IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 12, Issue 4 Ver. II (Jul. – Aug. 2017), PP 01-05
www.iosrjournals.org

Solution for Improving the Frequency of Operation of Metro Rail

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Abstract : *Automation is the use of control systems for operating equipment such as machinery, steering and otherapplications with minimal or reducedhuman intervention. The system explained in thisresearchpaperworks on driverless operation using automation. A communication linkis set up between the master and slave locomotive whichisused for distance minimizationbetweenthem, therebyimproving the frequency of operation. The system isalsoequippedwith certain specialfeatureslike anti collision system and automaticbrakingwhichcanbefruitful in lowvisibility and emergency conditions.*

Keywords: *Anti Collision, Automatic Braking, Automation, Communication, Distance minimization, Driverless*

Date of Submission: 07-07-2017 Date of acceptance: 15-07-2017

I. Introduction

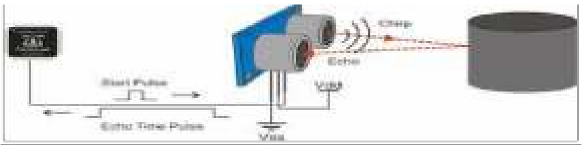
In the country's capital, the most preferred means of transport is the Delhi Metro. Launched in 2002, it became a massive success. The passenger growth that the Metro Officials had estimated while developing plans for the Metro System was way less than the actual passenger growth resulting in overcrowding. The problem of overcrowding could be solved by two possible ways, which are increasing the number of coaches or better utilization of existing assets i.e. by improving the metro frequency. While the problem of adding coaches depends on the manufacturing capacity of the plants and will lead to huge costs, the frequency is a parameter that can be improved. The present frequency of operation of Delhi Metro is 135 seconds, which is way lower than the International Standards (90 Seconds). According to data provided by Delhi Metro, having trains every 90 seconds instead of the existing 135 seconds will require massive investment in infrastructure. The major loop hole in metro's operation is the inability of an approaching train waiting outside a station to enter the station platform, unless the train ahead has completely exited the station. This loop hole will be exploited by us to improve the frequency of operation of metro rail.

II. Work Objective

The objective is to set up a smart traction system which utilizes an ultrasonic module to determine the distance between the two locomotives. The locomotive which is ahead will be termed as Master, while the one which is following it will be called the Slave. This distance value will be fed as input to the controller which analyses it(according to the in-built program) and give a command to the gear motor to either increase or decrease its speed. This will ensure that as the master locomotive starts to move to exit the station, after a certain safe distance the slave locomotive will begin to move, thereby reducing the effective gap between them resulting in improved frequency of operation.The mathematical equation to calculate the distance between object and ultrasonic module is:

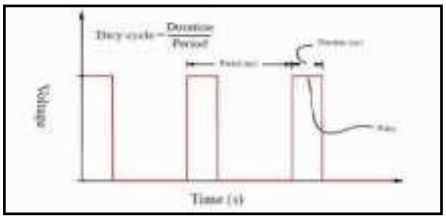
Distance=(speed of sound*time)/2

(Time = the time between when an ultrasonic wave is transmitted and when it is received, you halve the number byas the sound wave has to travel to the object and back.)



(figure1: working of ultrasonic distance sensor)

Pulse width Modulation (PWM) technique is used to vary the speed of slave locomotive by limiting the power.



(**figure2:** duty cycle)

III. Working Of The Project

In this project ultrasonic waves are used to measure the distance between two locomotives. If the measured distance is below a pre-determined value, then thecircuit automatically stops the locomotive. When ultrasonic sensor detects the object, then the circuit measures the distance and displays the same on the LCD screen. At the same time, microcontroller compares the distance with the values set in the system and takes an action accordingly. When the power is turned ON, the locomotive starts to move and the distance is measured by the ultrasonic sensor. When sensor detects an interruption, speed of the motor reduces automatically. Motor is connected to the pin no 5 of the IC via transistor driver circuit. Transmission and reception of ultrasonic waves is done through 40 KHz receiver and transmitter module.

A. The Distance Minimization Code

```
#include<NewPing.h>
#include<LiquidCrystal.h>

int trig1=4,echo1=5,maxd=200,dist1;
unsignedintuS;

NewPingsonar1(trig1,echo1,maxd);
LiquidCrystallcd(13,12,11,10,9,8);
void setup()
{

pinMode(3,OUTPUT);
analogWrite(3,127);
lcd.begin(16,2);
lcd.setCursor(0,0);
lcd.print("Locomotive");
lcd.setCursor(0,1);
lcd.print("Dist :");
  }
void check()
{
uS=sonar1.ping();
 dist1=(uS / US_ROUNDTRIP_CM);
}

void loop()
{
check();
if(dist1!=0)
  {
```

