SEVENTH FRAMEWORK PROGRAMME
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PUT-Poznan: TNA-Project-185- Modelling 6-DOF parallel kinematics manipulator with Matlab-Simulink software and its visualisation in Virtual Reality environment

Proposer: Prof. Dr. Zoran PANDILOV, University "Sv. Kiril i Metodij"-Skopje, Faculty of Mechanical Engineering, Republic of Macedonia

Visited institutions: Department of Mechatronic Devices and Virtual Reality Laboratory at Poznan University of Technology, Poland

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During my research stay I was hosted by professor dr hab. inż. Andrzej Milecki and his research team: mgr inż. Amadeusz Nowak, dr inż. Filip Górski and mgr inż. Damian Grajewski. The research was very complex and divided in two phases.

The first phase was modelling of the very complex model of the 6 DOF parallel kinematics manipulator which consists of several subsystems: trajectory generator model, controller and servo system model for each strut (leg) and mechanical structure model which consists of large number of different mechanical parts. The modeling was done with Matlab-SIMULINK and SimMechanics Toolbox. The SimMechanics Toolbox allowed us to use the complete CAD model of the geometry of the 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool) in modeling and automatically calculating the selected properties. Using the Simulink model for the servo system for controlling of each strut (leg) of the hexapod the influence of changing and optimization of several servo system parameters (position loop gain Kv, proportional gain Kp of the velocity controller, integral gain of velocity controller-Tn, electrical drive time constant Te, total moving mass m, sampling period Ts, etc.) on positioning accuracy (length) and dynamic stiffness were simulated, tested and validated.

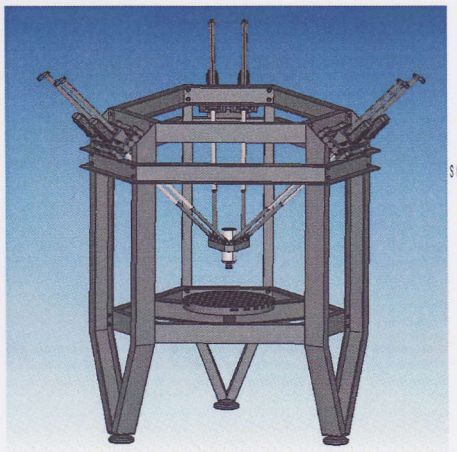

Fig. 1 CAD model of the Hexapod CNC machine tool

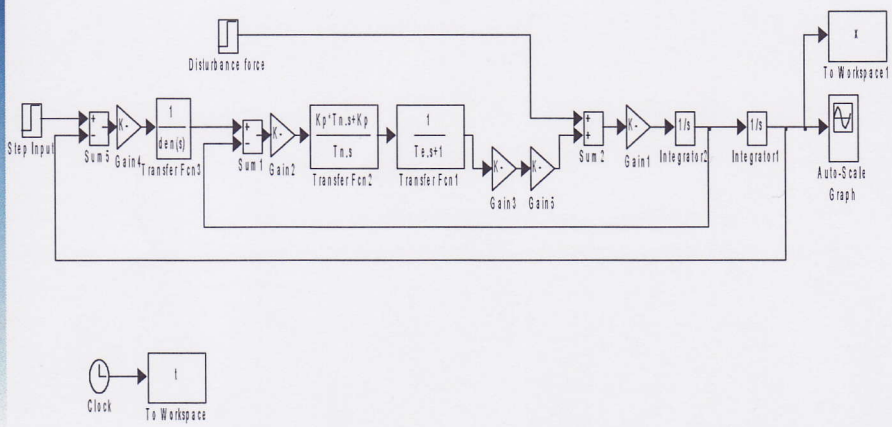

Fig. 2 Simulink model of servo system for controlling of each strut (leg) of the hexapod

