DESIGN A SOLAR POWERED CLEAN CAR

A REPORT SUBMITTED TO DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING OF BRAC UNIVERSITY

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Abstract

Prior to year 2000, most vehicles in Bangladesh were used to run on petroleum. Though we have to import it and in international market the demand of petroleum oil is always higher than the supply and that's why it is always expensive. In this case if we use solar based electric vehicle which is driven by electric motor that is much more cost efficient. But the problem is the solar panel cannot supply the whole power that is needed to run the motor. So in the project we use additional battery which combinedly supplies power to motor. So that our design can be said as hybrid solar car. To develop our idea we will find out the external area of a car that where we can fix the solar panel, designing a new vehicle, working on battery charger, voltage and motor controller Above all we will try to design and implement a cost effective hybrid solar car which will be pollution and noise free.

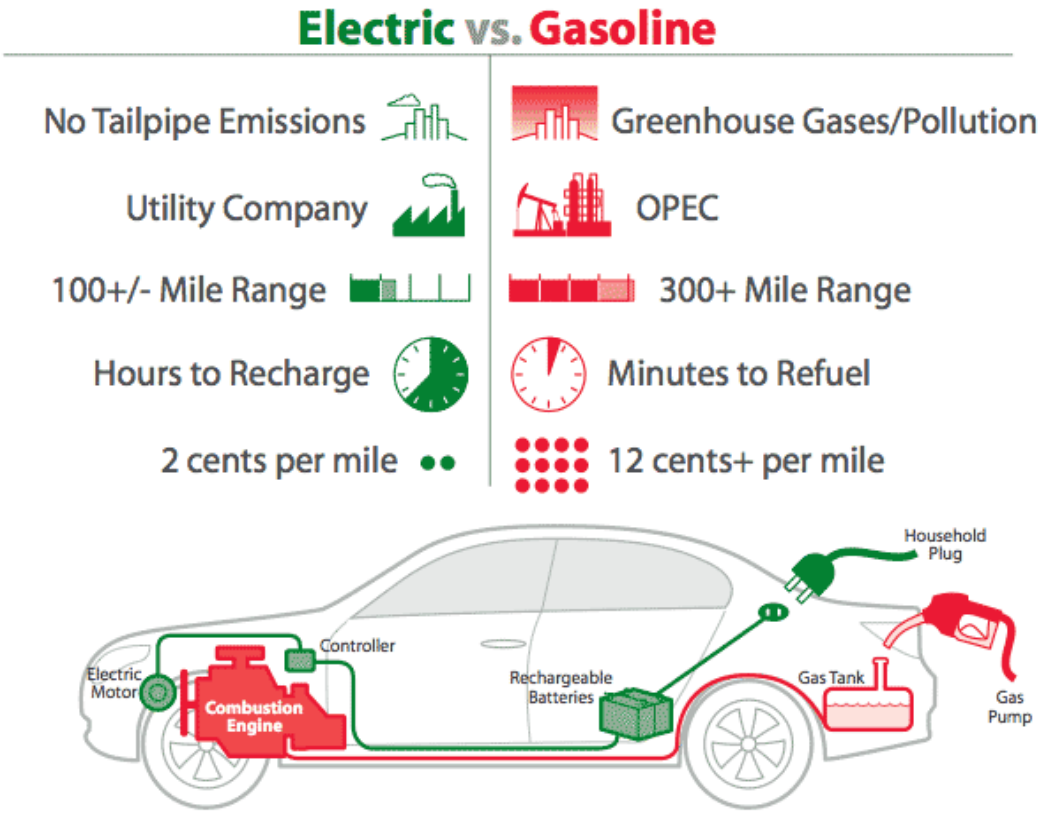
INTRODUCTION

1.1 FUEL PROBLEM IN BANGLADESH

Prior to year 2000, most vehicles in Bangladesh were used to run on petroleum. Petroleum oil is not a natural resource of Bangladesh, so that each year we have to import it. In international market the demand of petroleum oil is always higher than the supply and that's why it is always expensive. Though Bangladesh government subsidies petroleum oil, but because of increasing the price of petroleum oil in world market, the price of petroleum in our country is increasing day by day. An alternative solution of this problem was found in 2000 and CNG automobiles were launched in Bangladesh which are run in natural gas. But the reserve of natural gas of Bangladesh is not high enough as well as new mine is not discovered and using natural gas in power plants this alternative solution is in danger.

1.2 ELECTRIC VEHICLE

An electric vehicle is powered by an electric motor where there is petrol/diesel engines are used in gasoline vehicle. They have only half the initial cost of a gasoline vehicle. The power of electric vehicle is less than gasoline vehicle. But it is impossible to find out the difference among them while driving. While gasoline vehicle have a heavy noise and pollute the air, electric vehicle are smooth and silent and also have on pollution emits while driving. The idea of electric vehicle is new. The components of an electric vehicle are DC electric motors, Electric controller, Battery tray, 12V Lead acid batteries, Battery Charger and Many motors for driving smaller parts. Because of fuel problem in Bangladesh introducing electric vehicle is to reduce the pressure on fuel and our environment will be good enough. There is a comparison is given below to realize how much better an electric vehicle in comparison with gasoline vehicle.



1.3 POWER SHORTAGE PROBLEMS IN BANGLADESH

Bangladesh is facing electricity shortage problem for many years and this problem in increased in last few years and exceeded the general people's patient. Geographically Bangladesh is located in tropical region so that except few month of the year, most of the part of the year is summer and it is a sunny day in morning. The temperature is rises up to 40 degree Celsius and it is unbearable to stay without electricity. Electricity is one of the major demands in all aspects of our life though we cannot ensure 24 hours electricity supply. Almost of the whole year we are facing load shedding problem and it is unbearable in summer. Power Development Board (PDB) sources informed that the officially estimated power demand is now 5000MW against a generation of around 3500 MW.

So in this type of circumstances it is not that much an effective idea to introduce electric vehicle in Bangladesh.

1.4 RENEWABLE ENERGY TO FIGHT AGAINST FUEL PROBLEM

Renewable energy comes from natural resources such as sunlight, wind, tides, rain and geothermal heat, which are all renewable. These energies are derived from natural processes that are restored constantly. Electrical energy is derived from solar, wind, ocean, hydropower, biomass, geothermal resources, bio-fuels and hydrogen. If we can use renewable energy to produce power for electric vehicle then it has no bad impact on our power shortage problem and as well as we reduce the pressure on using fuel.

1.5 SOLAR POWER IS THE BEST AS RENEWABLE ENERGY

Solar energy is the most effective energy supply for electric vehicle in comparing with other renewable energy source. Other source of renewable energy cannot be used in electric vehicle. The body frame of the vehicle can be used as solar plate from where the vehicle can get the total power. Bangladesh is situated between 20.30 - 26.38 degrees north and 88.04 - 92.44 degrees east which is an ideal location for solar energy utilization. Here solar radiation varies between 4 to 6.5 kWh per square meter and maximum amount of radiation is available in summer. So for Bangladesh electric vehicle using solar power is most effective.

1.6 SOLAR POWER CAR

A solar vehicle is an electric vehicle powered by solar electricity. This is obtained from solar panels on the surface (generally, the top or window) of the vehicle or using a solar jacket in electric bicycles. Photovoltaic (PV) cells convert the sun’s energy directly into electrical energy.

Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However indirectly solar-charged vehicles are widespread and solar boats are available commercially.

Solar cars combine technology typically used in the aerospace, bicycle, alternative energy and automotive industries. The design of a solar vehicle is severely limited by the amount of energy input into the car. Most solar cars have been built for the purpose of solar car races. Exceptions include solar-powered cars and utility vehicles.

