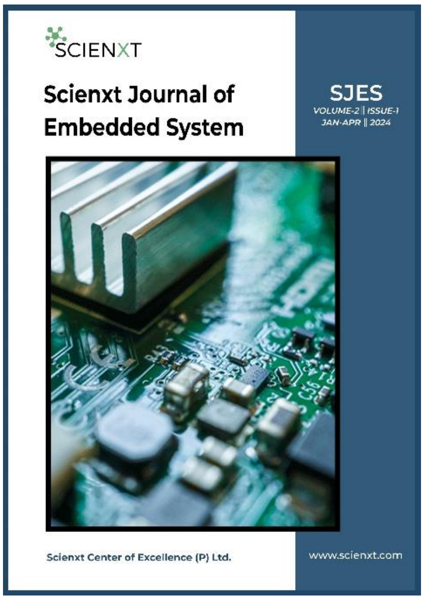

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A review paper on solar panel based vehicle

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Abstract:

The primary aim of this project is to develop and construct a solar-powered electric vehicle in accordance with the engineering specifications outlined for the Shell EcoMarathon Urban Division competition. While the competition guidelines do not mandate the inclusion of a solar module, this project incorporates solar energy for charging the vehicle battery. Given the competition's focus on efficiency, energy efficiency is a paramount consideration. Time and budget constraints were significant challenges for the project. To address these, subsystems such as the frame, drivetrain, power, suspension, and steering were meticulously designed and integrated into a comprehensive master assembly model. SolidWorks, a computer-aided design (CAD) software, was utilized for design and modeling, along with finite element analysis (FEA). Supporting tools such as Excel, Vsusp, and solar analysis software were employed for subsystem planning, data collection, and organization. Subsystems that underwent quantitative modeling and analysis were procured and fabricated, while those that did not reach the design and analysis phase were not constructed, pending further analysis. Moving forward, optimization and exploration of new subsystem configurations should be prioritized. This project represents the initial iteration of a future Shell Eco-marathon competition vehicle.

Keywords:

CAD, Competition vehicle, Design, Engineering, Electric Vehicle, FEA, Solar, Solar Energy, Shell Eco-marathon, Vehicle Subsystem,

1. History of the solar-powered car:

The journey of solar-powered cars commenced with a modest 15-inch model crafted from balsa wood back in 1955. Since then, a multitude of remarkable innovations have unfolded. Today, solar car races are held worldwide, with the fastest solar car clocking a speed of 56.75 miles per hour. Additionally, the prospect of mass-produced solar-powered cars looms on the horizon. This timeline, curated by Solar Power Guide, commemorates the strides made in solar technology and invites us to envision the promising future ahead.

1955: Introduction of the first model solar panel car William G. Cobb, a General Motors employee, crafted the Sunmobile, featuring 12 selenium photovoltaic cells and a miniature electric motor.

1976: Unveiling of the first legally drivable solar car Alan Freeman developed a three-wheeled vehicle powered by sunlight and pedals. In 1981, the UK ceased taxing electric vehicles, prompting Freeman to register and insure his creation for road use.

1980: Debut of the Ugly Duckling, the inaugural civilian car partially powered by solar energy Developed by a team at Tel Aviv University, this vehicle weighed over 1,320 pounds and boasted 432 solar cells generating 400 watts of peak power.

December 1982: The Quiet Achiever marks the first practical long-distance solar-powered car Larry Perkins and Hans Tholstrup completed the maiden manned transcontinental journey solely using solar power, crossing Australia at an average speed of 14 miles per hour. The vehicle was handcrafted resembling a lightweight aircraft.

1985: Switzerland hosts the Tour de Sol, the premier rally for solar-powered vehicles Seventy-two vehicles participated, with 50 completing the journey powered solely by onboard solar energy and an initial charge of the onboard accumulators. Thousands of spectators lined the roads to witness the race, sparking a revolution.

1987: Inauguration of the inaugural Australian World Solar Challenge Twenty-three participants, inspired by the pioneering feats of the Quiet Achiever, competed in the first international solar racing event. GM's Sunraycer clinched first place with an average speed of 42 mph.

1990: Commencement of the inaugural American Solar Challenge The University of Michigan's Sunrunner triumphed in the maiden edition of this annual solar car race, initially named Sunrayce USA, covering nearly 2,000 miles across the United States.

