ROAD POWER GENERATION

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2016

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DECLARATION

I hereby declare that the project entitled **"Road Power Generation"** is an authentic record of my own work carried out in the Electrical & Instrumentation Engineering Department, Thapar University, Patiala, under the guidance of **Dr. Mandeep Singh (Associate Professor, EIED)** during **July'16-Dec'16**.

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Date: December 20, 2016

ABSTRACT

Scientific inventions have provided us with various means of comforts and luxuries. The invention of electricity is one of the greatest of its wonders. Electricity has become a lifeline for human population. It is used in every walk of life – engineering, communication, transport, construction, surgery, etc. Its demand is increasing day by day. Modern technology needs a huge amount of electrical power for its various operations.

Most electricity today is produced by the burning of fossil fuels. This method of electricity generation is the biggest source of pollution in the world. Fossil fuel burning increases the carbon dioxide content in the atmosphere and contributes to greenhouse effect and global warming. Sulphur dioxide, Nitrogen dioxide and other released gases contribute to smog and acid rain. Moreover, fossil fuels are limited. There is an immediate need to explore non-polluting methods of electricity generation, and work on them to increase their efficiency and reduce cost associated with them.

Through our prototype of Road Power Generation, we have tried to demonstrate how electricity can be harnessed by channelling the kinetic energy on busy roads using three modules based upon – Wind Power Generation, Piezoelectric effect and Electro Kinetic power generation. The electricity generated by these three modules has been stored in a battery, and used to power the street lamps, thereby creating self sustained power generating roads.

ACKNOWLEDGEMENT

We take this opportunity to express our profound sense of gratitude to all those who helped us throughout the duration of our project work on “Road Power Generation”.

We express our indebtedness to our mentor and guide Dr. Mandeep Singh for providing us an opportunity to undertake this project and providing his crucial and valuable feedback that influenced the development of this project. We have tried our best to learn from him, as much as we could, in all spheres of life. We would also like to thank our parents and friends for their support throughout the project.

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CHAPTER 1
INTRODUCTION

Electricity is one of the most important blessings that science has given to mankind. It has become a part of modern life and one cannot think of a world without it. It is used for lighting rooms, working fans and domestic appliances. All these provide comfort to people. In factories, large machines are worked with the help of electricity. Essential items like food, cloth, paper and many other things are the product of electricity. Modern means of transportation and communication have been revolutionised by it. Electric trains and battery cars are quick means of travel. Radio, television which are the most popular forms of entertainment, are the result of electricity. Modern equipment like computers and robots have also been developed because of electricity. Electricity plays a pivotal role in the fields of medicines and surgery such as X-ray, ECG. The use of electricity is increasing day by day.

Electricity production is the single largest source of pollution in the whole world. Most electricity today is generated by burning fossil fuels. Burning fossil fuels results in the conversion of carbon to carbon dioxide, which is then released into the atmosphere. This results in an increase in the Earth's levels of atmospheric carbon dioxide, which enhances the greenhouse effect and contributes to global warming. Ozone, sulphur dioxide, NO_2 and other gases are often released, as well as particulate matter, contribute to smog and acid rain. The focus is now shifting more and more towards the renewable sources of energy, which are essentially, non-polluting. For meeting up the regular demand of energy we need to design a system that will produce electricity without harming nature.

There are lots of models formulated to solve this problem and save the resources for future generations. The two most important points to be considered while thinking of a new source of energy are:

- Firstly, the source of energy should have no carbon dioxide emission.
- Secondly, it must be a renewable source of energy.

There are thousands of crowded cities with enormous flow of vehicles, which offer large amount of energy. Therefore, it is necessary to design a suitable and efficient topology of an energy conversion system for extraction of kinetic energy of vehicles. Through our project on Road Power generation, we are trying to:

a) Design a prototype of electrical power generation which does not negatively impact the environment
b) Harness the wind power of rapidly moving vehicles on roads to generate electricity
c) Generate electricity from the kinetic energy of vehicles on the road
d) Utilize the wasted vibration energy using piezoelectric technology
e) Develop a model of a self-sustained system that uses the generated energy to control street lamps

CHAPTER 2
LITERATURE STUDY

There is a need to diversify our energy sources and reduce our dependency on fossil fuels as major source of energy. Instead of increasing the power load of the public electricity grid that highways need (lightning and service facilities), Road Power Generation will make highway project integrated to meet the requirements of sustainable development and will contribute to the support of public electricity grid instead of consuming it.

2.1 Piezoelectric Sensors

The idea to utilize piezoelectric sensors to generate electricity is used in many ways. There have been several attempts by individuals to harness energy using these sensors. The work by Gregory Thomas is very impressive. He has explained the design in a very informative YouTube video "THE PIEZOELECTRIC SYSTEM ON ROADS". Piezoelectric battery charging shoe is another example by Stevens. The ultimate goal for these shoes is to charge a cell phone, mp3, or power a light when out on a long walk. International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463 Vol. 2 Issue 6, June-2013, Piezo-Smart Roads Priyanshu Kumar Electronics Engineering. Electricity Generation Due to Vibration of Moving Vehicles Using Piezoelectric Effect Mukti Nath Gupta, Suman and S.K. Yadav.

