International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 6, June-2018

DESIGN AND FABRICATION OF EPBS (ELECTRONIC PULSE BREAKING SYSTEM) FOR TRAILERS

Naresh K.S[1]

[1]*Assistant professor, dept. of mechanical, NHCE, Bangalore-560103,* [1]*nareshreddy044@gmail.com*

Abstract: ***The Electronic Pulse Braking system is electric brake controls for vehicles where the rate of vehicle deceleration is automatically sensed to produce a pulsed electric brake actuation of the brakes of the vehicle. The Electronic Pulse Braking system includes a braking ECU on each trailer and a communication interface being provided so that the braking ECU on a trailer and the braking ECU on a second trailer are able to communicate with one another. A control system is incorporated into the braking equipment of a Vehicle to Provide a trailer braking Command Signal the respective braking ECU on the first and second trailer receive an input from a respective sensor on the first and second trailer adapted to detect lateral acceleration or Wheel speed in the event that one of the sensors detects lateral acceleration and a Wheel speed indicative of a loss of stability, the sensor generates a signal for actuating stability control. Which signal is passed via the communication interface to the braking ECU on the other trailer, so that the other trailer can actuate stability control? In this present work the effort has been made to introduce the EBS system in the trailer of the vehicle for the uneven road surface conditions and visualize the impacts theoretically***

Keywords-Electronic pulse braking system (EPBS), ECU, communication interference, wheel speed sensor

I. INTRODUCTION

Tractor trolleys are commonly used in rural India. The major transport goods and labor is done with tractor trolleys, braking system is a most important element. Applying a tractor's brake will reduce tractor speed only, but due to inertia of a trailer tractor tends to move further and various loads are applied on trolleys when it is loaded. During the inclinations stresses are developed on the joint between the tractor and trolley. This may cause the deformation of the joint due to stresses. In order to avoid all these problems, to provision of braking system on trailer is necessary, because it is difficult for tractor driver to control a tractor-trailer with tractor brake, as tractor has low capacity brakes which is mainly designed to stop tractor itself. As tractor & trailer have different inertial force, it is necessary to implementing the EPB system on trailer which is operated from Tractors Foot Pedal. This consists of ECU on trailer and communication interference being provided. So the electronic pulse braking system is activated, torque is reduced to zero.

***Fig 1.1** accident due to absence trolley brake*

Braking System: Braking system is most important in an automobile for stopping vehicle. Brakes are applied on drum or disk to stop the vehicle by converting its kinetic energy into potential energy (heat).The good braking will always use for safety of the passengers and drivers.

Types of Braking System: The common types of braking systems are hydraulic braking, frictional pumping braking, electromagnetic braking and servo braking. There are some brakes to operate smooth in different road conditions. Accidents happen due to poor or very low braking systems. The most common types of brakes are present below.

- **Electromagnetic Brake System**
- **Frictional Brake System**
- **Hydraulic brakes**
- **Air brakes**
- **Antilock Brake System (ABS)**

Autonomous Braking Controller

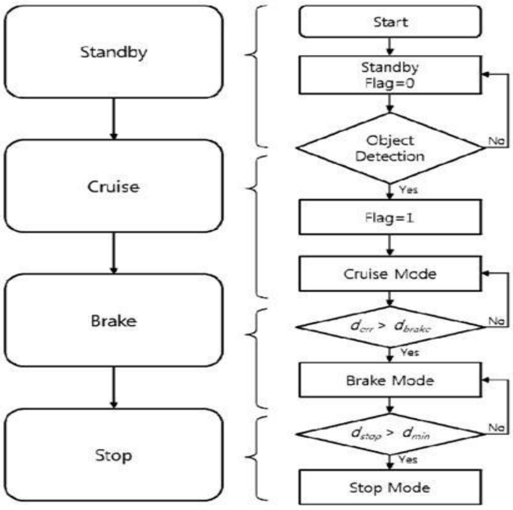

Fig 1.*2 autonomous braking controller*

Fig 1.2 Flow chart of the algorithm shows the autonomous brake algorithm which consists of four modes: A) standby mode, B) cruise mode, C) brake mode and D) stop mode.

