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Adaptive Traffic Drive with Implementation of Split Hybrids to Achieve Longitudinal Control Pilot in Low end Passenger Cars

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ABSTRACT

This paper presents the implementation of split hybrid technology in the low end passenger cars and thereby assisting the driver to overcome the difficulties faced during high traffic situation. Split hybrids are vehicles which uses two different power sources like battery and fuel that powers the individual axles. With the aid of this technique, we can automate the motor powered axle instead of engine. We use hub motors mounted at the wheels and automate these wheels without disturbing the wheels which are powered by the engine. This technique also helps us to achieve good mileage, reducing noise and pollution in high traffic zones.

Keywords: Driver Assistance, Hub Motors, Mileage Improvisation, Split Hybrids

I. INTRODUCTION

Nowadays, more cars are driven by the car owners instead of professional drivers .A owner cum driver has relatively less driving experience and driving knowledge than the professional drivers. This makes him to think that his car should be more user friendly for driving.

TRAFFIC is one of the stressful situations for a driver[1]. Pollution [2], Noise, harder driving experience [3] are some of the problems faced by the driver during high traffic. Some of the high traffic situations include Railway Gates, Traffic Signals during peak hours etc…[4]

The car population has increased tremendous in the recent year contributing to high traffic in the roads[5]. The rise in the car production every year is explained by the Figure 1[6].

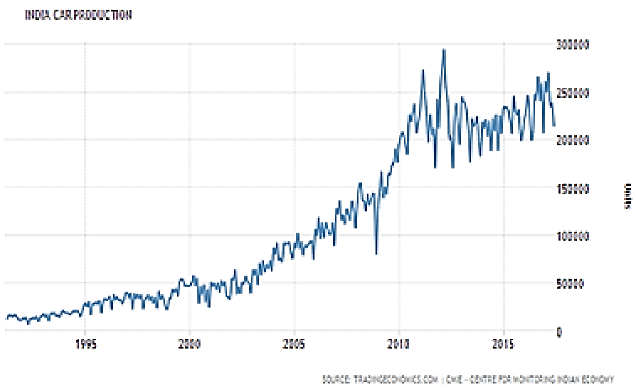

Figure 1. Year vs. Car production per year

This paper speaks about the project that is aimed to facilitate the driving experience of the driver during the high traffic situation i.e. to ease the traffic situation by automatic propulsion of the vehicle in a IC engine car like the one in electric cars [7] instead of waiting and responding for the driver's commands.

We could find driver assistance in various high end cars in India. Cars from Audi, BMW, Mercedes-Benz etc... have driver assistance facilities. Audi avails turn assist, Adaptive cruise control with stop-go function, hold assist, Active lane assist, pre sense front, pre sense rear, side assist[8]. With these various systems it assists the driver during traffic. BMW calls a technology called connected drive in its cars which is an integration of various systems like Active cruise control [9] with stop-go function, steering and lane control assistant, lane keeping assistant, lane departure warning, etc..[10] .With the aid of these systems, it provides assistance to driver in traffic. Various other traffic driver assistance available globally are self-park steering, lane centering steering, lane departure prevention, Super cruise control, vehicle to infrastructure communication, etc…..So cars with these technologies can be made traffic assisted. But these cars are price above 20 lakh INR. India has a great car market and the prices of best-selling cars in numbers are below 15 lakh [11].In these cars, we cannot find all the above mentioned features. So traffic assistance is not available in this car. To avail these cars traffic assistance feature, the cost of implementation should be low so that the budget of the car does not goes above the Indian budget. Also it is necessary to maintain a good mileage of the car. Considering all the points, automatic transmission is not a good idea of implementation to bring in the feature [12]. Without automatic transmission, it is difficult to propel the car with manual transmission since we have to actuate the clutch, ensure that the vehicle is in correct gear, etc… So implementation of split hybrid should be a good idea to achieve our needs [13].