Several designs are being proposed and utilised at different places in the world. One design consists of a thin box around the piezoelectric material, which is then placed underneath a layer of asphalt. As trucks pass over plates embedded in the asphalt they compress a tank of hydraulic fluid under the road, which in turn creates a series of pumping actions that turns a generator to produce electricity. When a car drives over the box, it takes the vertical force and compresses the piezoelectric material, thereby generating electricity. The energy—80 kilowatt-hours per kilo meter of road for car traffic—can be stored in a nearby battery or super capacitor, depending on the application, or sent directly to streetlights and other roadside devices. The energy being converted into electricity through piezoelectric effect is coming from motion of vehicle which will otherwise be wasted by heat when the road deforms under the weight of the car. The layer of piezoelectric material is stiffer than the road material it replaces, so it even saves a tiny amount of energy. Another design aims to capture energy when vehicles are slowing down in which cars or trucks would drive over a mat that would be installed on top of the road, on a highway off-ramp, or near a toll booth, saving wear and tear

on the car brakes and transforming some of the slowing vehicle's motion into electricity. The mat uses mechanical or hydraulic cells to generate electricity and can be customized for cars or cargo truck traffic. The idea of skimming kinetic energy from slowing vehicles before it gets wasted as heat has already undergone a few real-world tests, with mixed results. In such a test, the panels produced as much as 40 kilowatt-hours but panel seals suffered damage from grit, temperature extremes, and torsion from trucks turning on them. Efforts are being going on to modify the system considering the problems insurmountable. Engineers have created a new type of road capable of turning the vibration caused by cars into electricity. While the concept is not new, the application is a novelty. The piezoelectric generators harvest the vibrational energy and save it in roadside batteries that can be used by people. Accordingly, one truck can generate 2,000 volts which could already be used to power traffic lights or street lamps.This process is also known as Parasitic Energy harvesting. Under the upper asphalt there is a layer of piezoelectric crystals that produce electricity when squeezed. The same technology can be implemented on airport runaways and rail systems. The system also has the capacity to deliver real-time data on the weight, frequency and speed of passing vehicles as well as the spacing between vehicles. Future plans include placing the crystal generators in railways. Trains are advantageous in that they are guaranteed to apply pressure in the same place over and over again.

2.2 Highway Wind Turbines

The idea to utilize wind turbines on the highway is not entirely unique. There have been attempts by several individuals and groups to recycle energy from highways. The most impressive is a design displayed on a YouTube video entitled "Highway Helical Wind Turbine Project (Next Generation Highway's Potential For Wind Power)." In the video a group of Mechanical Engineering Students from YCET Kollam, Kerala display a prototype of their highway wind turbine.

Computer animated design of a highway wind turbine proposed by Mechanical Engineering Students in India. The students Nabeel B, Firoz khan T S, Krishnaraj V, Kannan Raj, Arun S, Shaiju mon T K, and Akhil Ganesh demonstrate a working prototype of their design. (Highway Helical Wind Turbine Project (Next Generation Highway's Potential For, 2012) Other designs include turbines built into highway dividers or on overhead poles as seen in the design by the Arizona State Student Joe. It was calculated that with cars moving at 70 mph, 9,600 kilowatts of electricity could be produced per year using his design.

2.3 Power Generation from Speed Breaker

The idea of power generation from speed breaker is presented very nicely by Karthik Dm in his video “Power Generation from speedbreaker.” Recently several attempts and models have been suggested and tested for harnessing kinetic energy of vehicles via a speed bump. Mechanisms which include springs by A.K. Singh, Deepak S., Madhawendra K. and V. Pandit, Rack and Pinion by Aswathaman. V and Priyadharshini.M in“Every Speed Breaker Is Now A Source of Power” ; by Shakun Srivastava , Ankit Asthana in “Produce electricity by the use of speed Breakers” and by Ankit Gupta, Kuldeep Chaudhary & B.N Agrawal in “An Experimental study of Generation of Electricity using Speed Breaker”and slider crank by Noor Fatima and Jiyaul Mustafa in “Production of electricity by the method of road power generation” have been suggested for producing electricity. Electrodynamics based models by Ankita and Meenu Bala in ”Power generation from speed breaker” have also been suggested, but are not only expensive to fabricate but involve complicated calculations and can’t be used a large scale very easily. Totaram uses a platform plate which is kept inclined on a raised base level to allow vehicles to pass over the raised surface. This system will not work till a vehicle passes on road way.

The ramp was invented by Peter Hughes, in the year 2002 an electrical and mechanical engineer who is employed by Highway Energy Systems Ltd. The company says that under normal traffic conditions, the apparatus will produce 30 kW of electricity. Other proposed applications for the road ramps heating roads in the winter to prevent ice forming and ventilating tunnels to reduce pollution. "The full potential of this is absolutely enormous." Hughes claims that 10 ramps could generate the same power as one wind turbine.

2.4 Motion sensing street lighting system

The work on it has been done by Abhijit Talukdar ,Kailash Laishram ,Kime Tayu ,Jyoti Kumar Barman(Dept. of Electrical and Electronics Engineering , Assam Don Bosco University Airport Road Azara Guwahati -781017 Assam, India)

CHAPTER 3
PROBLEM FORMULATION AND METHODOLOGY

3.1 Problem statements

3.1.1 Piezoelectric sensors

There is currently a significant cap on the generating capacity. Net profits will only be seen after at least 12 years, as an underestimate. There are also many more "costs," besides the financial costs of manufacturing and installation, to take into account, such as the environmental impact of manufacturing the PZT ceramics used . While piezoelectric devices are gaining popularity, they are less capable than previously claimed because of physical limitations.

3.1.2 Problem statement for highway wind turbines

A major hindrance in the growth of wind energy is fluctuation in the sources of wind. Highways appear to be a sufficient source of potential wind energy. An in-depth analysis of fluid flow due to traffic on highways must be performed to acquire boundary limits for the wind turbine design. The turbine must be able to store energy for use when there is low traffic, bumper to bumper or stop and go traffic. The design must be sustainable and environmentally friendly.

3.1.3 Problem statement for roller mechanism

The problem with this mechanism is that it can get damaged due to rust in rainy season. We have to check this mechanism from time to time as there are many chances of wear and tear in this mechanism. It will not work efficiently with light weight vehicles like bicycles .

3.2 Methodology

Each and every action needed energy. Thus a lot of energy is wasted in our day to day activities. As we know that energy can only be converted we can use this energy to solve our problem of finding a renewable source of energy. A lot of energy is also wasted on roads. Movement of cars on high speed contains lots of kinetic energy and vibrations. We can use the energy wasted on roads by cars to generate electricity that will power street lights. This will make our roads self-sufficient and will also reduce the load on our electrical system.