Solar cars are often fitted with gauges as seen in conventional cars. In order to keep the car running smoothly, the driver must keep an eye on these gauges to spot possible problems. Cars without gauges almost always feature wireless telemetry, which allows the driver's team to monitor the car's energy consumption, solar energy capture and other parameters and free the driver to concentrate on driving.

Solar cars depend on PV cells to convert sunlight into electricity. In fact, 51% of sunlight actually enters the Earth's atmosphere. Unlike solar thermal energy which converts solar energy to heat for either household purposes, industrial purposes or to be converted to electricity, PV cells directly convert sunlight into electricity. When sunlight (photons) strikes PV cells, they excite electrons and allow them to flow, creating an electrical current. PV cells are made of semiconductor materials such as silicon and alloys of indium, gallium and nitrogen. Silicon is the most common material used and has an efficiency rate of 15-20%. Of late, several consulting companies, such as Phoenix Snider Power, have started offering technical and financial services to institutes and teams developing solar cars worldwide.

1.7 WHY DO NOT DESIGN SOLAR POWER CAR

In our country most of the cars are imported from Japan and they are oil running vehicle. To reduce the cost of maintenance most users converts them into CNG running car. If we think about a common model of car like TOYOTA COROLLA it has 1496cc engine with front wheel drive VVT-i engine with a top speed of 180 km/h. It has a horse power of 110. If we convert the horse power into watt we get 82.06kw. Now the problem is if we want to design an equivalent car which has same horse power then we cannot get that much power from the solar panel, so that we have to supply the extra power from external battery. Then the total vehicle is no more a solar power car. Then that is shifted to a combined supply solar car. That's why we are trying to design a combined supply solar car.

POLLUTION IN DHAKA CITY CALCULATION

Pollution in Dhaka city is increasing day by day due to increasing industrial unit as well as motor vehicles. Motor vehicles especially private vehicles are increasing weirdly day by day and because of these private vehicle traffic jam and pollution is increasing. Most of the private vehicles in Dhaka city are reconditioned and they emits excessive amount of hydrocarbons and as well as particle materials.

2.1 PEAK HOUR CAR LOAD CALCULATION

In Bangladesh the traffic load is increasing day by day. But the traffic load is not same at all time. At morning from 8:00 a.m. to 11 a.m. and at evening from 4:00 p.m. to 8 p.m. the load of vehicles in the road is much higher than the any other time. This is considering as peak hour for vehicles passing. For calculating car load in the Dhaka city we choose top four vehicle crossing point of Dhaka city as Mohakhali, Moghbazar, Shahbag and Firmgate. Here we take the data of passing car in a minute and take three data likewise then find out the average and how much car is passing in an hour at the peak hour.

The following table is shown the peak hour car (private vehicle) load in Dhaka city.

AREA	ROAD	CAR PASSES/min			AVG. CAR PASSES/min	TOTAL AVG. CAR PASSES/min	AVG. CAR PASSES/hour
		1	*2*	*3*			
MOHAKHALI 10.02.2011 (10:10 a.m.)	Nabisco – Mohakhali – Banani	40	37	45	41	177	10620
	Banani – Mohakhali	57	55	40	51		
	Jahangir Gate – Mohakhali	30	26	23	26		
	Flyover (in / out)	30 + 34	23 + 26	32 + 33	59		
FIRMGATE 06.02.2011 (4 p.m.)	Bijoy Soroni – Firmgate	39	41	36	39	120	7200
	Firmgate – Bijoy Soroni	47	42	44	44		
	Khamar Bari – Firmgate	29	35	45	37		
SHAHBAG 06.02.2011 (4:30 p.m.)	Bangla Motor – Shahbag	50	57	55	54	167	10020
	TSC – Shahbag	30	40	40	37		
	Shisu Park – Katabon / Katabon – Shisu Park	43 + 32	44 + 36	30 + 42	76		
MOGBAZAR 06.02.2011 (6:30 p.m.)	Ramna Thana – Mogbazar	44	35	46	42	126	7560
	Mogbazar Rail Crossing – Mogbazar	36	35	36	36		
	Bangla Motor – Mogbazar	19	16	24	20		
	Mogbazar – Bangla Motor	27	28	28	28		

2.2 AVERAGE MILEAGE AND ODOMETER READING OF CAR IN DHAKA CITY

Most of the cars in Bangladesh are imported as reconditioned. Only very few are brand new. Because of this reason total mileage of these private vehicles are so large. The odometer reading shows the total mileage of a vehicle and then we find out the average mileage of these vehicles per year to calculate the polluting element that the vehicles emit.

The table given below is shown the average mileage and odometer reading of some private vehicles.

LICENCE NO. (DHAKA METRO)	ODOMETER READING	MILEAGE/PER DAY	MILEAGE/PER YEAR	AVG. ODOMETER READING	AVG. MILEAGE/PER YEAR
GA-141768	193493	25	09125	107756	12830
GA-172882	215415	31	11315		
KHA-127582	065711	10	03650		
THA-116534	141274	25	09125		
KHA-121453	143099	50	18250		
GHA-173969	200254	40	14600		
BHA-111277	044280	44	16060		
GHA-217835	063898	37	13505		
THA-116903	099027	40	14600		
GA-149855	001964	06	02190		
GA-177239	118741	37	13505		
CA-118523	169707	62	22630		
GA-276263	070030	31	11315		
CA-533780	054299	25	09125		
KHA-111705	123375	22	08030		
GA-148118	090037	40	09125		
GA-293227	033972	07	02555		
CA-515081	221099	68	24820		
GA-258881	054589	50	18250		
KHA-123812	050851	68	24820		

2.3 TOTAL AMOUNT OF POLLUTION A CAR GENERATES EACH YEAR

In developed countries there are safe pollution standard for all types of public and private vehicles. Vehicle cannot run in the road if it fails in the test. But in our country there is no safe pollution limits as well as most of the vehicles are reconditioned. For limitation of equipments we are taking help of the websites and from where find out the pollution that a car generates each year.

The table below is shown the total amount of pollution a car generates each year.

Non Methane Hydrocarbons (NMH) (kilograms)	Carbon Monoxide (CO) (kilograms)	Oxides of Nitrogen (NOx) (kilograms)	Particulate Matter (PM) (kilograms)
3.9773	53.886	7.698	1.0264000000000002

Assuming a car is in the road on average 2.5 hours per day and 300 days in year it is in the road. So pollution per hour by a car

Non Methane Hydrocarbons (NMH) (grams)	Carbon Monoxide (CO) (grams)	Oxides of Nitrogen (NOx) (grams)	Particulate Matter (PM) (grams)
5.303	71.85	10.264	1.3685

2.4 POLLUTION ON TOP POINT OF DHAKA (PEAK HOUR)

At peak hour which is considering from morning 8:00 a.m. to 11 a.m. and at evening 4:00 p.m. to 8 p.m. the rush of the vehicles is huge then any other time. The pollution in the top vehicle crossing point of Dhaka city in this time is shown below

AREA	POLLUTION PER HOUR			
	Non Methane Hydrocarbons (NMH) (kilograms)	Carbon Monoxide (CO) (kilograms)	Oxides of Nitrogen (NOx) (kilograms)	Particulate Matter (PM) (kilograms)
MOHAKHALI	56.31786	763.047	109.00368	14.53347
FIRMGATE	38.1816	517.32	73.9008	9.8532
SHAHBAG	53.13606	719.937	102.84528	13.71237
MOGBAZAR	40.09068	543.186	77.59584	10.34586

2.5 COMPARISON WITH THE SAFE POLLUTION LIMIT OF DEVELOPED COUNTRIES

In developed countries the safe pollution limits are pre-defined for each vehicle and each of the vehicles has to be passed in the test to run in the road. The polluting element emitted by a car in Dhaka city is huge in comparison with any other developed countries especially U.S.A. and European Union. The comparison is given below where considering only standard for petrol/gasoline private vehicle.

