The Solar Team (Analysis & Logical Design)

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Activity Report

Abstract—Modern modes of travel have varying degrees of renewable power, these range anywhere from diesel trucks to fully electric cars like Tesla's. Even the most renewable fully electric cars on the market still rely on dirty power grids to support them, however a fully PV power vehicle would sidestep this need. The main goal in this project is to create an efficient solar car capable of operating for extended periods of time off of solar energy alone. To do this the project must incorporate a storage system that can store energy and provide proper demanding power to the electric motors. A lightweight chassis will help carry PV cells and the rest of the equipment.

Index Terms—PV Cell: A photovoltaic cell is made of semiconductor materials that absorb the photons emitted by the sun and generate a flow of electrons.

1 Background

As the world is continually polluted by fossil fuels, coal plants, and the use of natural gasses it is becoming increasingly important to explore the use of other green power production methods and eco-friendly modes of transportation. Prior work done in fields of transportation can see evolution's such as the first internal combustion engine cars at the turn of the 19th century to the fully electrical vehicles and hydrogen cars that company's like Toyota and Tesla produce today. With the rise of modern electric cars, the questions of clean transportation have shifted from the cars themselves to the power-grids that supply them [1].

The purpose of this project is to create a solar car that can prove to collect and use power produced by light. From this milestone future versions can be improved on with more systems testing the limits of power produced by a photo-voltaic system. This PV power will be supplied through a solar panel array built directly into the car, sidestepping the need for a dirty power grid to supply the power for the car. The solar power will improve the limitations set by electric cars of today by allowing them to produce there own power on-board.

2 Requirements

The requirements are Power Production, Power Storage, Power Motion and a Chassis. Power generation refers to the PV panel system that will power all other parts of the solar car. This system should be capable of producing enough power to operate all other systems in the vehicle. The next system requirement for the solar car will be a storage system able to hold any excess power not immediately used by the rest of the systems in the solar car. This will allow for low sun-light(less than optimal) level operating conditions and relies on the efficiency of other main requirements to allow for excess power. The next system required is motion. This system should allow for motion with power draw regulated by an on-board micro controller. As the main load for the solar car, making an efficient system will draw less from the production and allow for more excess power to go into storage. The final requirement will be a chassis capable of supporting the power system and allow for the attachment of wheels. As a cohesive unit these systems are the basic requirements for a solar car.

2.1 Power Production

2.1.1 Functionality

The Power Production system uses photons from visible light to be captured by solar cells. This photo-voltaic system will provide electrical energy for all the systems. The energy generated is limited by the SI technology and by the intensity of light, this effects the amount of energy generated. Therefor the solar panels will be mainly exposed to light to produce sustainable amount of energy.

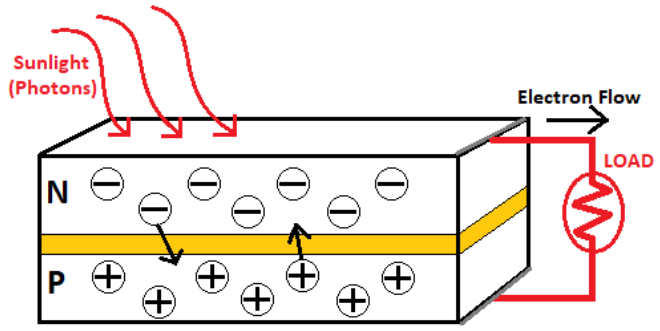

Figure 1. Power Production

2.1.2 Acceptance Criteria

The solar panel orientation and surface area will be the size of the solar car and will be sufficient to produce energy to power the solar car and systems. The desired voltage and current will be produced by the type of connections between the individual cells depending on the system component requirements. The power production should produce at least 40 Watts.

2.2 Power Storage

2.2.1 Functionality

Through the use of an on-board micro controller we will manage the internal systems of the solar car to store enough power in the battery while actively providing enough power to the motor to keep the car moving at a steady pace.

2.2.2 Acceptance Criteria

The car should be able to produce enough power to move itself while actively storing power into the battery. This stored power should be enough to run the car for 5 minutes even without direct exposure to sunlight after having run for an hour in direct sunlight.

2.3 Powered Motion

2.3.1 Functionality

Power motion refers the solar cars ability to move under its own solar power. This system will consist of 1-4 motors giving drive to the wheels. The power these motors will be provided with will be dictated by an on board micro controller that will regulate power for storage and use.

2.3.2 Acceptance Criteria

The car should be capable of moving at varying speeds i.e. 1-3 m/s on smooth terrain based on the level of power being produced by the power production system. This will allow for sustainable power draw within the overall solar car. The car should be efficient enough to drive for alt least one hour under ideal conditions.

2.4 Chassis

2.4.1 Functionality

The chassis is the basis for all other systems in the solar car. It should be capable supporting the weight of the three power systems, as well as allow for the mounting of wheels. The chassis should be constructed of some lightweight material so that it does not add to much to the overall weight of the whole system, but should still be sturdy.

2.4.2 Acceptance Criteria

The chassis of the car should be roughly 25″x15″ to allow for ample space for the PV panels and the subsequent power systems. The chassis should weigh within the total allowable weight of 10 pounds or less to avoid running system out of the efficiency range.

3 Design Alternatives

There are a few minute differences in the design that can be made in order to bring out the full potential of the vehicle.

3.1 Design Alternative 1

One of our design alternatives for the solar car is to have a small scale vehicle, around 25”X15” with fixed solar panels on top, that are either completely flat or slightly curved, which will be decided after testing.

3.2 Design Alternative 2

Our second design alternative is to take the same small scaled car in design alternative 1, but replace the fixed solar panels with ones that can actively track the sun.

3.3 Design Alternative 3

Our third design alternative is to have a larger scaled solar car of around 35”X25” with fixed solar panels similar to design alternative 1.

