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Simulation Research of the Aerodynamic Drag of 3D Structures for Individual Transport Vehicle

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Abstract : In today's world, a big problem of individual mobility, especially in large urban areas, occurs. Commonly used grand way of transport such as buses, trains or cars do not fulfill their tasks, i.e. they are not able to meet the increasing mobility needs of the growing urban population. Additional to that, the limitations of civil infrastructure construction in the cities exist. Nowadays the most common idea is to transfer the part of urban transport on the level of air transport. However to do this, there is a need to develop an individual flying transport vehicle. The biggest problem occurring in this concept is the type of the propulsion system from which the vehicle will obtain a lifting force. Standard propeller drives appear to be too noisy. One of the ideas is to provide the required take-off and flight power by the machine using the innovative ejector system. This kind of the system will be designed through a suitable choice of the three-dimensional geometric structure with special shape of nozzle in order to generate overpressure. The authors idea is to make a device that would allow to cumulate the overpressure using the a five-sided geometrical structure that will be limited on the one side by the blowing flow of air jet. In order to test this hypothesis a computer simulation study of aerodynamic drag of such 3D structures have been made. Based on the results of these studies, the tests on real model were also performed. The final stage of work was a comparative analysis of the results of simulation and real tests. The CFD simulation studies of air flow was conducted using the Star CD - Star Pro 3.2 software. The design of virtual model was made using the Catia v5 software. Apart from the objective to obtain advanced aviation propulsion system, all of the tests and modifications of 3D structures were also aimed at achieving high efficiency of this device while maintaining the ability to generate high value of overpressures. This was possible only in case of a large mass flow rate of air. All these aspects have been possible to verify using CFD methods for observing the flow of the working medium in the tested model. During the simulation tests, the distribution and size of pressure and velocity vectors were analyzed. Simulations were made with different boundary conditions (supply air pressure), but with a fixed external conditions (ambient temp., ambient pressure, etc.). The maximum value of obtained overpressure is 2 kPa. This value is too low to exploit the power of this device for the individual transport vehicle. Both the simulation model and real object shows a linear dependence of the overpressure values obtained from the different geometrical parameters of three-dimensional structures. Application of computational software greatly simplifies and streamlines the design and simulation capabilities. This work has been financed by the Polish Ministry of Science and Higher Education.

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