The model depicts the actual conditions on the Indian roads and tries to extract power from three key points that are,

1. Kinetic energy from the motion of vehicle on road
2. Energy from vibration produced by the tires of vehicles
3. Wind energy from the motion of car

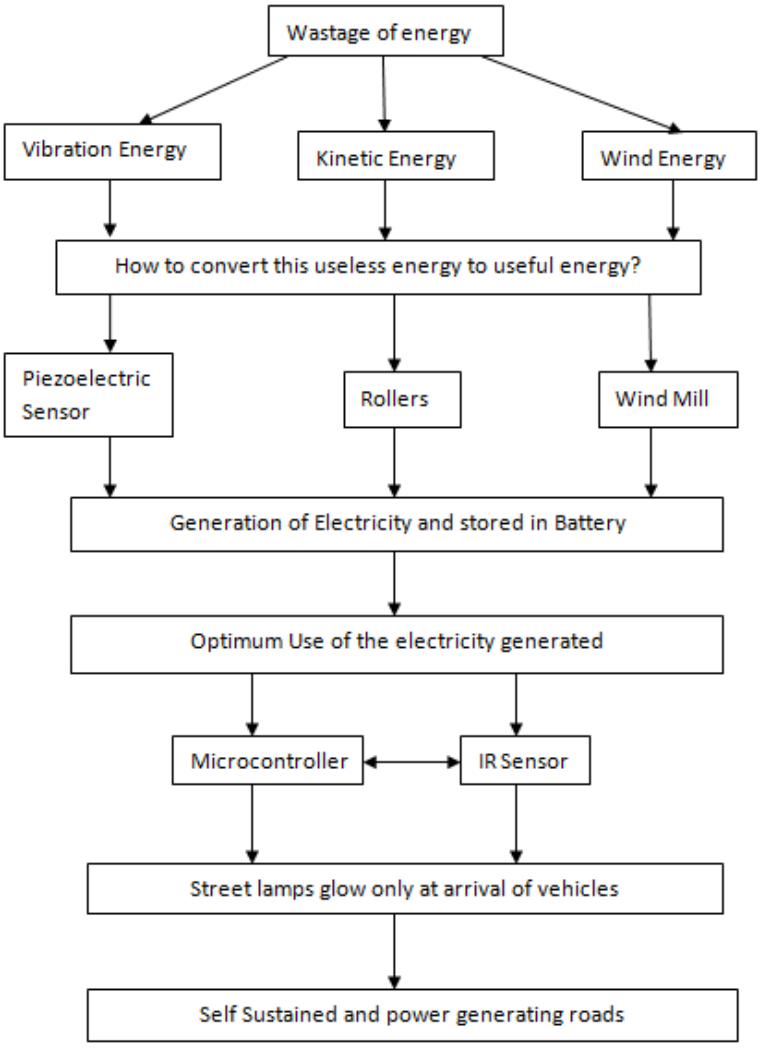

FIG 1: BLOCK DIAGRAM

The model in itself is a generator of electricity and a consumer of electricity. Electricity generated in stored in a battery and is used to light up the street. We have also used automatic

street lights that will be switched on (in the practical world, lights will be initially dim and will get lit up) when the sensor attached to street light senses the arrival of a vehicle.

Kinetic energy to electrical energy

All the objects in motion possess kinetic energy. Kinetic energy of an object increases with its speed. Thus, kinetic energy is abundant when a vehicle is in motion and we have used this motion to extract energy. Kinetic energy is then converted to electricity and stored in the battery. This energy is extracted by using a roller in place of speed breaker on roads. The roller is connected to generator. The energy generated by the generator is stored in a battery. Whenever a vehicle's tire comes in contact with roller their kinetic energy gets transferred or converted into rotatory motion of rollers. Rollers are connected to a gear system through a shaft. The gear system amplifies the motion of roller and the generator gets more rotations for every rotation of roller. A LED is connected to the generator to indicate the generation of electricity. As we have to store this generated electricity into a battery, a diode is connected to this module to stop the reverse flow of current when generation is now happening.

There is another way in which this module will be helpful. Our highways have bridges. While moving up the bridges we have to accelerate to maintain a speed and decelerate while our vehicle coming down the bridge. We have to apply brakes to avoid any maintain a constant speed. We know that, more the speed more it the kinetic energy of that object. Kinetic energy gets converted into potential energy when we use brakes. We can convert this kinetic energy directly into electrical. Braking phenomena is simply converting kinetic into potential energy. If we embed our rollers into the road of downward slope of bridges, then this kinetic energy will instead be converted into rotatory motion of our rollers. As braking converts energy from kinetic to other form, embedding rollers into the downward slope's road will also help in reducing the speed of vehicle. We can control the amount to braking but using more or less number of rollers. More rollers mean more braking or vice-versa. This method is more useful as energy that is converted into potential is waste and we do not want any type of energy wastage for a better future.

Vibrations to Electrical Energy

The energy consumed by the vehicle (sourced in the fuel combustion) utilized for a variety of applications; one of them is to overcome rolling resistance. A typical asphalt road can be described as a visco-elastro-plastic material, with elasticity being its dominant material characteristic. When a vehicle passes over a road, the road deflects vertically. This deflection

is released as thermal energy. For a road with embedded piezoelectric generators, part of the energy the vehicle expands on roads deformation is transformed into electric energy (via direct piezoelectric effect) instead of being wasted as thermal energy (heat).

Only part of the energy from the fuel combustion of the vehicle is used for moving the car along the road or run useful accessories, such as air conditioning. The rest of the energy is lost to engine inefficiencies. The energy expended on the vehicle's movement is mainly used to overcome rolling resistance, resistance occurring when the wheel is moving forward on the road surface. In addition to the energy used to move the wheel forward (in the horizontal direction), part of the fuel combustion is wasted on creating a deformation in the asphalt, which is basically the product of the loaded wheel's influence on the road surface. A typical asphalt road can be described as a visco-elastoplastic material, with elasticity being its dominant material characteristic. When a vehicle passes over a road, the road deflects vertically. The deflection is proportional to the weight of the vehicle and the asphalt stiffness. The only source for harvesting electric energy is this part of mechanical energy related to the asphalt vertical deformation, which is a percentage from the total energy of the vehicle (energy of the fuel combustion). It is known that the vertical load of the vehicle's wheels yields compression stress, diminishing with depth. Piezoelectric generators are embedded at a depth of about 5 cm; the area where the compressions stress is maximal. The external load results in the deformation in both the asphalt layer covering the generators and the generators, similar to the typical deformation in a piezoelectric column loaded under axial load. The deformation of the generator and the shortening of the piezoelectric columns embedded in the generators, generate charges on the piezoelectric columns that are the source for the electric energy. The energy needed to deform the road is a function of various parameters such as: the surface quality of the road, asphalt type, environment temperature and others.