	BANGLADESH (DHAKA)	USA (CALIFORNIA) (Tier 1 emission standard)	EUROPEAN UNION (Tier: Euro 5)
Non Methane Hydrocarbons (NMH) (kilograms)	3.9773	3.1	1.1
Carbon Monoxide (CO) (kilograms)	53.886	42	16.1
Oxides of Nitrogen (NOx) (kilograms)	7.698	6	.97
Particulate Matter (PM) (kilograms)	1.3685	1	.08

2.6 EXCEEDING NOISE POLLUTION

Sound pollution is another threat increasing excessively. Noise can be defined as the level of sound which exceeds the acceptable level and creates annoyance. Dhaka city is being exposed to high level of pollution and one of the major sources of pollution is motorization. Among the motor vehicle of Dhaka city 70% of them are private vehicle such as car. The sound of the engine and using the hydraulic horn are the main cause of noise pollution from the private vehicle perspective.

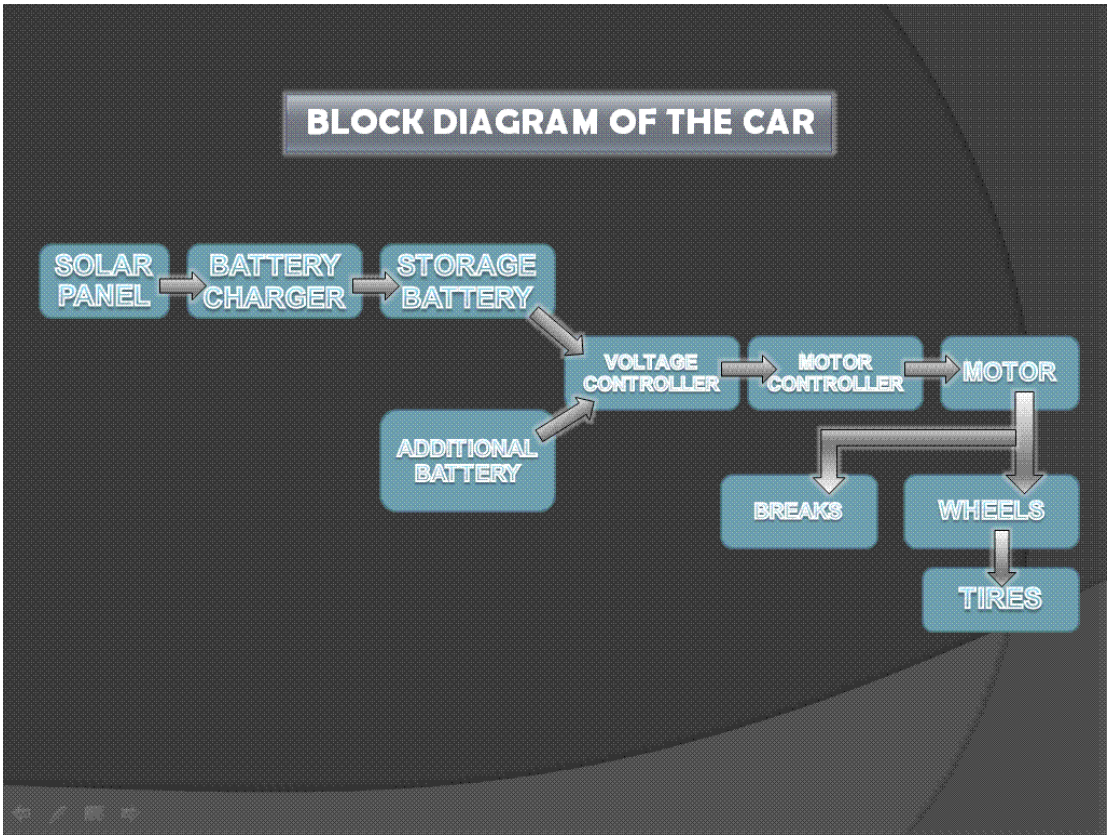
DESIGN OF THE CAR

3.1 STUDY ABOUT THE ELECTRIC VEHICLES IN BANGLADESH

In Bangladesh small electric vehicles are running as public transport. Normally these vehicles are running for a short distance such as local rickshaw. Some of the places these transports are used as substitute of rickshaw and are popular day by day because of much passenger can travel by it at a time in compare with rickshaw and most significant thing is no fuel cost is needed, just recharge the internal battery one or two times a day. There are two types of electric vehicle are running on the road, one is smaller and other is a bit big. There are four 12 volt 120AH Lead acid batteries are used in smaller vehicle and five same batteries are used in large vehicle. There is a 1500 watt brushless motor in each vehicle and the maximum speed of these vehicles is 35km/h and daily the batteries have to be charge at least 8-10 hours.

3.2 BLOCK DIAGRAM OF THE CAR

To design the combined supply solar car we take some idea from the electric vehicle running on Dhaka city. There would be a lot of components in our car such as Solar panel covered the whole body of the car, Battery Charger, to storage the solar power there are 12V Lead acid batteries with 120AH connected with the solar panel, extra 12V Lead acid batteries with 120AH for supplying the supplementary power, Battery tray, DC electric motors of 1500 watt, Voltage and Motor controller, and Many motors for driving smaller parts etc. The total components are shown below in the block diagram.



3.3 PHOTOVOLTAIC PANELS

A Photovoltaic (PV) panel another name is solar panel consists of so many PV cells wired in parallel to increase current and in series to produce a higher voltage. The module is encapsulated with tempered glass (or some other transparent material) on the front surface, and with a protective and waterproof material on the back surface. The edges are sealed for weatherproofing, and there is often an aluminum frame holding everything together in a mountable unit. In the back of the module there is a junction box, or wire leads, providing electrical connections. 36 cell modules are the industry standard for large power production.

3.3.1 TYPES OF PHOTOVOLTAIC PANELS:

- **Mono crystalline silicon**

This is the most oldest and expensive type of photovoltaic panel. But right now, it is the most efficient types of solar panels. In other words, when sunlight hits these photovoltaic cells, more of it turns into electricity than the other types below. This is more expensive because their high silicon content and this type of solar panel is best for the roof. The efficiency of this panel on averages 10% to 12%.

- **Poly crystalline silicon**

"Poly" panels have lower silicon levels than "mono" panels. So that it makes them less expensive to produce, but they're also slightly less efficient. But because of construction design it is not that much less efficient and it is also good for roofs. The efficiency of it on averages 10% to 11%.

- **String Ribbon**

This is a refinement of polycrystalline production; there is less work in production so costs are even lower. Module efficiency averages 7% to 8%.

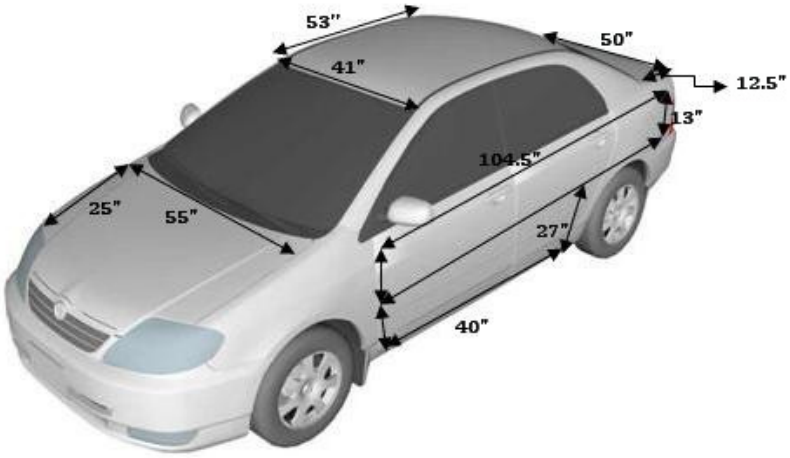
- **Thin film (amorphous silicon, cadmium telluride, copper indium gallium (di) selenide)**

Thin film is the most inexpensive material using in solar panel and because of this thin film these are the cheapest panels in the world. Another advantage of the panel is it produces almost no heat and that's why it is so cool. But still now it is very inefficient, which means its efficiency averages 5% to 7%.

