Name of proposed project:
SIMULATION AND VISUALISATION OF MOTION OF SOLAR CAR ALONG ROAD

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Description (Background)

In the near future, the era of vehicles operating based on petroleum products will come to an end, while the transition to electric vehicles moving due to solar energy (solar cars) will happen. The last years were characterized by the permanent competitions of solar cars and achievement regarding the average speed at about 90 km/h. Mass production of solar cars will be realized if their technical characteristics (overall dimensions, mass, speed, body capacity, etc.) will be close to the conventional cars. The obtained results and intensity of investigations in this field gives to us the confidence in reaching the necessary characteristics.

Thus, the availability of sufficient amount of solar radiation on the Earth surface is necessary for efficient operation of solar cars. It is known that the amount of solar radiation at the fixed point is the highest when sunbeams fall perpendicularly on a panel of car. If a solar panel has no flexibility, then this condition can't be available continuously along road because it needs the variation of orientation of this panel. Construction of a flexible solar panel capable to follow the Sun like sunflower seems unreasonable because the shape of the car must have aerodynamic feature.

The main feature of solar cars which distinguish them from conventional ones is the reality that the origin of energy occurs outside the car and therefore, cannot be controlled. If solar cars receive enough solar energy, they will operate regularly. This fact requires the optimal synergetic usage of solar energy and energy of accumulators. Since the amount of solar energy received by the panel depends on outside factors, the prediction of the amount of received solar energy in any point of road and at any moment of time is necessary for optimal managing of solar cars.

The objective of this project is to develop the mathematical model for calculation of the quantity of solar radiation falling on the panel of solar car in any point of road and in any moment of time. The algorithm based on this model and program package for calculation was realized.

The amount of solar radiation falling on the panel of the car at the given point and fixed instant of time depends on several factors. Some of those factors have deterministic character while others – random. The deterministic factors are the followings:

1. The zenith and azimuth of the Sun. At the given point of observation and fixed moment of time those angles determine the position of the Sun in the sky and are calculated by using formulas of astronomy.

2. The tilt of the road at the given point. The angle between the sunbeam and the normal to panel, thereby the amount of radiation, depends on tilt.

3. The relief of territory surrounding the given point. During some period of time the Sun may be shaded by relief (hills, mountains, etc.) and the amount of radiation falling on the panel will be essentially small.

The random factors acting to the amount of radiation includes clouds, aerosol, dust, mist, smoke, rain, snow etc.

Project objectives

The aim of the proposed project is to:

1) Develop a mathematical model of solar radiation falling onto a panel of solar car at any point of the road and any instance of time;

2) Simulation of motion of a solar car on basis of solution of differential equation of motion (taking into account all the forces affecting car: driving force, reaction force, resistance force (aerodynamic resistance, rolling resistance).

Chosen routes: Hamburg–Berlin, Baku–Shamakhi, and Zagatala–Tbilisi. Solar car: PowerCore SunCruiser"

3) Visualization of the simulated data in Esri's ArcGIS v10.3 in 3D spatial scene.

Expected results:

Expected results are related to the finding ways for the further improvements, namely:

- Adding features to exactly evaluate the random events related to weather conditions;
- The expansion of the model in order to use hybrid (solar and accumulator) energy;
- The application of the presented model for solution of optimal control problems of solar cars. This concerns the minimizing of travel time; the minimizing of consumption of energy from accumulator; the minimizing of both time of travel and energy simultaneously.
- The use of road signs to restrict motion of cars in case of necessity.

The foreign partner is needed to implement joint research.