Movement of vehicles are always constant on busy roads and highways so, power can be generated constantly by this concept. Power generated from ‘Piezo-smart roads’ concept is Greenpower and no harm to the environment. This power can be very well utilized for the street lightning and other small scale purposes. This source of electrical energy is a long term investment having merits of being a continuous source, independent and unaffected by climatic conditions.

But implementing this concept is a little bit tedious. The present day roads need to be relayed again in order to implement this concept. This will result in traffic congestions all over the city and needs a critical plan of implementation and management.

Wind Energy to Electrical Energy

Fabrication of vertical axis wind turbine (Involute Spiral) consists of different parts which are needed to be fabricated as parts of main assembly. Following are the parts of VAWT, to be fabricated. Blades- fabrication of blade consists of aluminium blades, steel pipes, aluminium sheet circular cross section base. Housing- fabrication of Housing consists of circular metal disc, bearing and metal rods. Adjustable Shaft- fabrication of adjustable shaft consists of hallow shaft, threaded solid shaft and guide rod. Lower column- fabrication of column consists of selecting the shaft and welding of supporting discs. Base- fabrication of base aims at providing a strong support to the turbine. Hence have flexibility in design in accordance with supporting strength. Apart from the parts said above, certain materials and components are required during main assembly of Vertical Axis Wind Turbine, such as aluminium strips, threaded rod, bolts for fastening, rivets, bearing and metal paste.

The design should provide the following-Be able to generate a non-trivial electricity supply to the streetlights when operating. Excess electricity can be fed back into the national grid or charge secondary batteries. The scale of the turbine should be within the limits of the Indian highways. Designed to operate at suitable wind speeds typical to India weather in highways areas. Possess a fail-safe system as a consequence of an over-speed event.

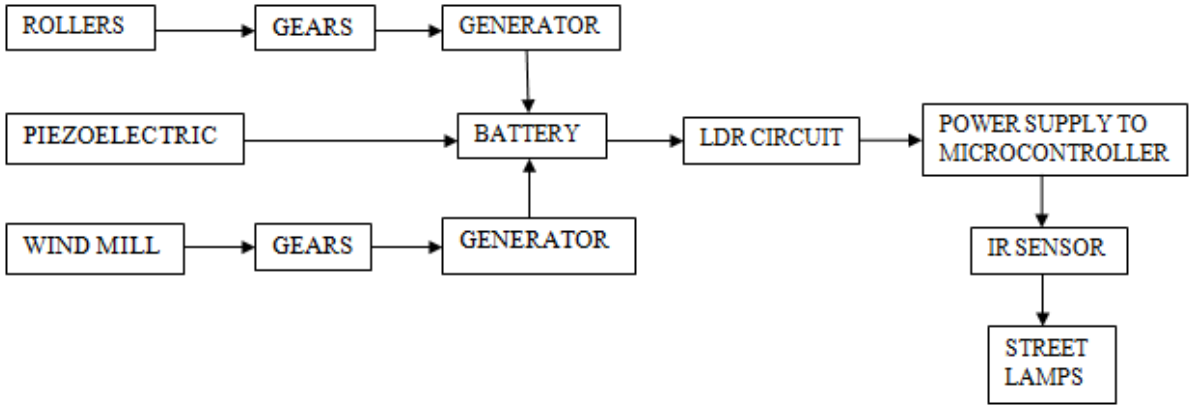

FIG 2: BLOCK DIAGRAM

When the vehicles pass over the rollers, the rollers rotate and this is amplified with the help of gear system employed adjacent to the rollers. Then the generator is installed along with it which generates electricity. This electricity is then stored in the battery. When the vehicles are moving, only the rotatory friction is to be overcome which leads to wastage of vibrational component. This is used by piezoelectric components to convert it into usable electrical

energy. This generated electricity is stored in battery. The wind mill is employed which converts wind energy to electrical energy. In our model, we have employed vertical axis wind turbine. The gear system is used with it to amplify the values and then the generator helps to generate electricity which is then stored in battery. After the electricity generated from all these modules is stored in battery, it is used as an input to LDR circuit. The LDR circuit switches on the lamps only at night which again adds on to energy efficiency. An LDR or "Light Dependent Resistor" is a resistor where the resistance decreases with the strength of the light. This LDR circuit is an input to microcontroller. The microcontroller controls the IR sensor which is motion sensing element. It switches on the street lamps only at arrival of vehicles and offs the light when when the vehicle passes away. In this way this entire system tends to be self sustained system.

CHAPTER 4
DESCRIPTION OF MODEL

There are different kinds of modules used for converting different forms of energy to electricity. The energy wasted on roads is converted to the useful green energy and thus converts roads dependent on the conventional sources to the self sustained independent roads and also as the sources of energy for households. This energy can also be used by electric cars to charge their batteries at various stops. It will reduce the consumption of hydrocarbons and help sustain a healthy environment.

The energy can be converted from one form to another. The various technologies are used for these conversions. Some of them are discussed below.

4.1 Wind energy to electricity

The 6V battery is supply to LDR which will activate the pnp transistor at night,or when the resistance of the ldr is very high. Thus, activating the load (or street light) of 3V. 50K potentiometer is connected in to vary the intensity of load or which controls the current passing through the load. 66 ohm resister is connected to limit the current within the load. The output from the generator is given to LED of 1.5V through resistor of 66V. Here LED is used to indicate that by rotating wind turbine charging of battery is done. Diode is used for unidirectional nature if current,thus not allowing the battery to rotate wind turbine or battery won't give current to generator (which will act as motor and turbine will start rotating).