3.4 REAL VEHICLE OUTSIDE AREA SURVEY

At the beginning of the project we have to calculate several cars' possible outside area to fix solar panel to get highest amount of energy from sun. Because of it we calculate several cars' possible outside area for making decision which solar panel would be use and where to use. The outside area calculation of the cars is given below.

Toyota Corolla G:



Hood= 55"*25" =1375 inch²
≈ 1350 inch²

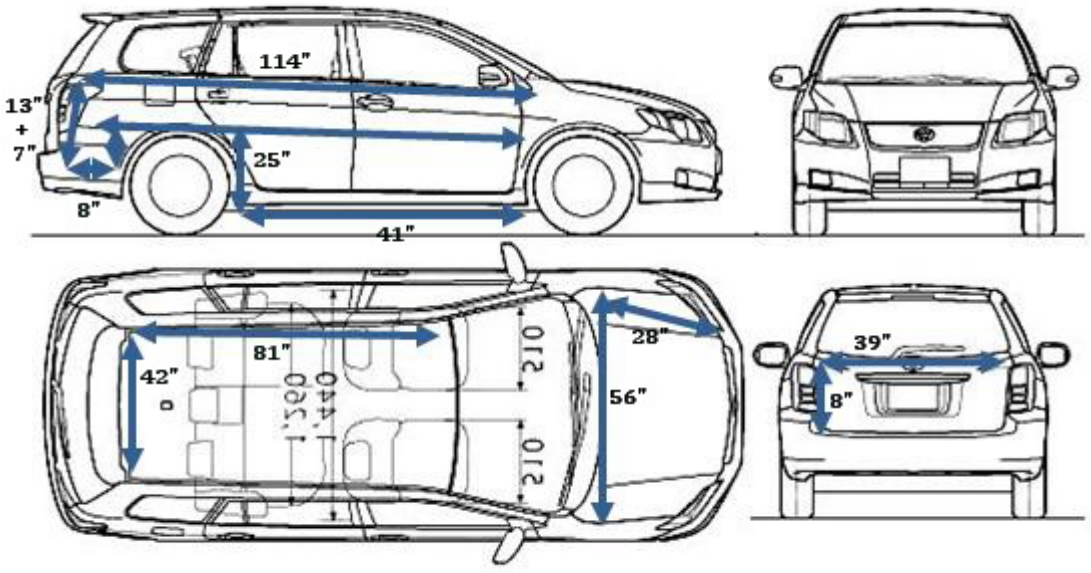
Roof= 41"*53" =2173 inch²
≈ 2150 inch²

Back= 50"*12.5" =625 inch²
≈ 600 inch²

One side= (40"*27") + (104.5"*13") =2438.5 inch²
≈ 2400 inch²

So total area for the car to use solar panel is ≈ (1350+2150+600+2400*2) inch²
≈ 8900 inch²

Toyota Corolla Fielder:



Hood= 56”*28” = 1568 inch²
≈ 1550 inch²

Roof= 81”*42” = 3402 inch²
≈ 3380 inch²

Back= 39”*8” = 312 inch²
≈ 300 inch²

One side= (114”*13”) + (41”*25”) + (7”*8”) = 2563 inch²
≈ 2545 inch²

So total area for the car to use solar panel is ≈ (1550+3380+300+2545*2) inch²
≈ 10320 inch²

3.5 SELECTING OF SOLAR PANEL

Mono crystalline and polycrystalline panels' efficiency is very high but these are much expensive. But we are always concern about cost efficient design. As we are designing a system which runs the whole vehicle with solar energy so our supply to battery should large and from the real vehicle study we don't get much space for implementing solar panel. In this circumstances considering the facts we have decided to use polycrystalline, which will not be too costly but efficient.

3.6 BATTERY

Battery is another significant part of our design. In our design there is a battery connected with charger to solar panel and a supplementary battery to supply the extra power to motor. These devices are store the DC energy from PV panel in chemical form, and when needed converts the stored chemical energy to electrical energy.

3.6.1 SOLAR SYSTEM BATTERY:

In solar system batteries are charged and discharged randomly. Life time of battery is depends on charging and discharging of battery. The charging capacity of the battery measured with Amp-hour. Battery ratings are depended according to cycle. In vehicle there is used shallow cycle battery which means battery have cycles between 10% - 15% of batteries total capacity. But in solar system there is used deep cycle batteries which have up to 50% - 80% of total battery's capacity. This type of battery is best for solar project.

3.6.2 AVAILABLE TYPES OF BATTERIES:

There are many variety of batteries found in the market but only four types of batteries are usually used in solar system.

- **Marine type deep cycle battery**

Marine type deep cycle battery is basically used in boats and camps where small load is used to get powered. These types of batteries do not have capacity for continuous service with charger or discharger.

- **Lead- acid battery**

Lead acid batteries can be used in solar energy storage. These types of batteries are deep cycled and have long life time for charging and discharging. Typical life time of lead- acid batteries is 3- 5 years. Life time of Battery actually depends on the charging and discharging cycle. Lead acid batteries releases some gas while charging. That's why these batteries are needed to be kept outside or cross ventilated place, where air circulation is good enough.

- **AGM battery**

The full meaning of AGM battery is absorbed glass material battery. It allows the electrolyte to be suspended in close proximity with the plate's active material. The AGM batteries are expensive batteries and typically cost twice as much as a premium wet cell battery. However they store very well and do not tend to sulfate or degrade as easily as wet cell. There is little chance of a hydrogen gas explosion or corrosion when using these batteries. The larger AGM batteries are typically good deep cycle batteries and they deliver their best life performance if recharged before allowed to drop below the 50% discharge rate. When Deep Cycle AGM batteries are discharged to a rate of no less than 60% the cycle life will be 300. AGM batteries are used in airplanes and hospitals where large charging time is needed.

- **Gel battery**

Gel Cell battery is similar to the AGM battery because the electrolyte is suspended, but different because technically the AGM battery is still considered to be a wet cell. The electrolyte in a Gel Cell has a silica additive that causes it to set up or stiffen. The recharge voltage on this type of cell is lower than the other styles of lead acid battery. This is probably the most sensitive cell in terms of adverse reactions to over-voltage charging. Gel Batteries are best used in VERY DEEP cycle application and may last a bit longer in hot weather applications. If the incorrect battery charger is used on a Gel Cell battery poor performance and premature failure is certain.

3.6.3 DC BATTERY SELECTION:

Among the four types of battery all are not suitable for solar system and some are much expensive. So, for selecting a type of battery for a solar driven vehicle like ours, we always have to concern about less expensive, comparatively light in weight and high energy supply and consumed battery. Considering the economic factor and availability in our country we will be using Lead acid batteries, which are being widely used as a solar system storage device. These batteries are comparatively cheap, efficient in power storing and have a life time of 3 – 5 years. Though these types of batteries release some hydrogen gas while charging and needs some

maintenance but still for large solar energy storage system lead acid battery is very popular. In our project we use two 12v-120Ah lead acid batteries.