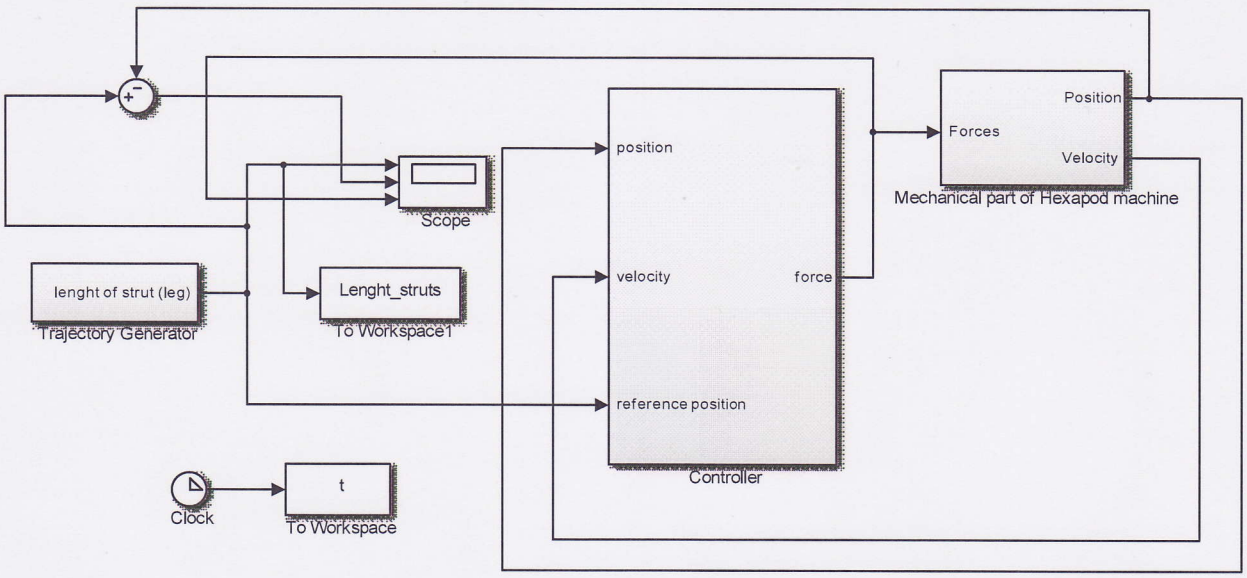

Fig. 3 Complete Simulink and SimMechanics model of 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool) consists of 3 subsystems: trajectory generator, controller and mechanical structure

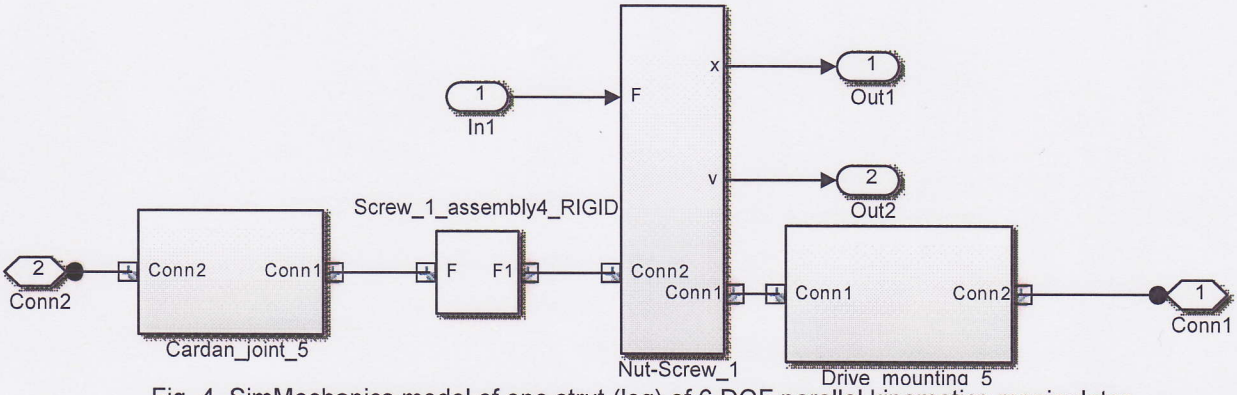

Fig. 4 SimMechanics model of one strut (leg) of 6 DOF parallel kinematics manipulator

The ready Matlab-Simulink and SimMechanics models were initially visualized in the Matlab program, but they were very simplified, comparing their visualization in Virtual Reality EON Studio program.

