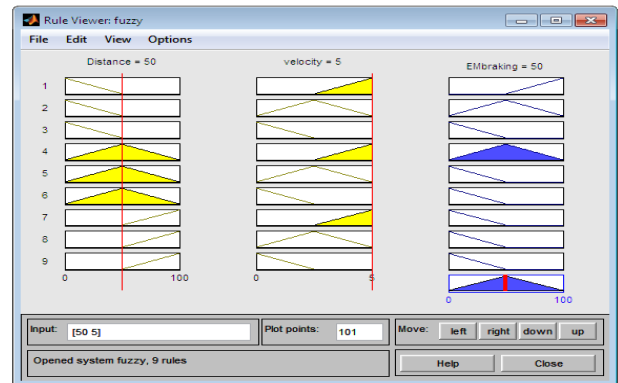


Fig. 8 Variation in distance as well as velocity input and electromagnetic braking output

**Case 4:** When distance is 8 cm and velocity is 5 kmph the electromagnetic braking is 70% therefore the towing vehicle will move slowly

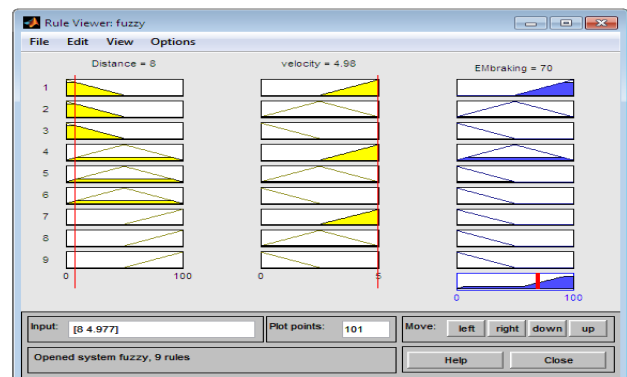


Fig. 9 Small variation in distance input and corresponding output values

**Case 5:** When distance is 1 cm and velocity is 5 kmph the electromagnetic braking is 81% therefore the towing vehicle will come stop thereby collision with a human or obstacle as been avoided

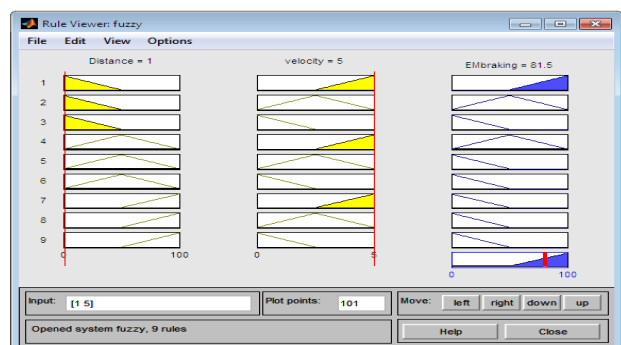


Fig. 10 Fuzzy controller response for distance input and corresponding electromagnetic braking output

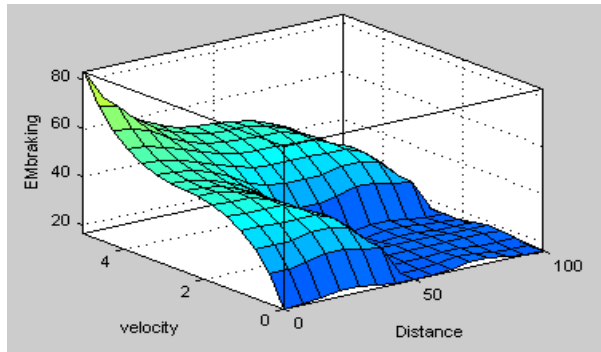


Fig. 11 Surface viewer with 3 dimension view

Surface viewer shows the input distance and velocity and corresponding output electromagnetic braking in a 3 dimension view as shown in fig. 11.

## VII. EXPERIMENTAL SETUP

The physical dimensions of the fabricated vehicle have been shown in fig 12. The vehicle has the mechanical strength and capability to withstand and pull a maximum load of 240kgs approximately. The dimensions of the vehicle have been enlisted in the Table 1 as follows. All the dimensions specified below are in cm.

COMPONENT	DIMENSION	VALUE
Steering wheel	Diameter	26.5
Front wheels	Diameter	13.0
Steering stem	Length	58.0
	Diameter	9.0
Front axle	Length	30.0
	Diameter	9.0
Frame	Length	100.0
	Breadth	59.0
	Thickness	1.8
Support shaft (3 nos.)	Length	55.0
	Thickness	1.8
Back axle	Length	58.0
	Diameter	12.0
Seat support	Length	30.0
	Breadth	31.0
	Gap	17.0
Sprocket Driver	Number of teeth	30
Sprocket Driven		11

Table 5.1 Specifications and physical dimension of the vehicle (measurements in centimeter)



Fig. 12 Fabricated Electric Hybrid Vehicle

## VIII. CONCLUSION

This system conserves energy by consuming less energy when compared to other systems. It doesn't involve any fossil fuels and hence is free from pollution. This way fossil fuels can be preserved. It can be used in industries for transportation purpose. Thus a four wheeled electrically operated and chargeable automobile is implemented to avoid collisions and provides intelligent vehicle with automatic braking, acceleration control and a maximum load capacity of 240 kgs. has been created to operate on industrial platform at a speed of 5kmph. A fuzzy logic controller is coupled to the sensing module for receiving the vehicle speed and relative distance and generating a safety warning device is coupled to the fuzzy logic controller and the sensing module for comparing the distance with the safety distance and outputting a warning signal according to the comparison result.

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