3.7 MOTOR

Motors used in Electric cars most of them are DC motors. The major reasons of using DC motor are these motors are cheap and the making procedure of controller for DC motor is simple than AC motor.

There are 2 main types of DC Motors used in Electric Cars. One is Brushed DC Motors and another is Brushless DC Motors (BLDC Motors).

- **Brushed DC Motors**

The brushed DC electric motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary magnets, and rotating electrical magnets. Advantages of this motor are low initial cost, high reliability, and simple control of motor speed and disadvantages are high maintenance and low life-span for high intensity uses.

- **Brushless DC Motors (BLDC Motors)**

Brushless DC motors use a rotating permanent magnet or soft magnetic core in the rotor, and stationary electrical magnets on the motor housing. A motor controller converts DC to AC. This design is simpler than that of brushed motors because it eliminates the complication of transferring power from outside the motor to the spinning rotor. Advantages of brushless motors include long life span, little or no maintenance, and high efficiency. Disadvantages include high initial cost, and more complicated motor speed controllers.

3.7.1 MOTOR SELECTION:

As our greatest concern on designing a cost effective solar car, among the two types of DC motor Brushless DC motor is most suitable for us because of its long life span, almost zero maintenance cost and high efficiency. Motor that is used in the project would be 800 watt Brushless DC motor.

3.8 CHALLENGES OF IMPLEMENTATION OF SOLAR PANEL

From the beginning of our project work we are focused on decreasing pressure on petroleum oil as well as not introducing electric vehicle because it will create an extra load to our national greed. To introduce solar driven vehicle we face three major problems and these are supplying power at night, charging solar panel in bad weather condition and most significant is not getting sufficient amount of energy from solar panel. These prime challenges coming in our way are described briefly here.

- **Power supply at night**

The greatest problem with a solar panel is it cannot supply power if there is no sun ray falling on the solar cells. So if anyone wants power supply from solar panel when there is no sun light he must have storage the extra energy to another device (battery) attached to the system. Two batteries continuously store the electric energy coming from the solar cells and supply that energy to load when required. So the system will have to have two batteries connected with solar panel to ensure constant power supply in the motor.

- **Charging at night and bad weather condition**

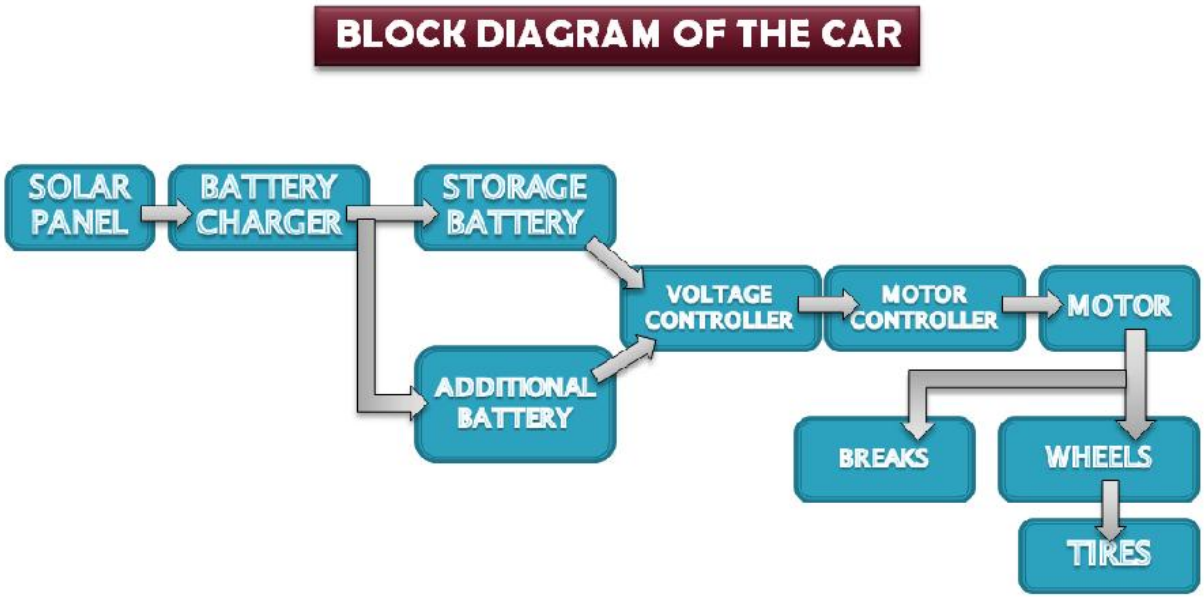
Bangladesh is the country of heavy clouds for several consecutive days in rainy seasons. This cloudy condition may harm to produce sufficient amount of energy to run the vehicle. So that on that time both the batteries cannot charged fully and supply energy to motor.

- **Solar panel cannot supply whole day' energy**

The motor used in the vehicle need high amount of power whole the day but the outer space of the vehicle covered by solar panel is not supply that amount of power constantly because it store energy to battery in a low rate and not all the time sunlight hit the solar panel in same way. So connecting both batteries with solar panel is ideal because when one battery is in full charge then other battery will store energy from solar panel.

3.9 CHANGES ON BLOCK DIAGRAM

To use the solar panel more effective and make the design more successful we re-design our block diagram where the supplementary battery will get energy from solar panel when the original battery will fully charged.