1993: Initiation of the Solar Car Challenge An annual U.S.-based solar-powered car race for students, attracting teams globally. The inaugural race was won by Los Altos Academy of Engineering's Cool Runnings.

2000: Inauguration of the inaugural Formula Sun Grand Prix An annual solar-car race conducted on closed-loop race tracks, governed by the Innovators Educational Foundation. The inaugural edition was won by the Rose-Hulman Institute of Technology's Solar Phantom V.

2005: Nuna 3 by Nuon wins the World Solar Challenge Developed by Delft University of Technology, it achieved an average speed of 63.85 mph.

January 2007: Jaycar Sunswift III sets the world record for the fastest solar car journey across Australia The team completed the journey within 5.5 days, surpassing the previous record by 3 days. The vehicle was capable of carrying a passenger facing backward, marking a step towards practical every day-use solar cars.

2008: Inauguration of the first Sasol Solar Challenge in South Africa Tokai University's solar car, the Tokai Falcon, emerged victorious.

2010: Development of the first Palestinian solar-powered car from scratch Engineering students constructed a solar-powered vehicle capable of reaching 12 mph with limited funds and resources.

2011: Introduction of the Solar Spirit III TAFE South Australia constructed this vehicle for the 2011 World Solar Challenge.

January 2011: Attainment of the Guinness World Record for the fastest solar-powered vehicle Invented by the University of New South Wales, the Sunswift IV set a record of 55.2 mph over a 1,600-foot distance.

2013: Renaming of the World Solar Challenge to Bridgestone World Solar Challenge Racers from across the globe raced solar vehicles across 1,878 miles (3,000 km) of the Australian outback. The race featured three classes representing the diversity of solar electric vehicles.

2013: Victory of the Phoenix in the Formula Sun Grand Prix Oregon State University's solar team created the Phoenix, covering 661 miles solely on solar energy.

2013: Stella Lux, the "family car," wins in the Cruiser Class of the World Solar Challenge Eindhoven University of Technology developed this vehicle, considered the world's first solar-powered family car.

2014: Sky Ace TIGA secures the Guinness World Record for the fastest solar-powered vehicle this solar-powered tricycle, constructed by Ashiya University and driven by Kenjiro Shinozuka, reached a speed of 56.75 mph (91.3 km/h).

2014: Sunswift eVe breaks the record for the fastest electric car over 500 km (310 mi) Achieving an average speed of 66 mph (107 km/h).

2018 :Attainment of the Guinness World Record for the lowest energy consumption by an electric car driving across Australia The record was set by Sunswift VI (Violet), invented by the UNSW Solar Racing Team.

2019: Announcement of Lightyear One, a long-range solar-electric car, by Atlas Technologies Costing $170,000, the vehicle is designed for independence and is expected to be available in 2022.

2019: Victory of Sunseeker in the 2019 Formula Sun Grand Prix Developed by the Western Michigan University solar race car team, it cost just $7,000 to build.

December 2020: Commencement of pre-orders for Aptera, the first mass-produced solar-powered car, by Aptera Motors Priced between $25,900 and $44,900, the Aptera is touted as the first solar electric vehicle requiring no charging for most daily use, capable of achieving 0-60 mph in 3.5 seconds.

January 2021: Introduction of the Sion solar car by Sono Motors Available for preorder for $34,000 from German company Sono Motors, the Sion boasts an expected range of up to 190 miles (305 km).

July 2021: Launch of the Squad Solar City Car by Squad Mobility, a two-seater capable of running entirely on sunlight Available for preorder for $6,800 from Amsterdam-based startup Squad Mobility, the Squad Solar City Car has a range of 12 miles and a max speed of 28 mph, making it ideal for city errands.

Similar to solar-powered homes, solar cars harness energy from the sun by converting it into electricity. This electricity powers the car's motor through a battery. Some solar cars direct power straight to an electric motor instead of using a battery. Prominent examples of the latest solar-powered cars include the University of Michigan solar car, the MIT solar car, and the Berkeley solar car.

Solar cars utilize photovoltaic cells to convert sunlight into energy. These cells, found in solar panels, absorb sunlight and convert it into electricity using semiconductors, typically silicon.

