Subject: Opinion on meeting the criteria for recognition of the technical solution

According to the submitted material and in accordance with the provisions of *The Rules of procedures and methods of evaluation and quantitative presentation of scientific research results of researchers,* brought by the National Council for Scientific and Technological Development of Serbia *("Official Gazette of the Republic of Serbia", No. 38/2008)* **reviewer: Dr Milovan Živanović, dipl. ing. Digital Control Systems Oziris, Kosmajska 32, 11450 Sopot, Belgrade, Serbia,** has evaluated that conditions for the recognition of the properties of the technical solution are fulfilled for the following result of the scientific research paper:

Title: **program system ORFLEX** (elastic ropes S-type Cable suspended Parallel Robot with one mode, **eSCPR** with one mode) (*Project:* Ambientally intelligent service robots of anthropomorphic characteristics, TR-35003 and the project: SNSF Care-robotics project no. IZ74Z0_137361/1*)*

Author: **Mirjana Filipovic**

Category of technical solution: **M85** *„Acknowledged program system"* ***– Software.***

Objective and significance: *The area which we deal with, the robotics is very important, because the modelling of the robot system movement dynamics with both rigid and elastic elements comes from it directly. The robotics is the area which can offer the solution and it represents the foundation of the further researches in many other areas. The reason for that is quite simple: the robotics has progressed significantly in the last 50 years. It is important to emphasize the importance of the further researches but now based on the new principles which set in this program system* ***ORFLEX****.*

Proposed solution is done in: *2014.*

Proposed solution is used in the following way: *It is used for further researches and discoveries of new phenomena in analysis and synthesis of kinematics and dynamics of elastic ropes S-type Cable-suspended Parallel Robots,* ***eSCPR*** *system with rigid and elastic elements.*

Area to which the technical solution refers is: *Robotics, Theory of Mechanics, Theory of elasticity and Theory of oscillations.*

Problem that is being solved with this technical solution: T*his technical solution is used for solving the problem of the effective implementation of the model of* ***eSCPR*** *system with elastic ropes (one mode), as well as testing their behavior in designed implementation conditions of the* ***CPR*** *task. It is also point to the need for implementation of various control laws.*

State of the problem solution in the world: *Not finding any other solution, some researches in* ***CPR*** *systems, applied the Meirovitch solution in the description of the real dynamics of the* ***CPR*** *system deformation defined in advance and by the amplitude and the frequency, or they used ways to modify the same solutions. By now the authors implemented the elastic deformations as the values on the principles "assumed modes technique" and they did not get any real values as a result of the robot system movements. Not finding any other solutions it is obvious that the* *researches in this area have been reduced in the last years.*

Essence of technical solution. *The elastic deformation of rope cannot be defined in advance (with both amplitude and frequency) and put in the system but completely inversely. The elastic deformation is a dynamic value which depends on the total dynamics of the* ***CPR*** *system movements. That means that the elastic deformation amplitude and its frequency change depending on the forces (inertial forces, Coriolis, centrifugal forces, gravity forces as well as coupling forces between the present modes, and the play of the environment forces). It, of course, depends also on the* ***CPR*** *configuration, camera carrier weight, dimension workspace, the reference trajectory choice, dynamic characteristics of the motor movements etc.*

Characteristics of the proposed technical solution are following:
This technical solution enables:

- *The key element in the* ***eSCPR*** *system with one mode modeling is the relation between the elastic deformations of the ropes and the motors angular positions. This novel procedure is named* ***ED+M method****, which means Elastic Deformations plus Motor motion.*
- *The kinematic calculation is named* ***KineSCPR-Solver*** *(Kinematic elastic S-type Cable suspended Parallel Robot (with one mode) Solver), and it gives a precise, direct and inverse kinematic solutions.*
- *The KinRSCPR-Solver represents the basis for generating the dynamic model of the* ***RSCPR*** *system.*
- *The software package* ***ORFLEX*** *has been developed for the* ***eSCPR*** *model (with one mode) evaluation.*
- *The influence of changing any parameters of the system can be analyzed through the* ***ORFLEX*** *software package.*

Possibility of implementation of proposed technical solution: *Solution can be applied to the future researches in this and associated areas. It enables implementation of different control laws. And just because it is in the pioneering research phase it can be expanded from different viewpoints, depending on the user's imagination.*

On the basis of the above mentioned, the reviewers have concluded that the result of the scientific research paper titled: program system ORFLEX presents the recognized program system that beside expert component also provides the original scientific research contribution.

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