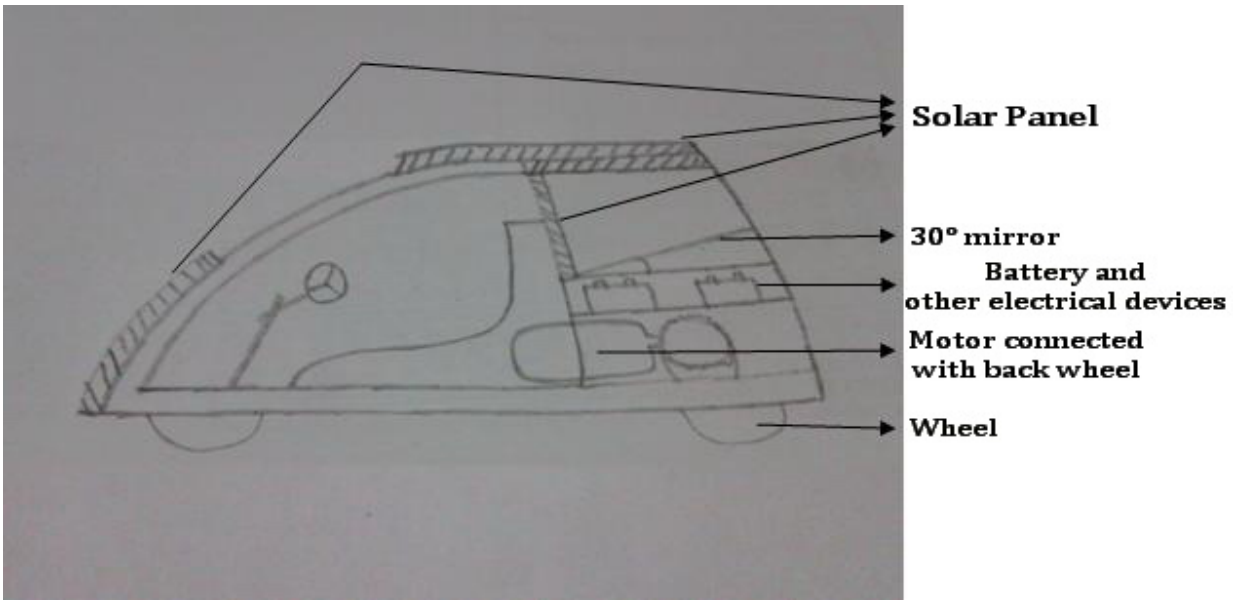


NEW BLOCK DIAGRAM

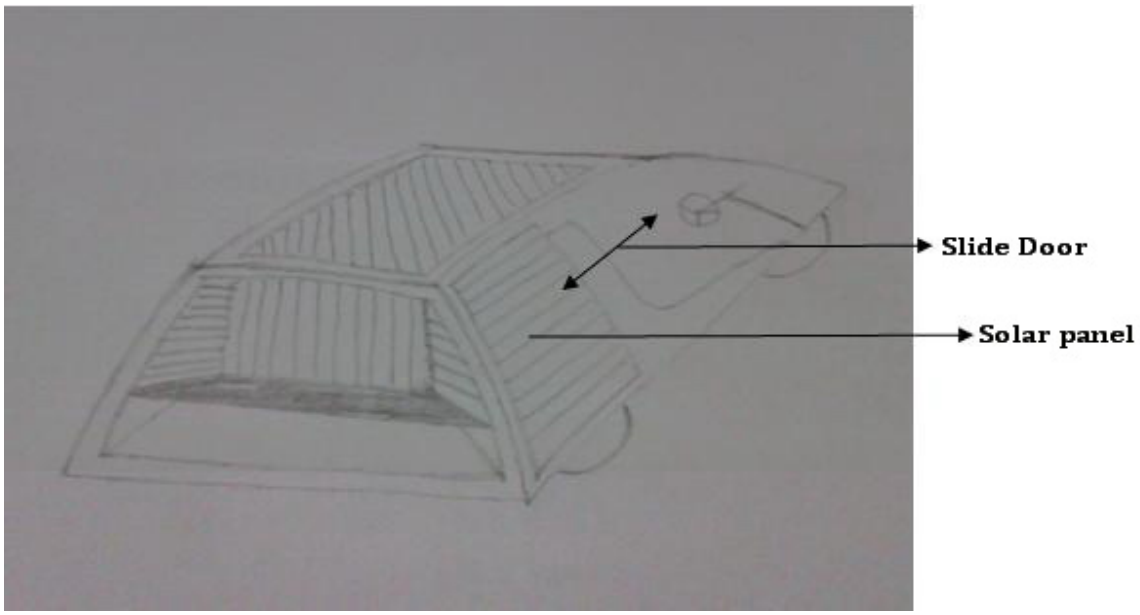
3.10 DESIGNING THE CAR

The designing of the car is the most significant part of this project. To design the car always considered that the highest amount of open space of the car will cover by solar panel which will absorbed the sunlight to supply energy to battery. Using mirror in 30° in backside and designing

sliding door covered by solar panel to get much energy from the pane. The car is too light that it will not create any extra load to the motor. Under the mirror there is a box casing for the batteries and the other electrical devices. The motor is connected with the wheel with pinion and chain mechanism. There is a push able switch near driver's foot to start the vehicle and a push able breaking system connected with the front wheel to break the vehicle.



Design of the Car (Side View)



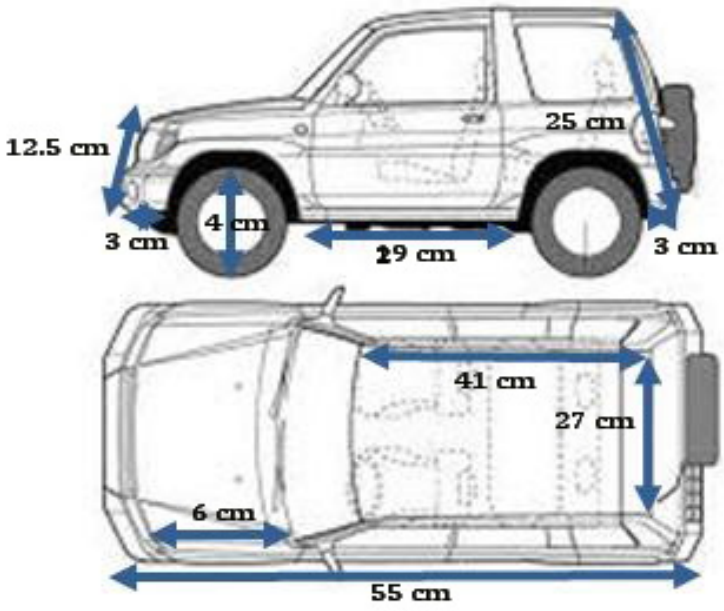
Design of the Car (Back View)

Because of high cost of implementing the solar powered car we will design a small prototype where almost all the mechanism of the designing car will use.

IMPLEMENTATION OF SMALL MODEL

4.1 DESIGNING OF SMALL PROTOTYPE

Implementation of solar driven vehicle is always slightly expensive because of the high expense of the materials used in that vehicle. To minimize the cost, under this project work we try to implement a small prototype of our actual design. But to minimize outdoor design complication we just design a small jeep shape vehicle where we will implement all internal design from our actual design.



Prototype model and measurement

According to the prototype design there is an ample amount of roof space in the design to implement solar panel and in behind the driver there is a good number of space for the motor mechanism and implement other devices with batteries. Total length of the prototype is almost 55 centimeters which has 41 centimeters length of roof and 27 centimeters of its width. The height of the jeep is 25 centimeters without considering the wheels and the hood of it near about

6 centimeters. Diameter of the wheels using in this prototype is 4 centimeters. Size of the solar panel is using in this prototype as almost 11 inches of long and 10 inches of width. Its voltage and current ratings are 18 volts - 0.56 amps with 10 watt.

4.2 MOTOR AND BATTERY SELECTION FOR PROTOTYPE

- **Motor**

According to our real design we would use Brushless DC Motor. But our vehicle is small and it is much heavy because of its steel structure and other battery and electrical components. So that, we use a brushed DC motor named gear-motor to run this vehicle. "Gear head" or "gear motor" and has the advantage of having lots of torque and with some scientific experiments it is found that at 12 volts, on high speed, the motor has 13.5 pound-feet and on low speed, has 17.5 pound-feet of torque.

In our project we used a small gear-head motor generally used in wiper mechanism of vehicles. The standard voltage requirement for the wiper motor is 12 volts DC. The electrical system in a running automobile usually puts out between 13 and 13.5 volts, so it's safe to say the motor can handle up to 13.5 volts with no problem. It wouldn't recommend any voltages higher than that. The minimum required current for the motor is 1.6 amps at 70 rpm, 0.9 amps at 41 rpm. These current ratings are for the motor spinning with no load. As we add mechanical load, these numbers can increase dramatically, doubling or even tripling under a heavy load. This factor must be taken into account when selecting a power supply. Since the motor will only use what it needs when it comes to current, it's best to provide a source with a higher current rating than it might need. It would require a 5 amps or greater supply to handle most circumstances.

Finally, the rating of the motor used in the project is 12 volts- 2 amps with 60 rpm.

- **Battery**

Battery use in real design will be lead- acid battery and these batteries are heavy in weight. As well as our vehicle is small but heavy because of its steel structure and other electrical components. So, to reduce its weight we used some Li-ion battery in replace of lead- acid battery. After implementing the Li-ion battery the weight of the vehicle reduce significantly.

The rating of the battery used in this vehicle is 3.7 volts -2400mAmps.

We use three batteries in series in replace of one lead- acid battery and in project six batteries are used in total.

4.3 CHARGE CONTROLLER

Constantly solar power systems will need a charge controller. The purpose of this is to ensure that the battery is never overcharged, by diverting power away from it once it is fully charged. Only if a very small solar panel such as a battery saver is used to charge a large battery is it possible to do without a controller. Most charge controllers also incorporate a low-voltage disconnect function, which prevents the battery from being damaged by being completely discharged. It does this by switching off any DC appliances when the battery voltage falls dangerously low.