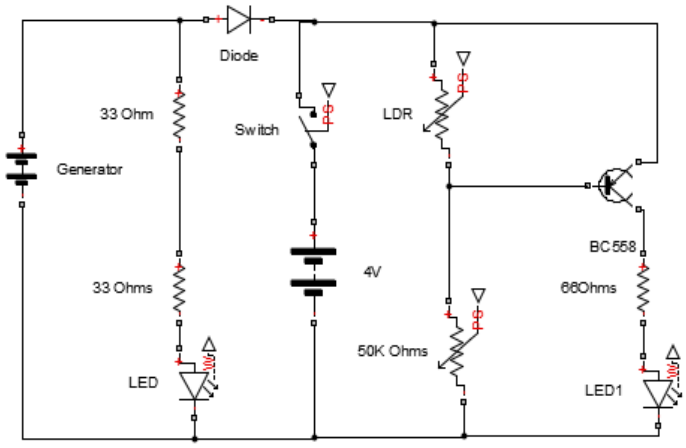

Fig 3: Wind energy circuit

4.1.1 Components used

Vertical-axis wind turbines (VAWTs)

It is a type of wind turbine where the main rotor shaft is set transverse to the wind (but not necessarily vertically) while the main components are located at the base of the turbine. This arrangement allows the generator and gearbox to be located close to the ground, facilitating

service and repair. VAWTs do not need to be pointed into the wind which removes the need for wind-sensing and orientation mechanisms.

Transistor

BC558 is a general purpose PNP transistor. It is used in switching and amplifier applications. The DC current gain varies in range 110 to 800.

Light Dependent Resistance:

LDR is a device whose sensitivity depends upon the intensity of light falling on it. When the strength of the light falling on LDR increases, the resistance decreases and while if the strength of the light falls on LDR is decreased resistance is increased. In the time of darkness or when there is no light, the resistance of LDR is in the range of mega ohms, while in the presence of light or in brightness in decrease by few hundred ohms.

4.2 Vibrational energy to electricity

Piezo elements come in handy when you need to detect vibration or a knock. You can use these for tap or knock sensors pretty easily by reading the voltage on the output. They can also be used for a very small audio transducer such as a buzzer. A piezoelectric sensor is a device that uses the piezoelectric effect, to measure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge. The prefix *piezo-* is Greek for 'press' or 'squeeze'. They have been successfully used in various applications, such as in medical, aerospace, nuclear instrumentation, and as a tilt sensor in consumer electronics or a pressure sensor in the touch pads of mobile phones. In the automotive industry, piezoelectric elements are used to monitor combustion when developing internal combustion engines. The sensors are either directly mounted into additional holes into the cylinder head or the spark/glow plug is equipped with a built-in miniature piezoelectric sensor.

The material which exhibits direct piezoelectric effect results in to inversion symmetry. It means it produces electrical charge due to applied mechanical force and conversely generates internal mechanical force on the application of electric field. The piezoelectric effect takes place in piezoelectric material when they are compressed along certain axis producing a measurable voltage on the surface of material; hence the piezoelectric material can be treated as efficient electromechanical transducer.

4.3 Kinetic Energy to Electricity

The friction force due to vehicle movement, acted upon the speed breaker system is transmitted to chain sprocket arrangements. The sprocket arrangement is made of two sprockets. One of the sprocket is larger in dimension than the other sprocket. Both the sprockets are connected with chain which transmits the power from the larger sprocket to the smaller sprocket. As the power is transmitted from the larger sprocket to the smaller sprocket, the speed that is available at the larger sprocket is relatively multiplied at the rotation of the smaller sprocket. The axis of the smaller sprocket is coupled to a gear arrangement. Here we have two gears with different dimensions. The gear wheel with the larger diameter is coupled to the axis of the smaller sprocket. Hence, the speed that has been increased at the smaller sprocket wheel is passed on to this gear wheel of larger diameter. The smaller gear is coupled to the larger gear. Therefore, as the larger gear rotates it increases the speed of the smaller gear which is following the larger gear and multiplies the speed to more intensity. Though the speed due to the rotary motion achieved at the larger sprocket wheel is less, as the power is transmitted to gears, the final speed achieved is high. This speed is sufficient to rotate the rotor of a generator and is fed into the rotor of a generator. The rotor which rotates within a static magnetic stator cuts the magnetic flux surrounding it, thus producing the electric motive force (emf). This generated emf is sent to the storage battery where it is stored during the day time and can be used in night time for providing power to street lights.

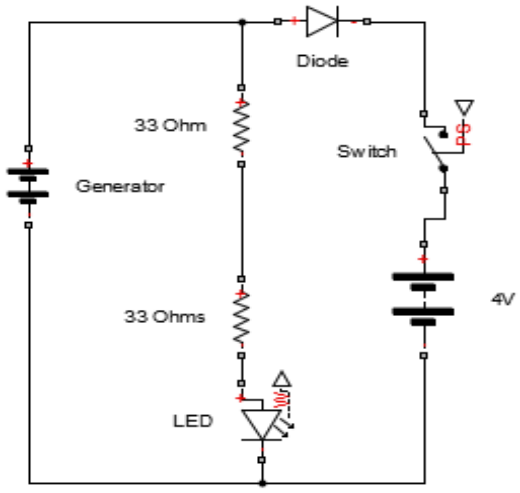

Fig 4. Generation from K.E.