A) Standby:-mode represents the general driving mode without obstacles. The subject vehicle is driven by a speed control system such as cruise control or by a driver on the standby mode. When an obstacle is detected in front, the system switches to the cruise mode where the subject vehicle is still controlled by the speed controller. Then obstacle is a certain object existing ahead of the subject vehicle such as a front vehicle on highway environment.

B) Cruise mode: the autonomous braking system does not operate because the predicted stopping distance, brake is shorter than the actual spacing, which means that the actual spacing is enough to stop the subject vehicle for avoiding the collision.

C) The brake mode: starts to operate as soon as the predicted stopping distance is close to the actual spacing distance. In this mode, the autonomous braking system is operated to slow down the vehicle using the brake actuator such as ESC or brake pedal mechanisms.

D) Stop mode :-in the stop mode, the vehicle is completely stopped for avoiding front collision. Figure 1.2 shows an operation example of the autonomous braking system in accordance with each mode. The prediction of the stopping distance, which is used on the cruise and brake modes, is very important for designing the autonomous braking algorithm. The brake system can decide whether to operate the brake actuators or not by comparing the predicted stopping distance with the spacing

Radio Communication: To receive radio signals an antenna must be used. However, since the antenna will pick up thousands of radio signals at a time, a radio tuner is necessary to tune into a particular frequency range. This is typically done via a resonator – in its simplest form, a circuit with a capacitor and an inductor form a tuned circuit. The resonator amplifies oscillations within a particular frequency band, while reducing oscillations at other frequencies outside the band. Another method to isolate a particular radio frequency is by which gets a wide range of frequencies and picking out the frequencies of interest, as done in software defined radio.

FREQUENCY BAND TABLE: The distance over which radio communications is useful depends significantly on things other than wavelength, such as transmitter power, receiver quality, type, size, and height of antenna, mode of transmission, noise, and interfering signals. Ground waves, tropospheric scatter and sky waves can all achieve greater ranges than line-of-sight propagation. The study of radio propagation allows estimates of useful range to be made.

Frequency	Wavelength	Designation	Abbreviation
3–30 Hz	105–104 km	Extremely low frequency	ELF
30–300 Hz	104–103 km	Super low frequency	SLF
300–3000 Hz	103–100 km	Ultra low frequency	ULF
3–30 kHz	100–10 km	Very low frequency	VLF
30–300 kHz	10–1 km	Low frequency	LF
300 kHz – 3 MHz	1 km – 100 m	Medium frequency	MF
3–30 MHz	100–10 m	High frequency	HF
30–300 MHz	10–1 m	Very high frequency	VHF
300 MHz – 3 GHz	1 m – 10 cm	Ultra high frequency	UHF
3–30 GHz	10–1 cm	Super high frequency	SHF
30–300 GHz	1 cm – 1 mm	Extremely high frequency	EHF
300 GHz – 3 THz	1 mm – 0.1 mm	Tremendously high frequency	THF

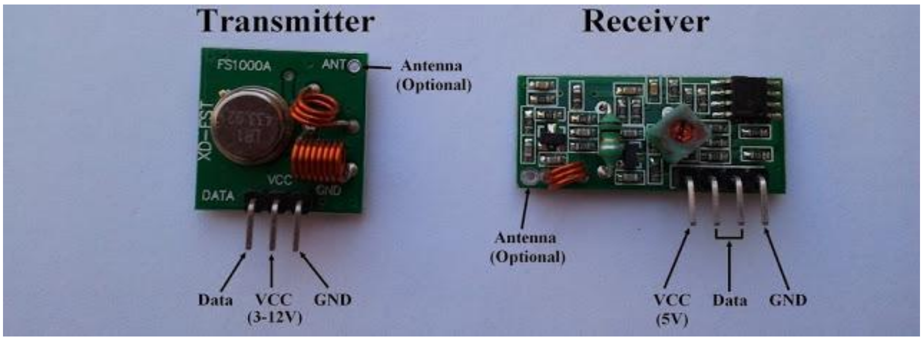

Fig1.3 *transmitter and receiver*

Application of electronic pulse braking system

1. The speed of tractor is generally up to 50kph. So for this speed limit use of electronic pulse braking system in trolley is proper and accurate.
2. The hydraulic braking and EPB system should be applied smoothly and quick action on both tractor & trolley.
3. Optimizes stopping distance and improves brake stability
4. Enables control of more functions enhancing trailer efficiency and safety
5. Range of options can be fully customized to fleet preferences and needs
6. Optimizes the cost of building, operating and maintaining a trailer throughout its life.
7. Can be mounted and retrofitted to all trailer types, including road trains, bi-trains and tri-trains.