II. METHODOLOGY

This paper includes

1. **AUTOMATIC PROPULSION OF THE VEHICLE** - based on the acceleration, deceleration and distance of the front vehicle.
2. **DESCENT ALERT HORN** - if the front vehicle descents down very close.
3. **AUTOMATIC FOLDING OF OUTSIDE REAR VIEW MIRRORS (ORVMs)** - the ORVM folds if there is a chance for it to be hit in traffic.

The car is provided with an ON/OFF switch to be mounted on the steering wheel .This allows the driver to choose Automatic propulsion of the vehicle only if he wants it.If not, only the descent alert horn and automatic folding of ORVMs are active. This avoids automatic driving of the cars at lower speeds when the driver doesn't need it.

In traffic, we need higher Torque to overcome the inertial resistance at lower speed. So use of e-Motor facilitates our operation since e-Motor have higher torque at lower rpm[14].

Acceleration and gradients causes load transfer to the rear wheels, so rear wheel propulsion ensures traction of the vehicle. For e.g. Railway gates roads are at gradients. Also more than 70% of the passenger cars on the Indian roads are Front Engine Front Wheel Driven [15]. This facilitates the easier mounting of Motor at the rear wheels.

2.1AUTOMATIC PROPULSION OF THE VEHICLE:

2.1.1 Biomimicry

Using the concept of biomimicry, we study what the driver do in the traffic thereby we find what we shall do to assist.

Basically, a driver recognizes

- ✓ The distance of the front vehicle ,
- ✓ Whether it is accelerating or decelerating.

With the help of these information, he uses the clutch pedal (in case of manual transmission), and presses the acceleration pedal or the brake pedal.So, if the car has the ability to sense the distance of the front vehicle, acceleration and declaration of the front vehicle, the car can be automated for propulsion.

To recognize the distance, we use an infrared sensor. By calculating the distances periodically and by comparing the distances, we can understand whether the front car is accelerating or decelerating. With the help of these data, we can use a microcontroller, program it with our required logics and automate the propulsion[16]. We use infrared sensors instead of

Ultrasonic sensor because infrared sensor has wide angle of detection [17].Figure 2&Figure 3 shows the sensing range of ultrasonic and infrared sensor respectively.

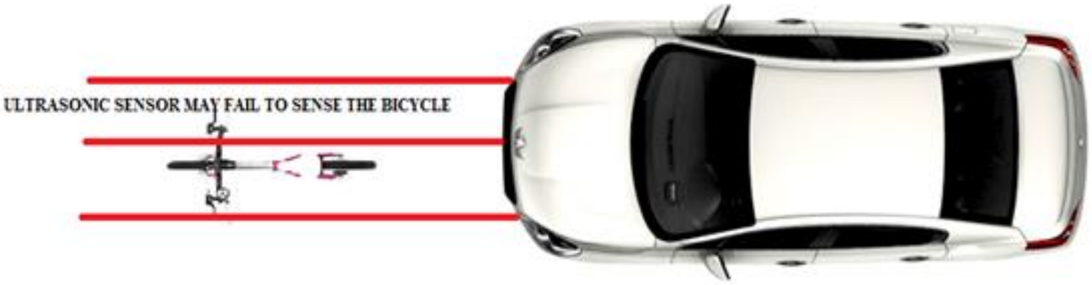

Figure 2. Ultrasonic sensing

Figure 3. Infrared Sensing

Also to steer the vehicle, we place infrared sensors in the sides of the cars. We get the information of the steering wheel from the potentiometer. The car identifies the path it will proceed for the steering angle and activates the sensors it that direction. For example, if the driver steers left for a smaller angle, the sensors in the front and the first few sensors in the left side of the car is only activated as shown in Figure 4. The car propels with these data. If he steers left for a larger angle, the sensors in the front and more sensors in the left side of the car is activated as shown in Figure 5. The number of sensors activated is proportional to the steering angle.Also for fail safe application we position the sensors at different heights as shown in Figure 6.Figure 7&Figure 8 shows the fail safe sensing of different heighted vehicle.