4.4 Automatic Lighting

All the voltages generated by the modules are stored in a battery and the DC voltage is connected to 7805 embedded in the circuit of 8051 microcontroller. 8051 has a code stored in it that is used to control the street lamps. The code is as follows:

```
ORG 00H
MOV P1,0FFH
HERE:JB P1.0,HERE1
SETB P2.7
SETB P2.6
HERE1:JB P1.1,HERE2
SETB P2.5
CLR P2.7
HERE2:JB P1.2,HERE3
```

```
SETB P2.4
CLR P2.6
HERE3:JB P1.3,HERE4
CLR P2.5
CLR P2.4
HERE4:SJMP HERE
END
```

The circuit diagram is as follows:

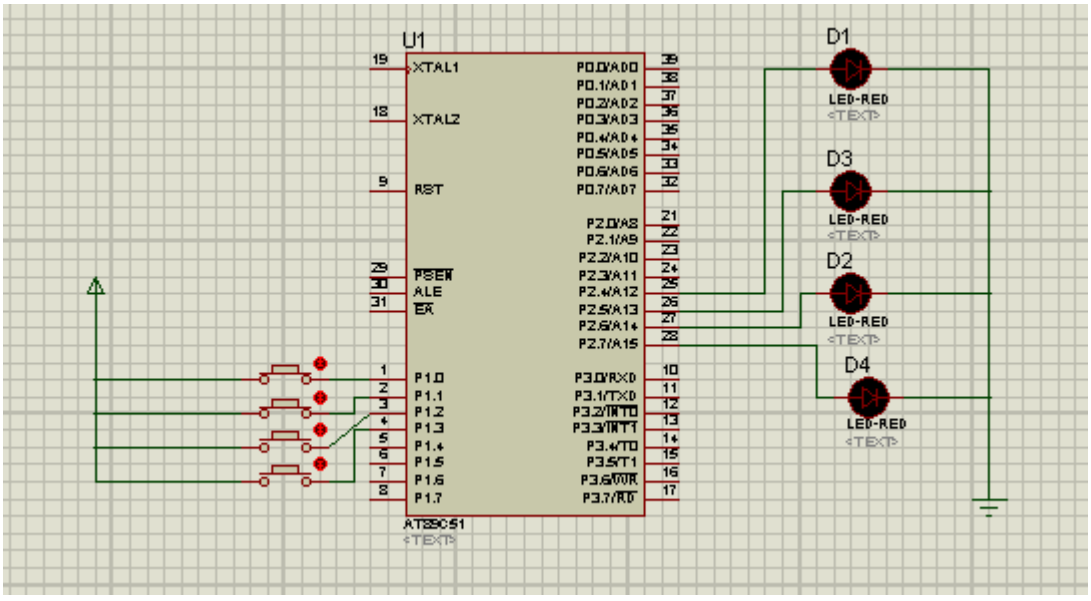

Fig 5. Circuit diagram of Controller

4.5 Working:

Road power generation project is a self-sufficient system that is generating power from energy dissipated by a vehicle as it moves on the road. Generation takes place from three major wastages of energy that are kinetic, wind and vibration. The model tries to harvest and recapture the maximum amount of wind energy from the automobiles running on the highways. A Vertical Axis Wind Turbine is used in this project which is mounted on the dividers. The VAWT is coupled with disc type alternator is placed on the highway road dividers. As the wind is forced by passing vehicles from both sides, the wind speed on the centre place of highway roads will be more than at the pedestrian walking lane. This wind is forced to the VAWT from two directions heavily but this VAWT makes use of both the wind directions and rotates in one direction only. If the speed of the turbine increases results in increasing the speed of the alternator and the corresponding increased power is obtained at the output terminal.

Second major source of energy generation used in the model is converting the energy dissipated due to vibrations on the road. This is converted by using piezoelectric sensors. Output of piezo sensors is a voltage spike. The magnitude of this spike is dependent on how hard the piezo sensors are hit. It can be as large as hundreds of volts.

Our model also generates energy from kinetic energy. Kinetic energy is collected by using a roller in the place of speed breakers. The motion of tyres of vehicle rotates the roller. These rollers are connected to the shaft of generator. More the speed of the car, more it the energy/ power generated. The power from all these sources is collected and stored in the battery. This power is then used to run a microcontroller circuit.

Microcontroller is used to automate the street lights and save energy by switching the lights only when a vehicle crosses the road. IR sensors are mounted on the road that detect the motion of a car and switch on only the lights which are required

CHAPTER 5
RESULTS

5.1 Highway Wind Turbines

Data has been collected by the use of digital anemometer at different location on the highway medians. The changes were recorded at different height and different location. The graph given below gives the actual data collected in highway for wind velocity at different height during certain interval of time.

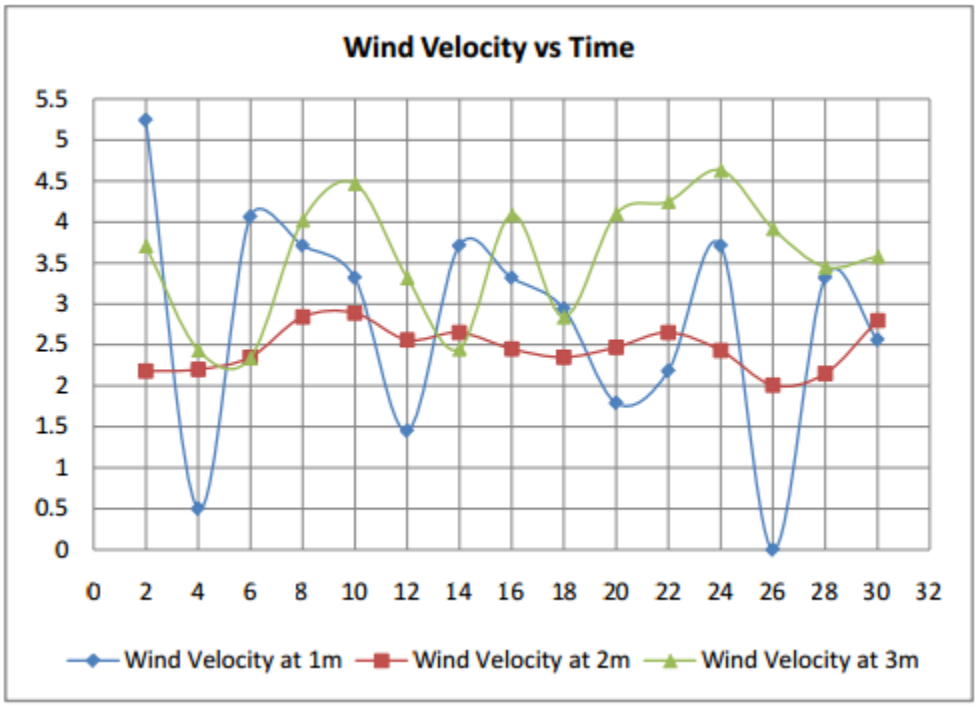

Fig 6. Wind Velocity Vs Time

The input power can be calculated by using the formula P= M*ω Where, M- Input torque ω- Angular velocity The angular velocity can be calculated by knowing the rpm of the blade shaft and the torque can be calculated by knowing the velocity of the wind.