The sun's energy frees electrons in the semiconductors, generating a flow of electrons that produces electricity to power the battery and specialized motor in solar cars.

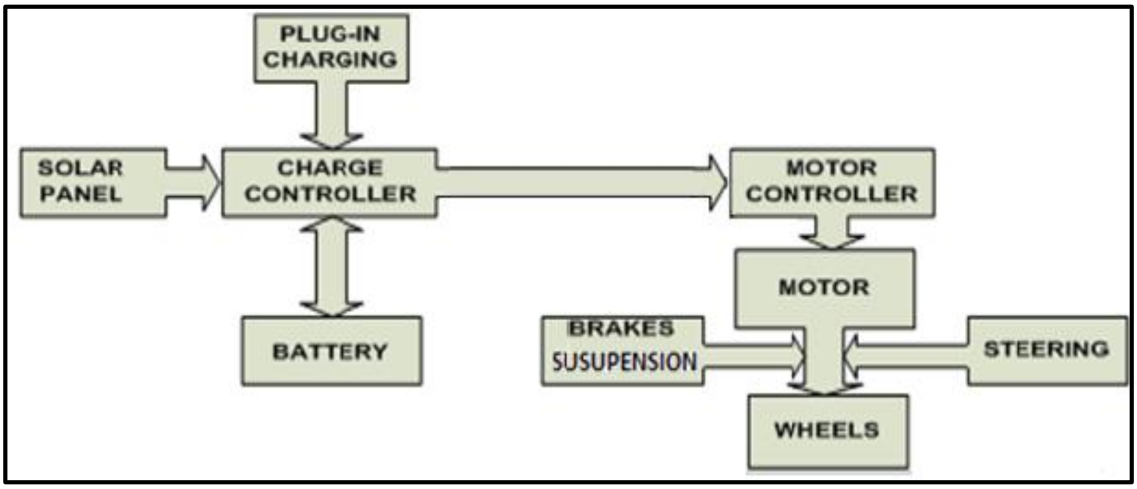
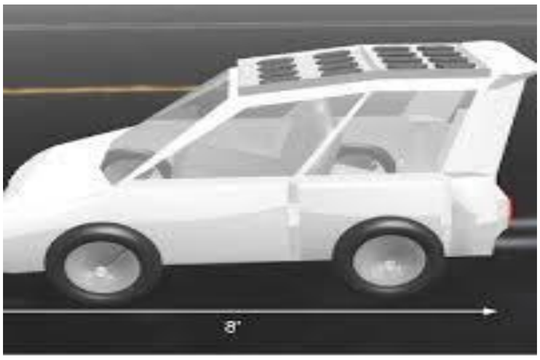
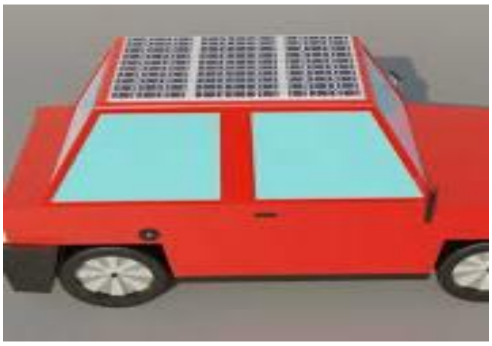


Figure. 1: System architecture of the solar car

2. Solar panel:

Solar cars utilize the sun's energy as their power source, making solar panels integral to their operation as they are tasked with capturing solar energy. In this project, mono crystalline and flexible solar panels are employed. These panels boast a thin, semi-flexible design, allowing for easy mounting either on the car's roof or bonnet, thanks to their adaptable nature. .FIGURE: 3D model of the Solar Car





3. Batteries:

The solar panels will harvest solar energy and transform it into usable electrical power. This energy will then be stored in lead-acid batteries, ready to supply the motor with power as needed.

4. Charge controller:

The batteries are linked to a charge controller, which safeguards their longevity by preventing both overcharging and overdischarging. Embedded within the charge controller is a microcontroller programmed to monitor voltages at the battery and solar panel terminals. Based on these readings, it accurately adjusts the charging current supplied to the battery, ensuring optimal charging conditions.