Figure 4. When steered right for a lower angle

Figure 5. When steered right for a higher angle

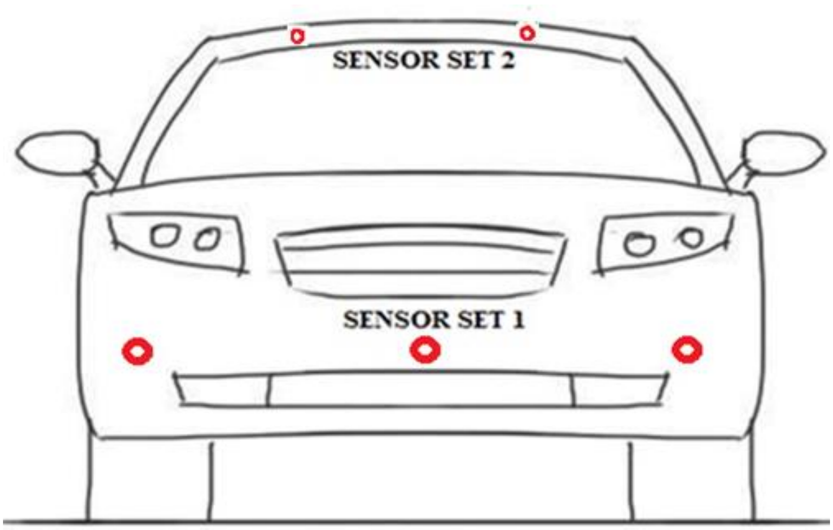

Figure 6. Sensor positions at the front

Figure 7. Sensing a truck

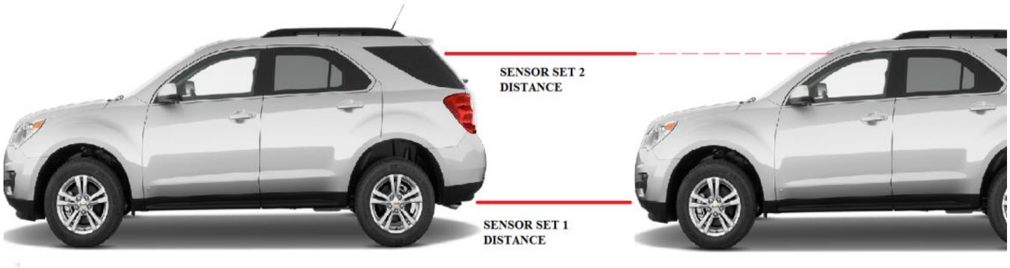

Figure 8. Sensing a car

2.1.2 Acceleration

The motor speed increases with the voltage. So by increasing the voltage across the terminals of the motors we could accelerate the vehicle [18]. The acceleration is proportional to the acceleration of the front vehicle and distance from the front vehicle [19].

2.1.3 Braking

2.1.3.1 Slow current decay braking

Generally a motor can be braked by cutting of the power supply. The inertia of the rotor still maintains it to rotate. But this makes the motor to act as a generator generating a back emf. So if the motor terminals are connected to an external resistance, power is utilized and dissipated as heat. Thus the motor comes to rest .

2.1.3.2 Fast current decay braking

In this method, the motor when needed to be braked faster is given reversed potentials. This generates a mechanical force in the rotor in the opposite direction of rotation. Thus the motor can be braked rapidly.

Both slow current decay and fast current decay can be used for braking.

- ✓ Slow current decay braking can be used for slow deceleration of the front vehicle or when deceleration needed to occurs at the larger distance or at slow speeds
- ✓ Fast current decay braking can be used when rapid deceleration is needed