3.4 Design Alternative 4

The fourth design alternative for our solar car is to build a car with a similar scaling as in design alternative 3 but replace the fixed solar panels with solar panels that actively track the sun similar to design alternative 2.

3.5 Design Justification

The best design choice for our vehicle is a small vehicle with solar panels that track the sun. This design choice has a very high score in terms of power production, which has become one of, if not, the most important aspects of our project. Being able to produce enough power in order to get the vehicle moving is the first big hurdle for this project. With the vehicle being smaller scale, we are able to have better control of the size and weight of the vehicle so that we can maximize our efficiency and know how much power we need to produce in order to move our vehicle. At this moment in time, cost and power storage are not a high concern for this project, focusing primarily on delivering enough power to the vehicle to have it move relying solely on solar power.

4 Logical Design

The solar car will be composed of a few systems that will produce power, store power, use the power, and a system that will physically hold all the systems. The power will be produced from photo-voltaic cell array that will be mounted on the solar car top which should produce at least 40W. The power will be sent to the micro-controller and regulator to be sent to the other systems. The power storage system will collect the energy and should run in lighted conditions for an hour and be able to sustain enough power to run without power production for at least five minutes. The motion system will have a load that draws the power, this will be the micro-controller and the motor(s). This should provide enough power to be able to sustain a velocity of 1-3 meter per second on a smooth terrain. The chassis will be about 25 x 15 inches and contain all the systems on it and should not have a total weight exceeding 10 pounds to keep the motion system running in an efficient state. The best design for our solar car is design alternative 2, due to its small scale, it will be more cost efficient, but not be able to produce as much power via its solar panels. This issue is solved with the addition of a tracking solar array, allowing us to make full use of the available solar panels.

References

[1] I. A. G.Rizzo and M.Sorrentino, “Solar energy for cars: perspectives,” pp. 1–6, May 2010.

		Options							
Criteria	Weighting	Fixed solar(Small)		tracking solar(Small)		Fixed solar(Large)		Tracking solar(Large)	
		Score	weighted total	Score	weighted total	Score	weighted total	Score	weighted total
Power production	7	4	28	8	56	7	49	9	63
Power storage	3	3	9	4	12	6	18	6	18
Powered Motion	5	6	30	5	25	4	20	3	15
Chassis(weight/Scale)	5	7	35	5	25	5	25	3	15
Cost	4	8	32	5	20	4	16	2	8
Total:			134		138		128		119

Figure 2. Weighted analysis

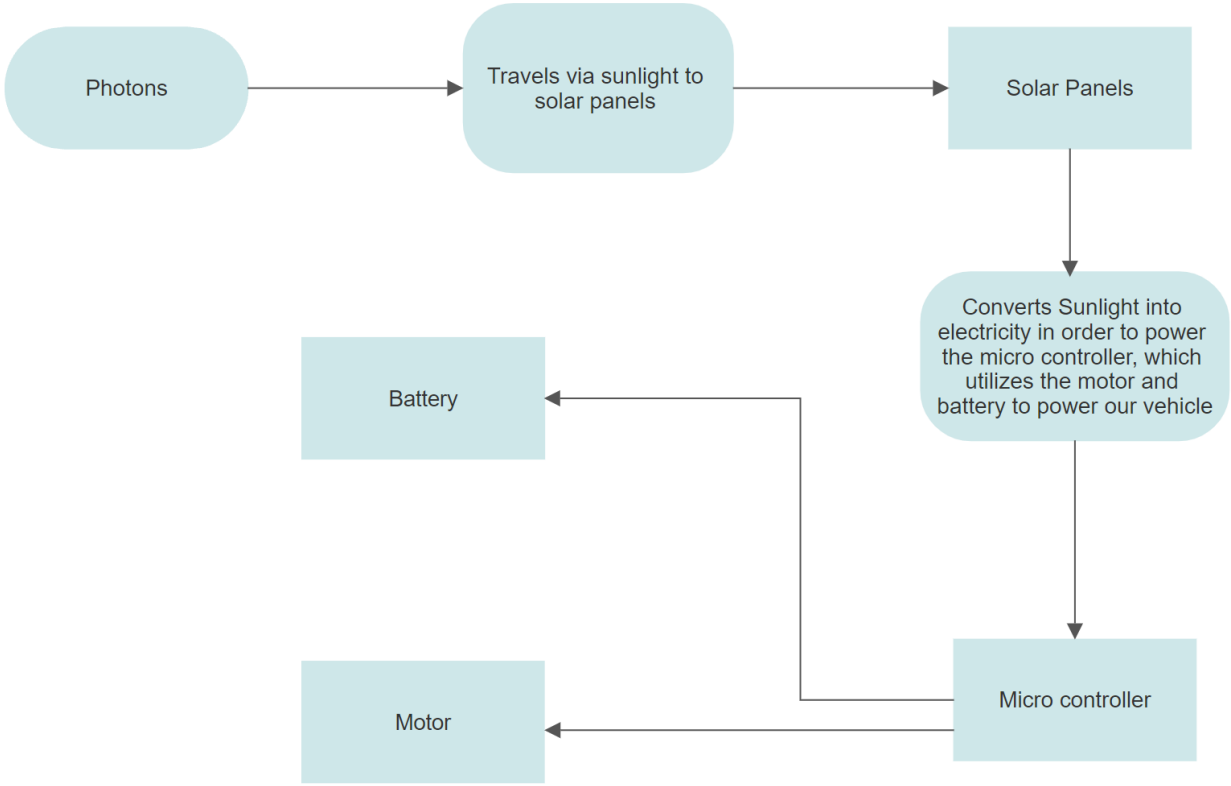

Figure 3. Data Flow Diagram