II. DESIGN CALCULATION

- **DESIGN OF COMPONENTS**

Force Analysis on trailer wheels.

R_F= (W(x+μh) cosΘ)/b

R_R= (W (b-x-μh) cosΘ)/b

Where,

- W= weight of vehicle
- R_F & R_R = Normal Reaction at Front & Rear Wheel
- b= Wheel base
- h= height of C.G. of the vehicle from the surface of the road
- α= Retardation produced by braking
- μ= Coefficient of friction between wheels and the road surface
- X=Horizontal Distance between center of gravity & wheel center
- Then inertia force =(Wα/g)
- Braking force at the wheel = μR_F(at front wheel)=μR_R (at rear)

- **Dimensions Of the Trailer**

Under Full Load Condition

- W=8*10^3*9.81Kg
- X=1.155 m
- μ=0.5 (in limiting case)
- h=1m
- b=2.316m
- V=35 km/hr

- **Normal Reaction at Front & Rear wheel**

- R_F=(W(x+μh) cosΘ)/b
- R_F=(8*10^3*9.81*(1.155+0.5*1))/2.316
- R_F=55815.51 N
- R_F=R_R = 55815.51N

- **Braking Force At Front And Rear Wheel**

R_F=R_R=μR_F =μR_R=0.5*55815.51 =27907.75N

= 28000 N

Braking Force on One Wheel = 28000/2

= 14000 N

Distance Travel before Stopping

$S=V^2/2\ \alpha$

$\alpha= (\mu\cos\Theta-\sin\Theta)g$

$\alpha=\mu g$ (since $\Theta=0$ for plane road)

$=0.5*9.81=4.905 m/s^2$

$S= (35*1000/3600)^2/2*4.905$

$S=9.635$ m

Torque Capacity Of Wheel

$\tau=\mu F*(D/2)*(4\sin\theta/2\theta+\sin2\theta)$

$=0.5*14000*(0.4/2)*(4\sin52.5/2*52.5+\sin2*52.5)$

$\tau=41.8$ N-m

Braking Efficiency

η=Braking Force / Total Weight

$=28000/9.81*8*10^3$

$\eta=35.67$ %

Stopping Distance after Braking

$V^2-u^2=2\alpha\ s$

Where,

V= final velocity

u=initial velocity=0

$V^2-0=2*4.905*9.635$

$V^2=94.519$ $V=9.722$ m/s

Braking Force On Tractor & Trailer Kinetic Energy Of The Vehicle

Mass m = 8 Ton = 8000 kg

Speed V=35 km/h =9.722 m/s is equal to KE

$E=mv^2/2=8000*9.722^2/2$

E=378069.13 joule or N-m

Braking Distance-

Vehicle Braking distance from velocity V =35km/h is equal to =9.635 m

For vehicle stop in desired distance we need braking force equal to:

F= E/s =378069.13/9.635

F =39239.14N

COMPONENTS AND CONTROLLING UNIT

- **Programmable Circuit Board (PCB):** The PCB is a microcontroller board based on the mega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) are the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform.

  The structure of Arduino is its disadvantage as well. During building a project you have to make its size as small as possible. But with the big structures of Arduino we have to stick with big sized PCB's. If you are working on a small micro-controller like mega8 you can easily make your PCB as small as possible.