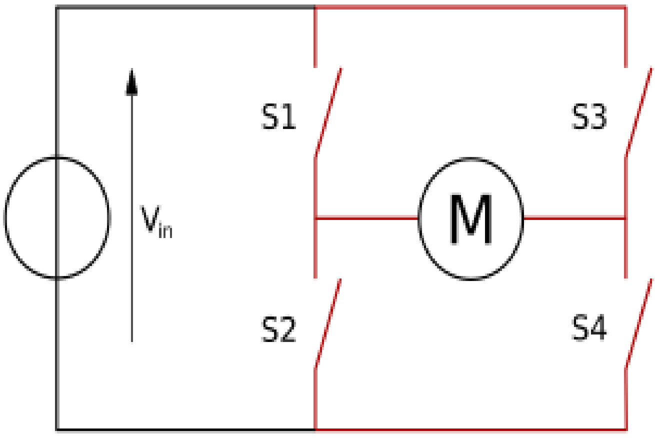

Figure 9 . H-Bridge

Table 1. Current direction Control

S.No.	Input 1 (S1&S4)	Input 2 (S2&S3)	Output 1	Output 2
1.	5 V	0 V	+ive	-ive
2.	0 V	5 V	-ive	+ive

2.1.4 Magnitude control

The magnitude of acceleration or braking needed is decided by the microcontroller [20]. The microcontroller decides these with the input signals from the sensors and acts according to the logics programmed. The information such as distance from the vehicle in the propulsion direction, the acceleration or deceleration of the respective vehicle is used in the logics programming. The acceleration and deceleration is calculated by periodic distance sensing and comparing the distance.

2.1.5 Motor drive unit

For acceleration and braking of the motor, we can use the concept of H-Bridge [21]. H - Bridge is a set of four MOSFETs connected to 4 signal voltages (2 pairs - each pairs are combined), one driving voltage, one ground and two outputs. This is the most used technique for fast current decay braking i.e. the direction of the current in the motor can be reversed in this technique. This is done by using the 2 input signals variations [22]. A simple representation of H-Bridge is explained by the Figure 9 and various possibilities are described in Table 1.The Inputs 1&2 are controlled by the ARDUINO microcontroller and the outputs 1&2 are connected to the terminals of the drive motor. Thus, by control the direction of the current and magnitude of the current, we can accelerate and brake at different rate.

III. DESCENT ALERT HORNS

The horn is actuated automatically if the front vehicle descent below the threshold distance we set. The horn is set OFF when the front vehicle stops descending. For example if the threshold is set to be 20cm, if the car comes back within 20cm, the horn is actuated and set OFF once the front vehicle stops descending. The horn is set ON if the front vehicle still descends.

IV. AUTOMATIC FOLDING OF THE ORVMs:

The first part is the car that is more likely to be hit by an obstacle in the traffic is the Outside Rear View Mirrors (ORVMs). So if any obstacle is predicted to likely enough to hit those ORVMs. The ORVMs folds individually in both direction based on the direction of the obstacle.

Two proximity sensors on each ORVMs, one facing the front and other facing the rear is placed and is connected to the microcontroller. The ORVMs are mounted on the motors as seen in many cars and are connected to the microcontroller for actuation. The microcontroller senses the direction of the obstacle, if any, either from the front or from the rear, and folds the individual ORVMs in the direction either folds to the back or to the front respectively so that it avoids the obstacle from hitting it.

V. EXPERIMENTAL SETUP

We developed a prototype with

- An Ultrasonic sensor called HC-SR04 which has a sensing range of 2-400cm.
- An ARDUINO UNO as our microcontroller.
- A normal DC motor as our actuator.
- An IC L298N to control the motors direction of rotation. One direction for propulsion and the other direction for braking.
- A piezo buzzer as our horn.

The prototype was designed for automatic propulsion in linear direction and descent alert horns. The ultrasonic sensor was given inputs with an obstacle. The distance of the obstacle is continuously sensed by the sensor. The logics were fed in the ARDUINO UNO microcontroller with ARDUINO software. The logic is explained by Figure 10. With the data of distance sensed, the microcontroller actuated the motor at different speeds based on the logics. The horns are also actuated on the logic discussed. The motor's rpm and the horn actuation were studied with the input distance.Our experimental setup is shown in Figure 11.

