Prototype Design of Parking Guidance System using Piezo Electric Energy Harvesting

Zaheer Thaddi, Varun Unecha, Vinit Mundada, Fatema Trawadi, Shubham Kudale

***Abstract**: To alleviate this congestion and improve the environment quality in urban centre, the project is introduced Parking Guidance System (PGS) to sense curb-street parking using a drive-by sensing. To quantify the system's benefits, the project has examined the effect for the deployment of this system on network mobility, i.e. travel time and delays, and greenhouse gas (GHG) emitted from vehicles through a design and a development of simulation model replicating one central business district area. The findings demonstrate that PGS has the potential to improve mobility and reduce vehicular emissions at any level of market saturation whether or not near-real-time traffic data is integrated into the route guidance system. The most significant reductions in vehicular emissions and delays are realized under conditions where the demand for parking is much greater than the availability of parking places; suggesting that as cities become more densely populated, PGS will become more necessary to reduce congestion and improve urban air quality.*

***Keywords**: Parking Guidance System (PGS), Piezoelectric Transducers (PZT), Renewable Energy,*

I. INTRODUCTION

Due to the inherent uncertainty associated with public on-street parking spaces, a relatively large number of drivers travelling within central city areas spend a significant amount of their total trip time looking for an on street parking space. A review of sixteen studies performed by Shoup revealed that between 1927 and 2001 the average cruising time to find a curb-street parking in the central business district areas of eleven cities on four continents was about eight minutes. In recent survey performed by Urbitran/Parson Brinckerhoff, 54% (weekday) and 41% (weekend) of parkers spent more than 20 minutes to find curb-street parking space. This search for parking spaces intensifies the overall amount of traffic congestion and worsens environmental quality within an urban center. Based on 2005 statistics, motorists waste 4.2 billion hours in congestion resulted to purchase an extra 2.9 billion gallons of fuel for a cost of $78 billion.

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Zaheer Thaddi, Civil engineering dept, Trinity College of Engg & Reaerch, Savitribai Phule Pune University, Pune, Maharashtra, India. E-mail: tzaheer10@gmail.com

Varun Unecha, Civil engineering dept, Trinity College of Engg & Reaerch, Savitribai Phule Pune University, Pune, Maharashtra, India. E-mail: vunecha9@gmail.com

Vinit Mundada, Civil engineering dept, Trinity College of Engg & Reaerch, Savitribai Phule Pune University, Pune, Maharashtra, India. E-mail: vinitgetsetgo@gmail.com

Fatema Trawadi, Civil engineering dept, Trinity College of Engg & Reaerch, Savitribai Phule Pune University, Pune, Maharashtra, India. E-mail: fatematrawadi30@gmail.com

Shubham Kudale, Civil engineering dept, Trinity College of Engg & Reaerch, Savitribai Phule Pune University, Pune, Maharashtra, India. E-mail: shubhamk9014@gmail.com

For this reason, parking guidance systems (PGSs) have been deployed in an effort to reduce car cruising for parking spaces particularly in central business districts (CBD). While early PGSs relied on variable message signs (VMSs) to inform drivers of the number of available parking spaces in garages or parking lots, PGSs have shown potential to go beyond the original scope.

II. PROBLEM

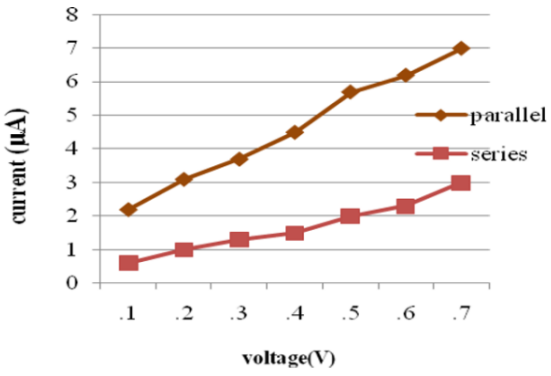
When a car is moving at a slow speed in search of parking space this leads to congestion of traffic. Due to slow movement of a car there is increase in emission of carbon dioxide than a car moving at normal speed. This carbon dioxide emitted from the car is harmful to the environment and cause air pollution. Due to this more manpower is required to handle the traffic and this increases the cost of management.

III. OBJECTIVE

- To reduce congestion, arising due to finding a parking spot.
- To reduce carbon-di-oxide emission.
- To reduce cruising time of the vehicle during finding the suitable parking spot.
- To provide a clean energy harvesting system.

IV. STUDY OF CONNECTIONS

Next to determine the kind of connection that gives appreciable voltage and current necessary, three PZT are connected in series. A force sensor and voltmeter is connected to this series combination. As varying forces are applied on this connection, corresponding voltages are noted. Also the voltage generated across the series connection and the current is measured. Similarly the connections are done for parallel.



Graph 4.1 V-I graph of parallel and series connection

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V.HARDWARE SETUP

PZT's are connected in series; these PZT's are connected to the battery. The voltage generated across PZT's is supplied to a battery for it to recharge and supply the dc loads. This DC voltage is then supplied to Arduino.

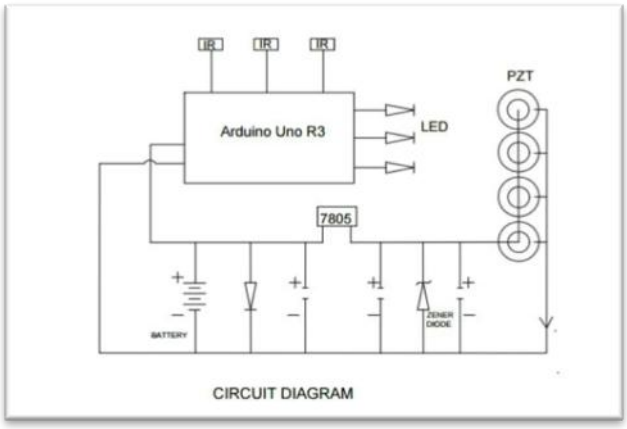


Fig No 5.1 Hardware Setup.