Table 1:Generation from Kinetic Energy

Sl. NO.	HEIGHT(m)	RPM	ANGULAR VELOCITY	TORQUE(Nm)	POWER(Watt)
1	2.2	110	11.52	9.22	106.25
2	2.4	128	13.40	8.52	114.26
3	2.7	136	14.24	8.58	122.22

Theoretically, the power output of any wind turbine

$$P_a = \frac{1}{2}\rho A V^3 \text{ in watts}$$

ρ- Air density at that particular height and location, (normally 1.225 kg/m3)

A- Swept area by blades

V- Wind velocity in m/s

Table 2. Power output

Sl. No.	Wind velocity (m/s)	Power output (in watts)
1	3	56.9
2	5	256.5
3	7	685.0

The efficiency of the wind turbine can be calculated by the formula

$$Efficiency = \frac{output}{input}$$

Practically, At 3 m/s wind velocity turbine is rotating at 110rpm which accounts for 68.9 watts according to the equation. Hence one can obtain an output of 60-90 watts with an average wind speed of 3-5m/s. The graph given below gives the actual data collected in highway at different wind velocity.

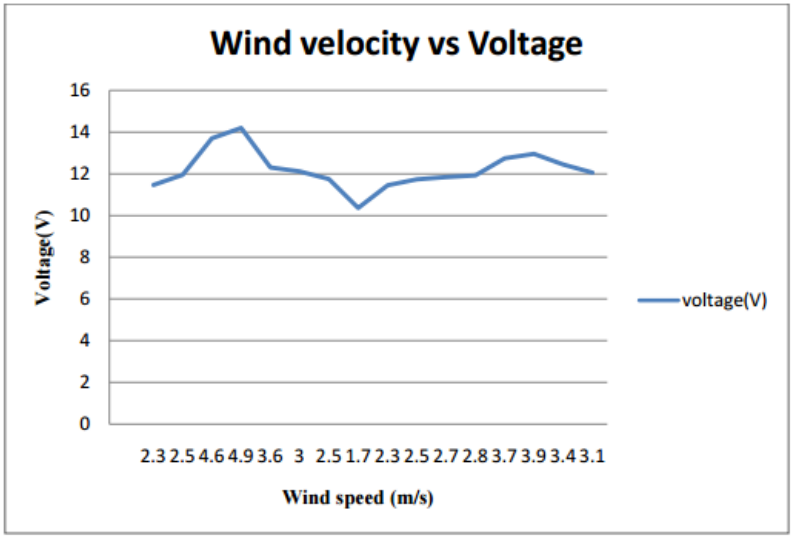

Fig 7. Wind Velocity vs Voltage

5.2 Roller Mechanism

The mean power readings has been taken from our consideration as the vehicle with constant load passes on the setup with different speeds the corresponding current and voltage has been taken and plotted the graph between them which is almost linear.

Sno	Voltage(volts)	current (Amps)	Power(watts)	Vehicle weight
1	4	0.17	0.68	205
2	2	0	0	205
3	0.7	0.05	0.035	205
4	6.3	0.6	3.78	205
5	7.2	0.5	3.6	205
6	4.3	0.3	1.29	205
7	1.4	0.1	0.14	205
8	3.3	0.35	1.15	205
		Mean power	**1.334375**	

Table 3: Mean Power for the vehicle with constant weight

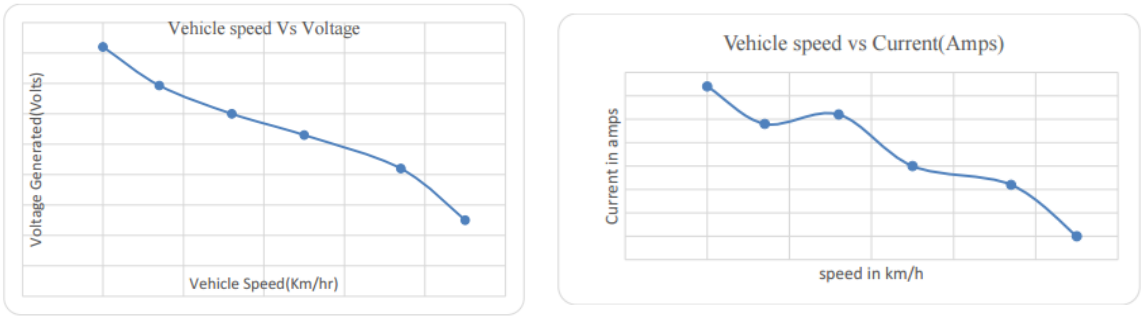

Fig 8. Speed vs Current and Voltage

Table 3. Generation from rollar

Load (Kgs)	Voltage(Volts)	current(Amps)
135	2.3	0.1
205	3.1	0.22
270	4.08	0.31
300	5.5	0.42
440	7.2	0.6
600	8.6	0.74

Fig 9. Load vs Current and Voltage

5.3 Peizoelectic Sensors

Those crystals exhibiting the piezoelectric effect are laid 5 cm below the surface of the road. A vehicle passing down a road way and causes deformation of the road. Every time the vehicle moves over the crystal, the piezoelectric crystal is slightly deformed. Generally all the energy wasted on the piezoelectric crystal deformation is transferred into electricity via piezoelectric generator. It converts the mechanical energy of the road deformation into electricity which is either stored in batteries or connected directly into the grid.