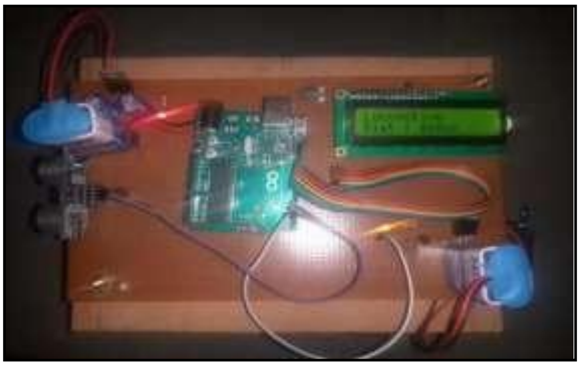
```
if(dist1>40)
analogWrite(3,40);
if(dist1>60)
analogWrite(3,20);
if(dist1>100)
analogWrite(3,0);
if(dist1<10)
analogWrite(3,255);
else if(dist1<25)
analogWrite(3,110);
if(dist1>=25&&dist1<=35)
analogWrite(3,60);
  }
lcd.setCursor(7,1);
lcd.print( (dist1/100) );
lcd.print( (dist1/10)%10 );
lcd.print( (dist1%10) );
lcd.print("cm");

delay(250);
}
```

IV. Observations And Results

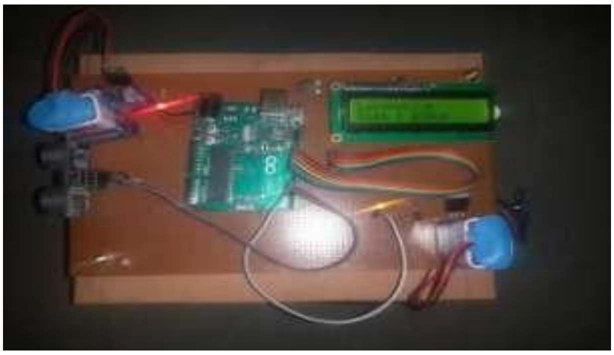
The principle of ultrasonic waves though very important poses a big challenge in its implementation that it works only when the object is in the line of sight. In order to solve this problem, a linear track was constructed on which both the locomotives will operate. Now the description about the different speed ranges depending on the distance between the two locomotives.

A. ***Case 1:*** When the distance between the two locomotives is greater than 60cm then the speed of operation is 50cm/sec.



(figure3: Distance between locomotives is greater than 60 cm)

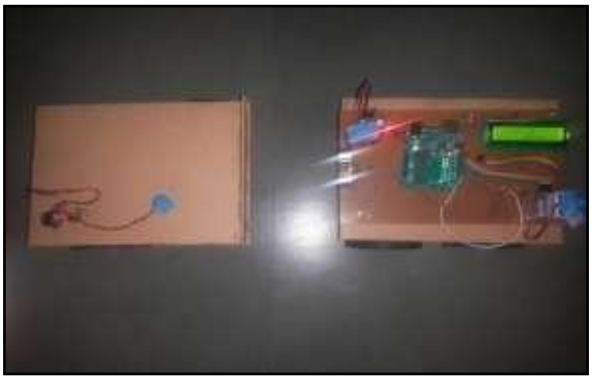
B. ***Case 2:*** When the distance between the two locomotives is greater than 30cm but less than 60cm then the speed of operation is 35cm/sec**.** As compared to Case 1, the speed of the slave locomotive decreases as the distance between the former and the latter decreases.



(figure4: Distance between locomotives = 30 cm)

C. Case 3: When the distance between the two locomotives is greater than 15cm but less than 30cm then the speed of operation is 15cm/sec. As compared to Case 2, the speed of the slave locomotive decreases as the distance between the former and the latter further decreases.

(**figure5:** Distance between locomotives = 15 cm)



(**figure6**: Distance between locomotives = minimum distance)

D. Case 4: When the distance between the two locomotives is almost equal to the minimum distance then the speed of operation is 0cm/sec i.e. the locomotive stops.

V. Conclusion

The world population is increasing at an alarming rate and we are not able to add capacity in proportion to that demand. The easiest way to reduce this deficit is to better utilize existing assets which is metro capacity in this case. Improving metro frequency can help in reducing overcrowding at stations, as an improved frequency will result in rushes getting cleared as soon as they starts to accumulate. Large capital investment is generally the hindrance that comes in the way of improving metro frequency. The smart traction system aims to improve metro frequency without significant increase in expenditure as it eliminates the need of a central control system by efficient and effective communication between trains running on the track. The control program embedded in the controller results in smoother acceleration and retardation in response to any obstacle in the system. The system can be extremely helpful in low visibility conditions using its super efficientanti collision system and automatic braking. The system employs an ultrasonic module sensor which works only for line of sight, and hence can create a problem when the track is curved. This problem can be overcome by replacing the ultrasonic module by an RF sensor. The major drawback of this system is the increased current demand which needs to be met as a result of increased frequency of operation.

Acknowledgements

The authors express their sincere gratitude to MrAjit Sharma, HOD, EEE Deptt, NIEC, Delhi for providing an opportunity to work in this area. The authors also thank Prof Md. SaquibFaraz, EEE Deptt, NIEC, Delhi for his technical support, valuable guidance and encouragement.

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IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) is UGC approved Journal with Sl. No. 4198, Journal no. 45125.

Lakshya Shahani. "Solution for Improving the Frequency of Operation of Metro Rail." IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) 12.4 (2017): 01-05.