Fig 1.4 *micro controler*

Development of PCB

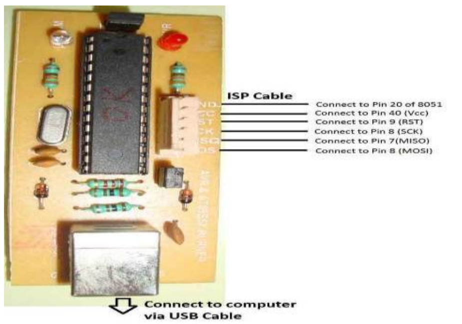

Fig 1.5 *PCB model*

The PCB (Arduino) can be powered via the USB connection or with an external power supply.The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and VIN pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- VIN: The input voltage to the PCB board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND (Ground pins): Each of the 14 digital pins on the Uno can be used as an input or output. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k-Ohms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the mega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt ( ) function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write ( ) function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Adriano language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

- **Servo Motor:** A servo system mainly consists of three basic components - a controlled device, a output sensor, a feedback system. This is an automatic closed loop control system. Here instead of controlling a device by applying the variable input signal, the device is controlled by a feedback signal generated by comparing output signal and reference input signal. When reference input signal or command signal is applied to the system, it is compared with output reference signal of the system produced by output sensor, and a third signal produced by a feedback system.

This third signal acts as an input signal of controlled device. This input signal to the device presents as long as there is a logical difference between reference input signal and the output signal of the system. After the device achieves its desired output, there will be no longer the logical difference between reference input signal and reference output signal of the system. Then, the third signal produced by comparing theses above said signals will not remain enough to operate the device further and to produce a further output of the system until the next reference input signal or command signal is applied to the system. Hence, the primary task of a servomechanism is to maintain the output of a system at the desired value in the presence of disturbances.

A servo motor is basically a DC motor (in some special cases it is AC motor) along with some other special purpose components that make a DC motor a servo. In a servo unit, you will find a small DC motor, a potentiometer, gear arrangement and an

Intelligent circuitry. The intelligent circuitry along with the potentiometer makes the servo to rotate according to our wishes. As we know, a small DC motor will rotate with high speed but the torque generated by its rotation will not be enough to move even a light load. This is where the gear system inside a servomechanism comes into the picture. The gear mechanism will take high input speed of the motor (fast) and at the output; we will get an output speed which is slower than original input speed but more practical and widely applicable.

1. The output shaft of servomotor SG 90 is capable of travelling somewhere around 180 degrees. A normal servomotor is used to control an angular motion between 0 and 180 degrees, and it is mechanically not capable of turning any farther due to a mechanical stop built on to the main output gear. The angle through which the output shaft of the servomotor needs to travel is determined according to the nature of the signal given to the motor as input from the PIC microcontroller. Due to rotation of servomotor in 180 degrees, the brakes can be applied and released through given brakes mechanism.

Fig 1.6 *servo motor*

Arduino 1.6 software: The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.This software can be used with any Arduino board.

PROGRAMME: The developed program for success of our project as follows:

```
#include < Servo.h>Servo my servo; // create servo object to control a servo
int angle = 0;
// variable to store the servo position
Void setup () {
264|
Chapter 8: Physical Output
}
My servo.attach(9); // attaches the servo on pin 10 to the servo object
Void loop () {
}
for(angle = 0; angle < 180; angle += 1) // goes from 0 degrees to 180 degrees
{
My servo. Write (angle); delay(20);
// in steps of 1 degree // tell servo to go to position in variable 'angle' // waits 20ms
between servo commands
} for(angle = 180; angle >= 1; angle -= 1) // goes from 180 degrees to 0 degrees {
}
My servo. Write (pos); delay(20);
// tell servo to go to position in variable 'pos' // waits 20ms between servo
Commands
```

III. MODLEING

Solid edge is a 3D CAD, parametric feature and synchronous technology solid modeling software. The ordered modeling process begins with a preparation of the 3D models of the individual components of the system. An assembly is built from individual part documents connected by mating constraints, as well as assembly features and directed parts like frames which only exist in the assembly context.