Solar charge controllers are specified by the system voltage they are designed to operate on and the maximum current they can handle. The system voltage is usually 12 or 24 Volts, or occasionally 48 Volts. The maximum current is determined by the number and size of solar panels used.

A single panel would need a controller of between 4 and 6 Amps rating, while larger arrays may need controllers of 40 Amps or more. Different settings are needed if sealed batteries are used to prevent the loss of electrolyte through gassing.

In our project we use an analog charge controller which supplies sufficient energy from solar panel to Li-ion battery.

4.4 CHARGE CONTROLLER WORKING PRINCIPLE

The principle behind a solar charge controller is simple. There is a circuit to measure the battery voltage, which operates a switch to divert power away from the battery when it is fully charged. Because solar cells are not damaged by being short or open-circuits, either of these methods can be used to stop power reaching the battery.

A controller which short-circuits the panel is known as a shunt regulator, and that which opens the circuit as a series regulator. Optionally there may also be a switch which automatically disconnects the power from the appliances or loads when the battery voltage falls dangerously low. This is known as a low-voltage disconnects function.

4.5 CONTROL OF THE CAR

Controlling mechanism of the vehicle and increase the speed of vehicle is another significant part of this project. To increase the speed of the motor we implementing gear train ratio and for control system of the car we design simple steering mechanism, develop starting the car and breaking system and front and reverse driving system.

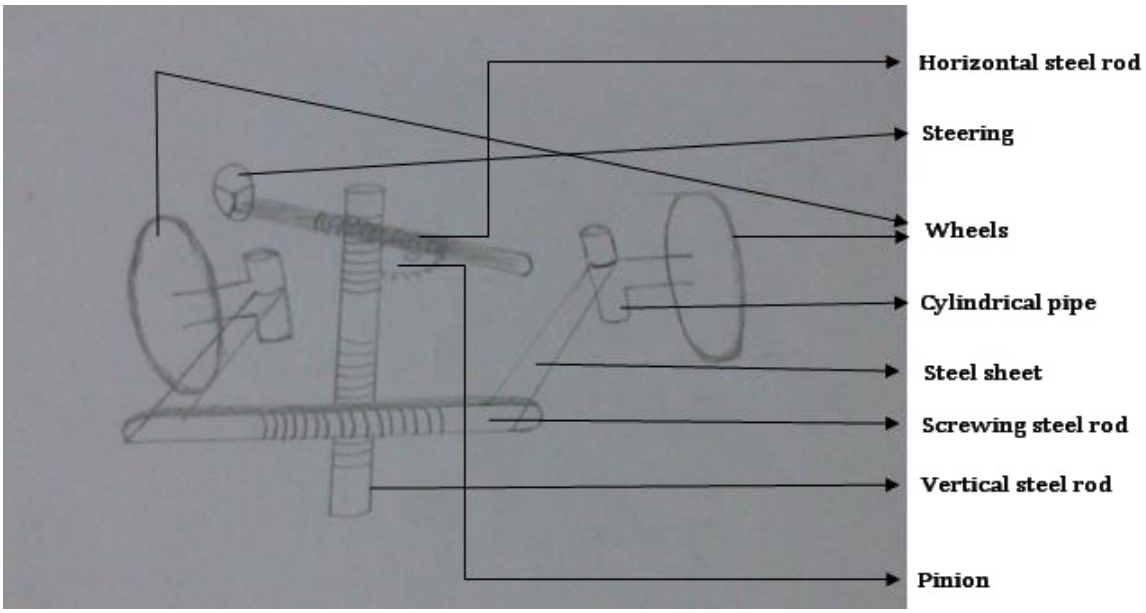
4.5.1 Implementing gear train ratio:

The motor using in this prototype is a small gear-head DC motor and its rotation per minute (RPM) is 60 which is less than other DC motors and wheel diameter is 4 centimeters. If this motor directly connected with wheels then the car runs per hour is over 452 meters. The speed is too low for a vehicle. So we implement gear train ratio, means the motor is connected with large pinion and the back wheels are connected with a small free ball and this pinion and free ball is connected with a flexible chain. The diameter of the pinion is 17 centimeters and free ball is 5.5 centimeters. So the pinion is over three times greater than the free ball and when pinion rotates for a single turn then consequently the free ball rotates three times which means when motor rotates for a single turn then the vehicle runs three times then the previous. After implementing gear train ratio car runs per hour is over 1.39 kilo-meters.

Pinion is three times larger than free ball

4.5.2 Simple Steering mechanism designing and selection:

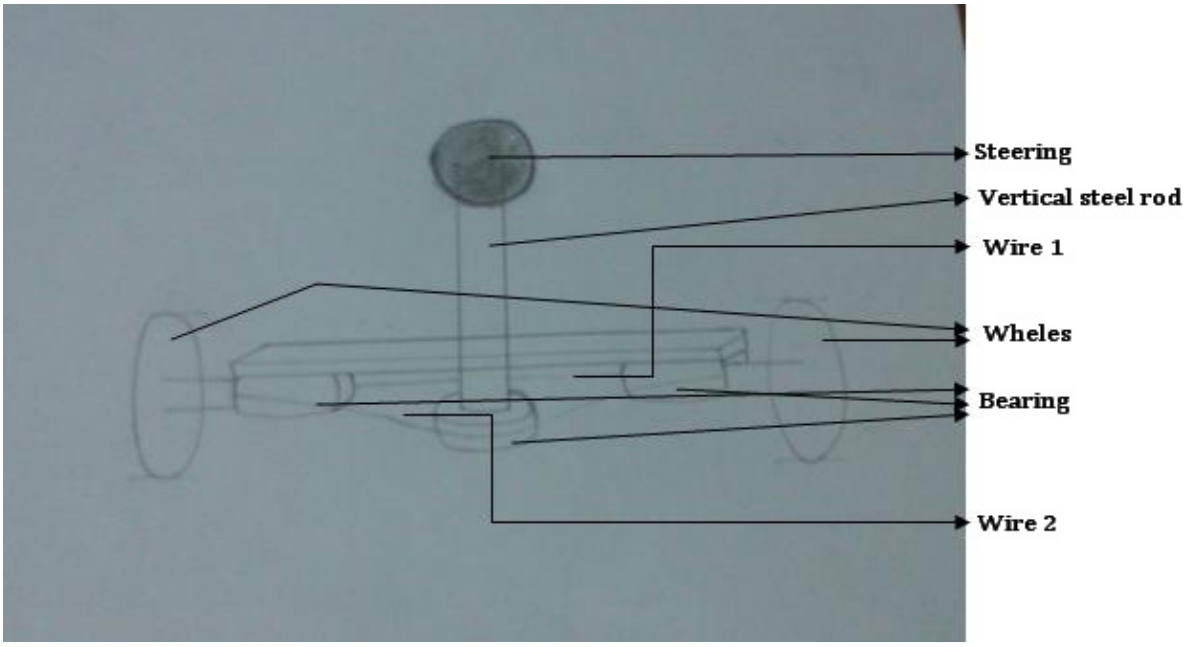
Steering mechanism of a vehicle is used for controlling direction of the vehicle. It actually moves both front wheels in a same angle when the vehicle changes its direction. All the steering mechanism using all over the world are much more complicated. At the beginning for our project we design a steering mechanism which is much easier than the mechanism generally used in vehicle. In the design the front wheels are attached with two cylindrical pipes. Two steel sheets are attached with those pipes. These two sheets are slightly joined with steel rod which has screwing in outside. Another vertical steel rod with screwing in outside joined with it with a small pinion. The steering is attached with same kind of screwing horizontal steel rod. This steel rod is connected to the vertical rod with a small pinion. When steering moves right then it rotates the horizontal rod in front results vertical rod goes down because of the screwing and then lower rod moves left which moves the wheel to right and when the steering moves left then the wheel moves to opposite.