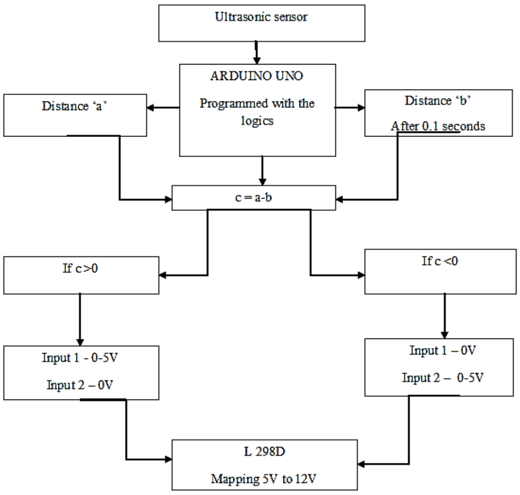

Figure 10 Logic of Operation.

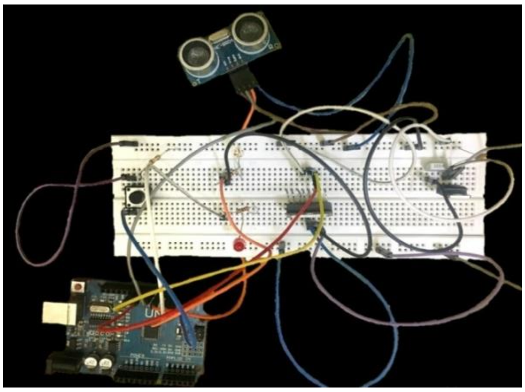

Figure 11. Experimental Setup

VI. RESULTS AND DISCUSSION

The rpm of the motor was as expected from the logics. The rpm of the motor increases proportional to the change in the distance of the obstacle. Also the rpm of the motor reduces as the obstacle distance reduces. The Figure12 explains the change in the terminal voltage of the motor with respect to the change in the distance of the obstacle. The motor began to rotate in the opposite direction at a particular instance. This problem is due to manual input and it will not occur in real time application like in cars because the motor will be cut off once the vehicle stops. The horn was actuated at the threshold distance and the horn was set off once the obstacle deceleration was stopped. The disadvantage of this paper is that the unsprung mass increase because of the use of the hub motor mounted below the suspension. It is not a big issue because this increase in unsprung mass is not very high and well within the range of appreciable [23].

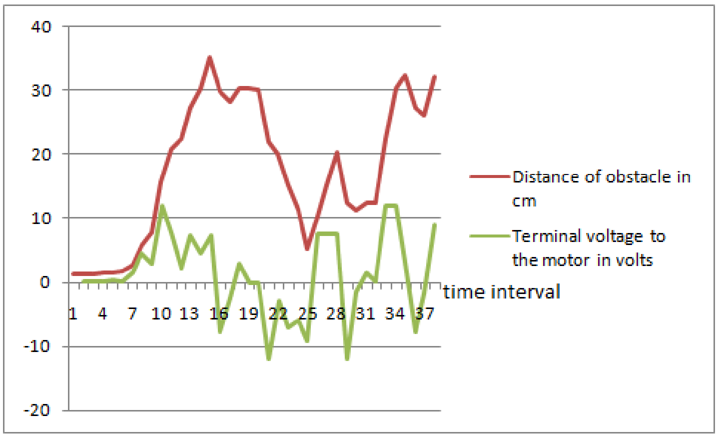

Figure 12. Variation of motor terminal voltage withrespect to the distance from obstacle

VII. CONCLUSION

Thus, with the implementation of split hybrid technique in low-end passenger cars, we could assist the driver during the traffic situation by simple automation of rear wheel mounted hub motors [24] .There is a vast scope for the real time application of this paper. A Low end passenger car which can drive itself in a traffic zone, if needed, is something which no one can say no [25]. Also, it could reduce pollution [26] in cities with traffic as it uses electric motor and the engine could be shut off based on the battery level. The battery specification for a car with this application is almost of small sizing [27]. This paper explains the methodology of automation of propulsion, descent alert horns, and folding of ORVMs.

VIII. ACKNOWLEDGEMENT

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