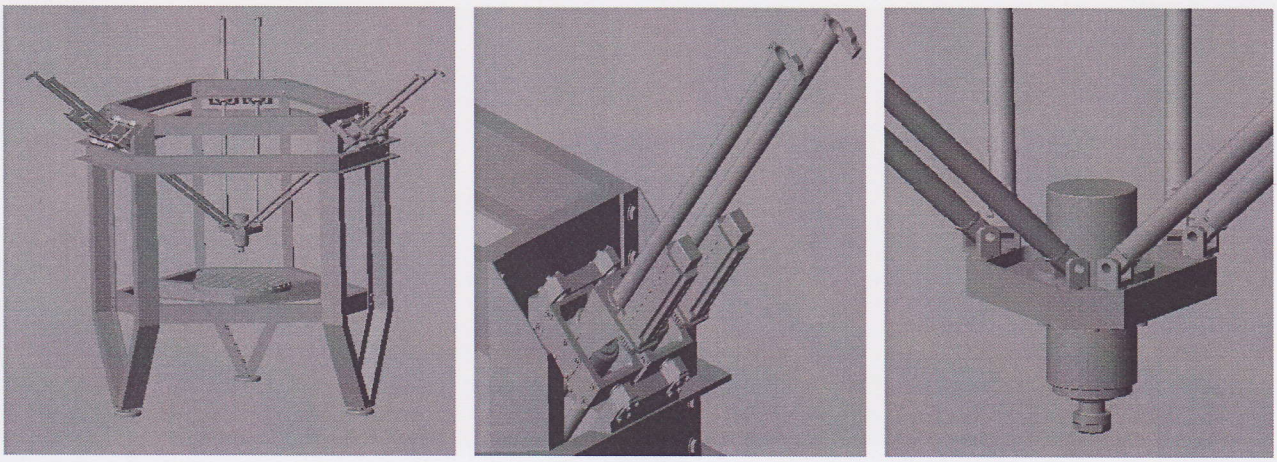

Fig 4. Simple visualisation of the model of 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool) in SIMULINK and SimMechanics

The second phase of the research was visualization of the whole complex model of 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool) developed in Matlab-Simulink and SimMechanics in Virtual Reality system with EON Studio software.

The using of EON software significantly improved the model and the visualization quality.

With the visualization we were able to simulate the real work and movement of the whole 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool).

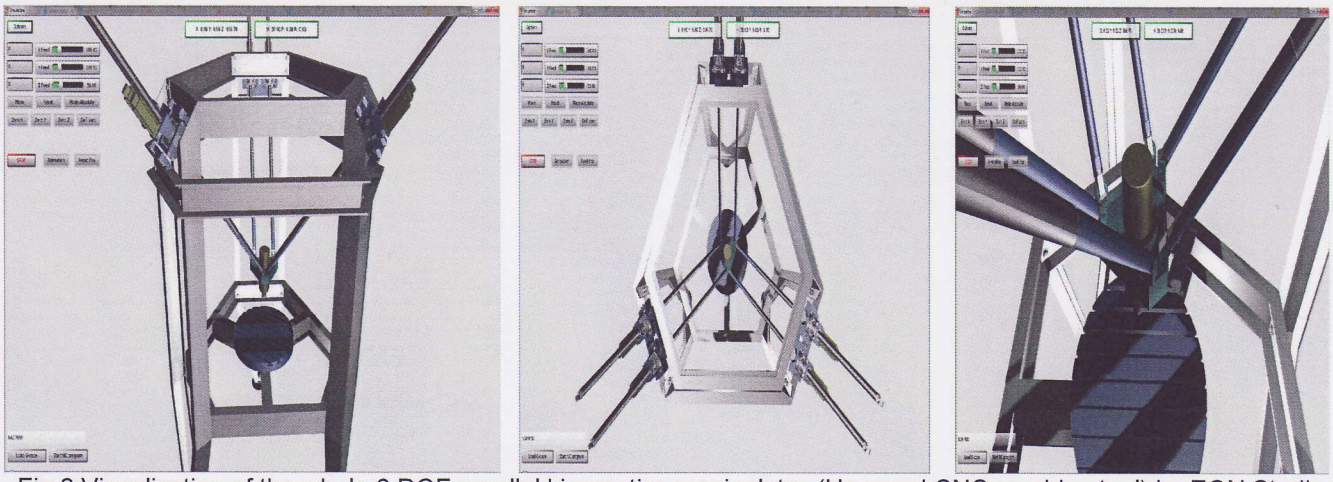

Fig.6 Visualisation of the whole 6 DOF parallel kinematics manipulator (Hexapod CNC machine tool) in EON Studio software