Steering mechanism 1

Another steering mechanism that we designed is easier than the previous one where two wheels are directly attached with two bearing. A single wire (wire 1) is welding with the two bearing. The steering is directly joined with a vertical steel rod and under that rod there is another bearing is attached. Another wire (wire 2) joined with first two bearing is joined with the bearing

connected with steering and it is positioned in between two bearing. When steering moves right then connected bearing rotates left and consequence wire 2 moves left and it moves the right wheel right. When right wheel moves consequence wire 1 moves right and results other wheel moves right. When the steering moves left then wheels moves to the opposite.



Steering mechanism 2

4.5.3 Starting and Breaking System:

The vehicle always runs with the energy from the battery and there is no such ignition similar to vehicle runs with oil. We use a simple push switch near driver's foot for starting the vehicle which actually completes the circuit to run the motor. When driver remove his foot from the push switch the circuit remains open and the vehicle off.

The starting push switch work as a kind of breaking button. When driver release his foot from the switch then automatically the motor stop but because of momentum it slightly goes in front. To stop this momentum force there is another push break switch which is directly connected with the front wheels. When driver push that switch it breaks the front wheels. We use simple bicycle break with the front wheels connecting with the push break switch.

4.5.4 Reversing and front driving:

Most DC gear motors are normally very easy to reverse; simply changing the polarity of the DC input will reverse the direction of the drive shaft. This changeover process can be achieved via a simple changeover switch or for remote or electronic control, via a suitable relay. When using a switch or relay then always the current ratings and allow for larger currents to be switched, as different mechanical loads and instant reverse can draw much higher currents than when the motor is being run unloaded. Another big advantage of DC gear motors is that variable speed control is easy and can achieved with just a suitable variable resistor / rheostat or variable DC power supply. For more precise control and maximum efficiency there are many other electronic PWM (pulse width modulation) solutions, although these tend to have added complexity. Most DC motors are designed to exhibit the same speed and output torque in either the forward or reverse direction. Drive shaft speeds rpm (Revs per Minute) are quoted with motor unloaded.

FUTURE WORKS

5.1 VOLTAGE CONTROLLER DESIGN

In our basic design there is a voltage controller for our solar powered clean car and the purpose of the voltage controller is to select one battery which will supply energy to the motor of the car. Because of using two batteries, any one battery have to give supply to the motor and that time the additional battery have to be charged by the solar panel. So the voltage controller is used to select among the two batteries. That's why we have to design a voltage controller. We will design it by using microcontroller and the logic we will be in the microcontroller chip is, the microcontroller first will take the readings of the two batteries. As our motor rating is 12 volts that's why the microcontroller will check which battery is giving the voltage which is needed to drive the motor. If one battery give value less than 12 volts voltage controller will automatically switch off the supply from the particular battery and start charging the battery with the solar panel. Now the additional battery have to be checked by the microcontroller weather it is giving 12 volts or not. If the battery gives 12 volts, the voltage controller will select the battery to supply energy to the solar panel. So in a sense we can say that by using voltage controller our car will be more efficient and the battery life of our car will be secured.

5.2 MOTOR CONTROLLER DESIGN

In the actual design of our project, there is controller to control the speed of the motor. In our implemented design we use a rheostat for control the speed of the motor manually but in future we will control the speed of motor using microcontroller.

5.3 IMPLEMENTING FLEXIBLE SOLAR PANEL

In future we are planning to use flexible solar panel in our solar powered clean car. Flexible solar cells are manufactured by depositing photovoltaic material on flexible substrates, such as ordinary paper, using chemical vapor deposition technology. By using flexible solar panel we can use the total surface area of the car and we get more energy from the solar panel to drive the car. In conventional solar panels, the supporting structures of the panel like glass, brackets metal etc. are mostly twice as costly as the photovoltaic materials manufactured on them. As paper costs approximately a thousandth of glass, solar cells using printing processes can be much cheaper than conventional solar panels. Such solar panels can produce a voltage more than 50volts. The current efficiency of the solar panel is near 1% and it will improve in the near future. Addition of Possible Large loads

5.4 INCREASING VEHICLE SIZE

The original design of our vehicle is for two passengers only. In future we will try to make it large because if the vehicle is large then more passengers it can carry and if the size of vehicle is large then there is a large area to implement the solar pane.

REFERENCES

1. (http://working-of-electric-cars.htm, 2011)
2. (http://www.dieselnet.com/standards/us/ld.php,2011)
3. (http://en.wikipedia.org/wiki/European_emission_standards,2011)
4. (http://www.cabq.gov/airquality/vehiclepollution.html,2011)
5. Md. Jobair Bin Alam, "Traffic induced noise pollution in Dhaka city" published on Journal of Civil Engineering, The Institution of Engineers, Bangladesh, Vol. CE 29, no. 1,2001
6. (http://Electric Rickshaw _ RetiredArchivedLeads _ Import Export Trade Leads TradersCity.htm)
7. **Solar Wholesale Products.** How Solar Energy Works. *Solar Wholesale Products.* [Online] http://www.solarwholesaleproducts.com/Page5.html
8. **Rightsol Services Network.** Solar energy, a wise choice. *rightsolservices.* [Online] http://www.rightsolservices.com/Charge-controller.htm
9. High-efficiency polycrystalline solar modules. *solarfun-power.com.* [Online] http://www.solarfun-power.com/en/products/modules/polycrystalline-modules
10. *Emissions from Photovoltaic Life Cycles.* **Vasilis M. Fthenakis, Hyung Chul Kim, and Erik Alsema.** s.l. : Environ. Sci. Technol [Downloaded from http://pubs.acs.org on February 13, 2009], 06 February 2008. 42 (6), 2168-2174, DOI: 10.1021/es071763q.
11. **Wachter, Bruno De.** Emissions from Photovoltaic Manufacturing. *leonardo-energy.org.* [Online] May Thu, 29 , 2008. http://www.leonardo-energy.org/emissions-photovoltaic-manufacturing
12. **U.S Department of Energy.** *A Consumer's Guide: Get your Power from the Sun.* s.l. : Energy Efficiency and Renewable Energy, U.S Department of Energy.
13. (http://www.scary-terry.com/wipmtr/wipmtr.htm)
14. (http://www.distel.co.uk/DC_motors_geared.htm)
15. (http://www.solar-power-answers.co.uk/controller.php)
16. (http://www.freesunpower.com/batteries.php)
17. (http://www.altestore.com/store/Deep-Cycle-Batteries/c434/)
18. (http://en.wikipedia.org/wiki/Brushed_DC_electric_motor)

19. (http://en.wikipedia.org/wiki/Brushless_DC_electric_motor)

20. (http://electriccarconversionblog.com/dc-motor-electric-car)

21. (http://www.bdbatteries.com/mcharging_procedures.php)

22. (http://www.howstuffworks.com/gears.htm)

23. (http://www.cs.cmu.edu/~rapidproto/mechanisms/chpt7.html)

24. (http://en.wikipedia.org/wiki/Vehicle_brake)

25. (http://www.physicsforums.com/showthread.php?t=590635)

26. (http://auto.howstuffworks.com/auto-parts/brakes/brake-types/brake3.htm)

27. (http://auto.howstuffworks.com/auto-parts/brakes/brake-types/brake.htm)