4.1. Plug-in-charging:

An essential feature to note is that the charge controller includes an extra input for charging the batteries from an AC power supply, simply by plugging it in. Consequently, the solar car will be equipped with a plug-in charging system, ideal for situations where sunlight is insufficient due to fog, clouds, or rain. This integration of an external plug-in system for charging the batteries from a conventional AC power source enhances the car's overall versatility and utility.

5. Motor and motor controller:

The chosen motor is a DC-series excitation motor with a rating of 1 kW, 60V, and 23 A. This particular motor is deemed adequate for propelling the car, as demonstrated further in subsequent elaboration. The motor controller is specifically engineered to regulate both the speed and direction of the motor's rotation, effectively governing the car's velocity and facilitating its forward/reverse motion. Wheels.

6. Steering, suspension, brakes, wheels:

These four elements constitute the mechanical aspect of the solar car. Front-wheel steering is chosen for its inherent stability and safety characteristics. The suspension system employed is sufficiently advanced to ensure a smooth and stable ride for the user while safeguarding the car and panels against sudden impacts. To ensure safety during travel, a drum braking system similar to conventional cars is utilized. The selection of wheels depends on minimizing rolling resistance, thereby maximizing the distance the solar car can travel with the available energy. Thinner yet robust wheels are preferred over thicker ones due to their lower rolling resistance.

7. Features of Solar Cars:

Solar-powered vehicles operate on direct or indirect sunlight.

Instead of relying on gasoline, they utilize rechargeable batteries.

They produce minimal carbon emissions.

Solar cars reduce both noise and air pollution.

They harness solar energy through photovoltaic cells.

Solar vehicles are not commonly used for public transportation; they are primarily utilized for demonstration purposes.

7.1. Advantages of Solar Cars:

Environmentally friendly: Solar cars produce no emissions, making them highly environmentally friendly as they do not rely on non-renewable resources like fuels. They do not emit hazardous toxins or greenhouse gases.

Reduce noise pollution: Electric motors in solar cars operate quietly, reducing noise pollution compared to traditional fuel-powered vehicles.

Fuel cost savings: Solar cars do not require fuel, resulting in significant savings on fuel costs compared to gasoline and diesel-powered vehicles. Additionally, they require less maintenance. Energy accessibility: Solar panels harness sunlight as the primary power source for solar cars, storing this energy for later use as propulsion.

Driving comfort: Solar cars, constructed from lightweight materials, offer smoother and faster rides.

7.2. Disadvantages of Solar Cars:

High upfront material and installation costs.

Requires a large battery bank due to the absence of solar power at night. Perceived by some as unattractive.

Devices operating solely on direct current can be more expensive.

Solar panel size varies based on geographic location for the same electricity output.

Energy generation decreases on cloudy days. Limited mass production of solar panels due to material scarcity.

Solar-powered vehicles may not offer the same speeds and power as traditional gas-powered vehicles.

Lower sun output during winter months may affect vehicle performance.

7.3. Uses of Solar Cars:

Commercialized four-wheel drives.

Lightweight transportation.

Suitable for areas where fuel-based vehicles are restricted.

8. Future scope:

Progress in Solar Panel Technology: Ongoing research and innovation aimed at enhancing the efficiency, resilience, and flexibility of solar panels utilized in Solar Energy Vehicles (SEVs) have the potential to amplify energy production from constrained surface areas. This entails delving into novel materials, manufacturing methodologies, and solar cell technologies.

Innovations in Energy Storage: Advances in battery technologies can bolster storage capacity, effectiveness, and overall functionality of SEVs. Enhancing battery density, charging efficacy, and lifespan can extend driving ranges and optimize the utilization of solar energy.

9. Conclusion:

In conclusion, projects focusing on solar electric vehicles offer a promising path towards sustainable transportation and reducing dependency on fossil fuels. Despite existing limitations and challenges, ongoing research, development, and innovation across various domains such as solar panel technology, energy storage, vehicle integration, and infrastructure hold the potential to overcome these hurdles and bolster the feasibility of solar electric vehicles. These vehicles have the capacity to contribute to mitigating greenhouse gas emissions, enhancing energy efficiency, and lessening reliance on conventional charging infrastructure. They also afford the advantages of tapping into renewable solar energy reservoirs and reducing operational expenses for vehicle owners. Nonetheless, it's crucial to acknowledge that while solar energy presents significant advantages, it may not single-handedly address the requirements of long-range or heavy-duty transportation applications.

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