VI. PROTOTYPE

While designing a parking space following aspects have to be considered-

1. Clearance between vehicles parked in the stalls.
2. Dimensions and turning radius of the vehicle.
3. Clearance between parked and parking vehicles.
4. Orientation of the parking.

A wooden plank of size 2ft X 1ft and 1 inch thick was selected, because it fulfilled all the requirements of the actual structure and was cheaply available. Then the base of prototype was divided into 2 equal halves, i.e. 2 halves of 1ft X 1ft. First half of the prototype would consist of piezoelectric tile of 1ft X 1ft and the other half of the parking spaces and the rest of the circuit. The other half of the prototype with parking spaces would consist 10 parking spots of the size 3cm X 6cm. Out of those 10 spots, 2 parking spots contain IR sensors, out of which 1 is reserved for handicapped i.e. it contains 1 red led and 1 blue led to differentiate it. The other parking spot consist of 1 red led and 1 green led. The rest of the parking spots consist of white LED's for illumination purposes. It also consists of in and out gates which are controlled by motor and IR sensor. The gates are given a delay of 2 seconds so that the car could pass through the gates and there is no rush or any other kind of chaos in the parking area

VII. WORKING.

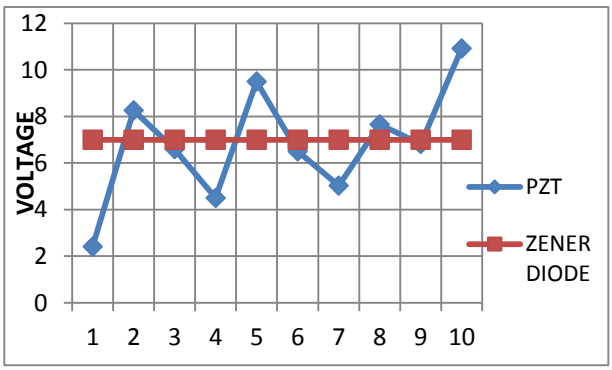
The piezoelectric material converts the pressure applied to it into electrical energy. The source of pressure can be either from the weight of the moving vehicles or from the weight of the people walking over it. The output of the piezoelectric material is not a steady one. So a regulator and zener diode is used to convert it into steady dc load. Here 15 PZT's are connected in series. This are further connected to zener diode and voltage regulator. . In this 15 PZT's were connected in series. These PZT's were glued on the foam sheet which is attached to the wooden plank of 1 inch thickness. Erasers are pasted to the PZT's. The plank of 8mm thickness is kept on these erasers. Then the pressure is applied on this plank and the voltage across each weight is checked.

Fig No 7.1 PZT arrangement.

Working voltage of the Arduino is between 7V-12V, so a constant voltage of minimum 7V is required. The working voltage to be constant zener diode of 7V is used.

Table No 7.1 Actual Readings.

	PZT	ZENER DIODE
1	2.41	7
2	8.26	7
3	6.6	7
4	4.5	7
5	9.5	7
6	6.5	7
7	5.03	7
8	7.66	7
9	6.82	7
10	10.92	7



Graph 7.1 Graph of PZT's readings.

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The readings obtained, shown above were checked against the weight of 90kg. It can be seen that, 4 out of 10 readings crossed the 7V line. That means the success rate of this test was only 40%. And it can also be seen that arduino cannot run on fluctuating voltage. Since the idea of powering arduino didn't work, a zener diode of 5V was used. The one end of the zener was connected with PZT's whereas the other was connected to the battery. The zener diode gets fluctuating discharge from the PZT's and converts them into constant charge of 5V. This 5V is then used to charge the battery. This battery is connected to the LED's, used for lighting purposes.

VIII. CONCLUSION

The maximum voltage that was obtained from this test was 10.92V. This voltage could power Arduino and LED's together. But this was not possible since the working voltage of the Arduino is 7V, and only 4 out of 10 readings were above 7V. This pulsating energy neither could power Arduino nor charge the battery. It can be concluded that the amount of energy required to power the arduino could not be generated for the above test. The energy generated could be used to power the LED that will light the parking lot. Also it can be concluded that the series connection cannot generate a great amount of voltage so, series-parallel connection may be able to deliver the desired output.

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Zaheer Thaddi, Civil engineering dept, Trinity College of Engg & Research, Savitribai Phule Pune University, Pune, Maharashtra, India. +91 9096773559, e-mail: tzaheer10@gmail.com

Varun Unecha, Civil engineering dept, Trinity College of Engg & Research, Savitribai Phule Pune University, Pune, Maharashtra, India. +91 9028883745, (e-mail: vunecha9@gmail.com

Vinit Mundada, Civil engineering dept, Trinity College of Engg & Research, Savitribai Phule Pune University, Pune, Maharashtra, India. +91 8308285678, (e-mail: vinitgetsetgo@gmail.com

Fatema Trawadi, Civil engineering dept, Trinity College of Engg & Research, Savitribai Phule Pune University, Pune, Maharashtra, India. +91 9730275844, (e-mail: fatematrawadi30@gmail.com

Shubham Kudale, Civil engineering dept, Trinity College of Engg & Research, Savitribai Phule Pune University, Pune, Maharashtra, India. +91 8237328494, (e-mail: shubhamk9014@gmail.com

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