The following are the individual components,

Fig1.7clipper plate

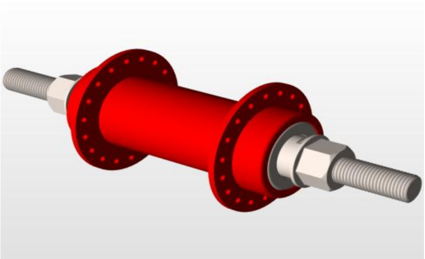

Fig 1.8 wheel hub

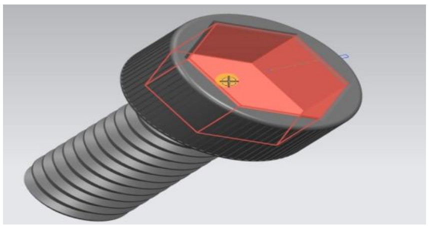

Fig1.9*clipperbolt*

Fig 1.10 *brake shoe*

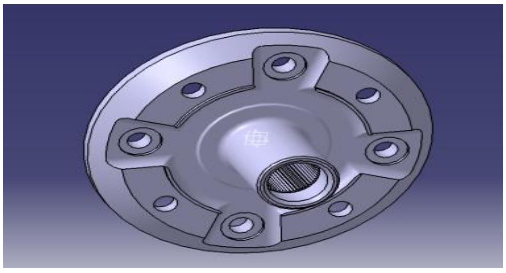

Fig1.11*dischub*

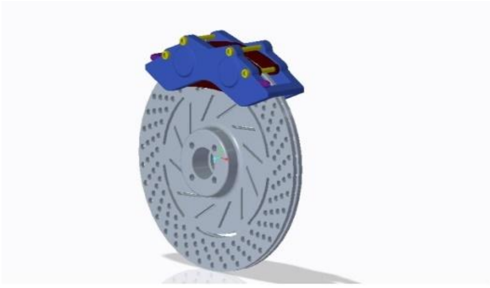

Fig 1.12 *disc*

Fig1.14 *fabrication and testing model*

IV. RESULT & DISCUSSIONS

The electronic pulse braking system is radio frequency based braking system. The prototype setup is working well and each part in the prototype resembles the main project which is successfully accomplished. The distance for safety is predetermined and encoded .By applying the pedal the setup activates, the braking is applied according to the predetermined value. The braking system is working efficiently and its ranges from 0.5m to 0.8 m whit in prescribed limit.

V. CONCLUSION

We have successfully completed the fabrication of EPBS for the prototype, this project guides us to how to implement the electronic pulse braking system for predetermined conditions, in panic situation of braking which reduces the accidents. In his project vehicle peed cannot reduced instantaneously to the zero due to heavy load condition and reactive torque**.** By doing this project practically we can reduce the 90% of accidents of tractors in rural areas, we are planning to execute this project with more advanced technologies with more safety features for the feature. we are prioritizing for the safety of driver as well as the tractor trailer in panic brake conditions .we believe there is a lot of work to be done on development side as well as positioning assembly parts In tractor trailer. This gives more advancement in feature of safety for braking of tractor trailer.

REFRENCE

[1].K Naveen Kumar ; Archana R K," *Functional Safety Management Aspects in Testing of Automotive Safety Concern Systems (Electronic Braking System)* **",**IEEE,2011.

[2]. Matthew Fry,; Martin Mederer , Neumarkt .; KornelStraub, PomaZ .; Budapest," *trailer electronic braking system*", U S Patented project, US007925409B2.

[3].David Charles Hour.; Paul Feetenby.; Malclom brearey," *electronic braking system for road vehicles operating with a trailer*" ,U S patented project, US006139118A.

[4]. Matthew FRY,; Martin Mederer,; Kornel Straub,; Gergely Szabo,;" *trailer electronic braking system* ",U S patent project, US 20100066161A1.

[5]. Malcolm Brearley,; Richard B. Moseley," *trailer braking in electronically controlled braking systems*", Europe patent project,5,050,938.

[6] Richard B. Moseley," *trailer braking in electronically controlled braking systems*", Europe patent project, 5,040,938

[7]Paul Mathew; Martin Mederer, Neumarkt .; KornelStraub, PomaZ .; Budapest," *trailer electronic braking system*", U S Patented project, US00792540HS2.

[8].Martin Mederer,; Kornel Straub,; Gergely Szabo,;" *trailer electronic braking system* ",U S patent project, US 20100066161Z1.

[9]. Paul feetenby, United kingdom," *electronic braking system for road vechile operating with trailer*", US patent no.6,139,118 date of patent oct 31,2000