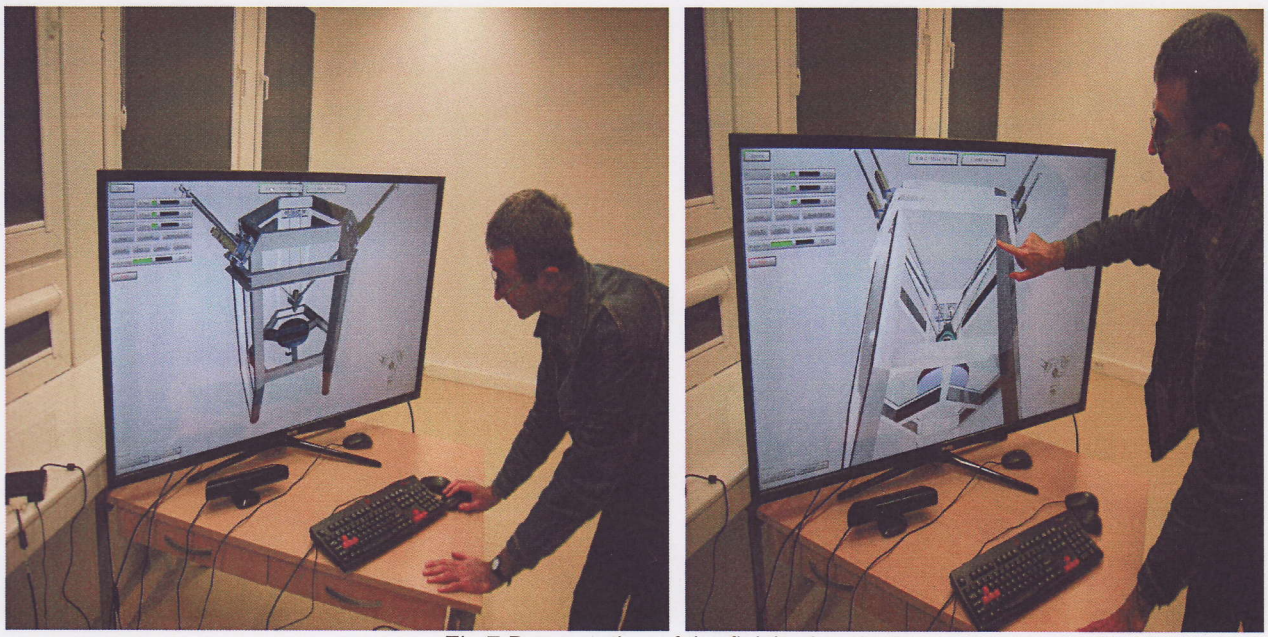

Fig.7 Presentation of the finished project

This whole research could be very useful to designers of complex 6 DOF parallel kinematics manipulators. Designer of such kind of manipulator must consider the manipulator dynamic too, which could be great problem in early, conceptual design phase. Precise calculations are time consuming and there is always a risk of some mistakes. Using simulation and visualisation environments, like Matlab-Simulink (Sim Mechnics Toolbox) and EON Studio software, is very helpful in checking the correctness of the 6 DOF parallel kinematics manipulator structure, especially in the beginning phase of the design, as well as, during the whole design process. It is possible easy to modify the model and instantly check the results. The designer could ensure that the different type of components (actuators, joints, sensors, etc.) are selected properly.

After the second finished TNA VISIONAIR project at the Poznan University of Technology, Department of Mechatronic Devices, I am deeply convinced, that our already established collaboration with my host institution and host institution colleagues, will continue in different research, scientific and educational issues.

User:

Prof. Dr. Zoran PANDILOV

Host:

PEŁNOMOCNIK PROJEKTU
EU FP7 VISIONAIR NR 262044

prof. dr hab. inż. Andrzej Milecki

Prof. dr hab. inż. Andrzej MILECKI