The energy harvested can be supplied road lighting, stoplights, speed sensors, road side hoardings etc. From the figure 9, it is seen that the piezoelectric crystals are embedded in the red marked spots. For example when a truck moves, the deformation is produced and the corresponding potential is produced. This is supplied to the nearby lamps for lighting. It is found that when one vehicle moves for every second, in a road span of 1Km embedded with these piezoelectric crystals, then power of 240.12Kw could be produced. A typical mercury vapor lamp requires around 500W.Hence the energy derived from the piezoelectric crystals will be adequate enough for lighting these lamps on the roadside. The busier the roadway the more energy is produced. Similarly this concept can be installed in pedestrians, Airports, Railway lines etc. The solution harvests the energy wasted during human movement (e.g. walking, driving).The popular indoor locations for such implementation would be major public transportation stations, e.g. shopping malls, entertainment parks etc.

5.4 Voltage Generation by model

Table 4. Model Voltage

S No.	Module	Voltage
1	Peizoelectric	15V DC
2	Roller	3V DC
3	Wind Mill	5V DC

5.5 Final Model

Fig 10. Real picture of Model

5.6 Standards

Generation standards

- Maximum storage in battery : 6V
- Roller generation 3-5 V
- Maximum generation is 15V.

Safety Standards

- No danger of shock.
- Piezoelectric and Vertical Axis wind turbine are water resistant whereas Roller mechanism needs a check time to time because it can get damaged due to rust during rainy season.
- No toxic and sharp objects.
- No external source of power.

5.7 Calculations

Roller Mechanism

The mass of a vehicle moving over the speed breaker=205Kg (Approximately)

Height of speed brake =5cm

Work done=Force x Distance

Force=Weight of the Body

Force=205 Kg x 9.81(gravity)

Force=2011.05 N

Distance travelled by the body = Height of the speed brake=5cm

Output power=Work done/Sec= (2011.05 x 0.05)/60=1.67 Watts (For One pushing force)

Power developed for 1 vehicle passing over the speed Breaker arrangement for one minute= 1.67 watts

Power developed for 60 minutes (1 hr) =100.2 watts

Power developed for 24 hours=2.3 Kw

This power is sufficient to burn four street lights in the roads in the night time

CHAPTER 6

CONCLUSIONS

Piezoelectric

At a time when governments are finding it hard to make land available for new power plants, extracting energy while using the vast spread of highways all over the world seems no less lucrative proposition. However, this idea has not yet gained enough ground among the policy makers even though researchers have shown that energy could be extracted from highways by fitting them with piezoelectric devices, solar panels, wind turbines and other energy generating tools. Future of the world would depend on our ability to create a self-sustaining environment where everything could be put to some use and dependent on each other. The energy generating road designs could become a starting point for a self sustaining future. We thus conclude that this thought will be a revolution in power production and curb down the energy costs thereby improving our country's economy. This energy is produced by consumers' participation without requiring any kind of input energy. Further concentration in the work would result in the better production of energy. We can see a better dimension of this piezoelectric concept in the futuristic world.

Highway Wind Turbines

Our work and the results obtained so far are very encouraging and reinforce the conviction that vertical axis wind energy conversion systems are practical and potentially very contributive to the production of clean renewable electricity from the wind even under less than ideal sitting conditions. It is hoped that they may be constructed used high-strength, low-weight materials for deployment in more developed nations and settings or with recyclable materials and local skills in less developed countries. The Involute wind turbine designed is ideal to be located at the highways medians to generate electricity, powered by wind. The heavy vehicle traffic gives it an advantage for more wind opportunity. With the idea of putting it on highway medians, it will power up street lights and or commercial use. In most cities, highways are a faster route for everyday commute with different places and in need of constant lighting makes this an efficient way to produce electrical energy.

Roller Mechanism

No one is happy with present situation of electricity in India .We need electricity for every small thing , more suitable and compact mechanisms to enhance efficiency. So, our project is

a small step to try to improve this situation and contribute something for the society. Although less electrical output is being generated, the idea of generating electricity from kinetic energy of the moving vehicles has been successfully implemented. If this concept is further developed, it has a high potential.

Future Scope

Piezoelectric

Industrial and manufacturing units are the largest application market, for piezoelectric devices, followed by the automotive industry. There is also high demand from medical instruments as well as information in telecommunication. The global demand for piezoelectric devices was valued at the approximately US$14.8 billion in 2010. The largest material group for piezoelectric device is piezocrystal and piezopolymer due to its low weight and small size. Piezoelectric crystals are now used in buzzer, solar system also. This technique can solve the problem of electricity to road lighting system, and without the need of kilometers of electrical wire which runs along the side of the road. It is more efficient operation techniques with cost effective device. Piezoelectric materials are capable of carrying high load and operating very high frequencies. It requires no maintenance as there are no moving parts. It acts as a capacitor and therefore requires very little power. However, protection of sensitive piezoelectric devices is required against harsh weather condition, and strong electric fields (200-500V/mm) can break down dipoles and depolarize a piezoelectric material.

Highway wind Turbines

An economical, small scale Vertical Axis Wind Involute Turbine is fabricated using aluminum sheet and mild steel materials etc. From test results of Vertical Axis Wind Turbine over a wide range of wind speeds, it is noted that this turbine produces 40 watts for a wind speed of 3-3.5 m/s and which can be even increased by following measures.

- Optimizing the design of blades so as to give better aerodynamics.
- Using a best alternator which produces more voltage for low rpm.
- Using gear mechanisms to increase rpm for alternator input and hence can have higher power output.
- Structural fabrication should be more accurate in order to have proper functions of windmill.
- Using fixed base system to reduce the weight of the whole system.

Roller Mechanism

The rollers which are used in this project can be designed for heavy vehicles, thus increasing input torque and ultimately output of generator can also be increased by using the multiple transmission system which is more efficient method for generating electricity.

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