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50. Internationales Wissenschaftliches Kolloquium
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SACR - a software for simulation and control of robots

ABSTRACT

The paper introduces the SACR software program (Simulation And Control of Robots), developed by the Mechatronics Department, Institute of Mechanics, is used to simulate and control robots. The SACR program allows the users to operate fully a control process of robot: trajectory planning, kinematic and dynamic analysis, checking critical parameters of actuators and robot control. The SACR program version 1.0 has been applied to the parallel robot (Hexapod) PR6-01, a product of the Mechatronics Department, Institute of Mechanics. Hexapod PR6-01 will be used as a clamping table applying to conventional machine-tools in Vietnam to expand fabricating capacities.

1. INTRODUCTION

In robot research, there are two important problems: simulation and control. The simulation of robot by computer not only helps users to have a visual picture about its working process but also optimizes parameters of robot design, chooses working modes as well as determines parameters for control. The next problem, which is a decisive factor for the effective performance of robot, is the development of a control system of robot (including choosing suitable hardware, developing optimal control algorithms). This is an advanced and effective approach for research and application of robots. Thus, it is necessary to develop a software program to control a full working process of robots including planning trajectory; simulation; checking dynamic parameters of actuators; displaying results in different modes such as numerical table, diagram, and 3D view as well as transmitting data and receiving feedback parameters to control. The SACR program is divided to three modules: the trajectory module, the simulation module and the control module. The SACR program with version 1.0 (SACR 1.0) has been applied to parallel robot PR6-01. Robot PR6-01 is a hexapod that substitutes a typical clamping table of conventional machine-tools to expand fabricating capacities.

SACR program has been written in VC++ language and used OpenGL technology. The SACR is developed with opened-structure to expand for different purposes in future.

2. ALGORITHM FLOW CHART AND STRUCTURE OF SACR

The flow chart of the SACR program can be described in figure 1.

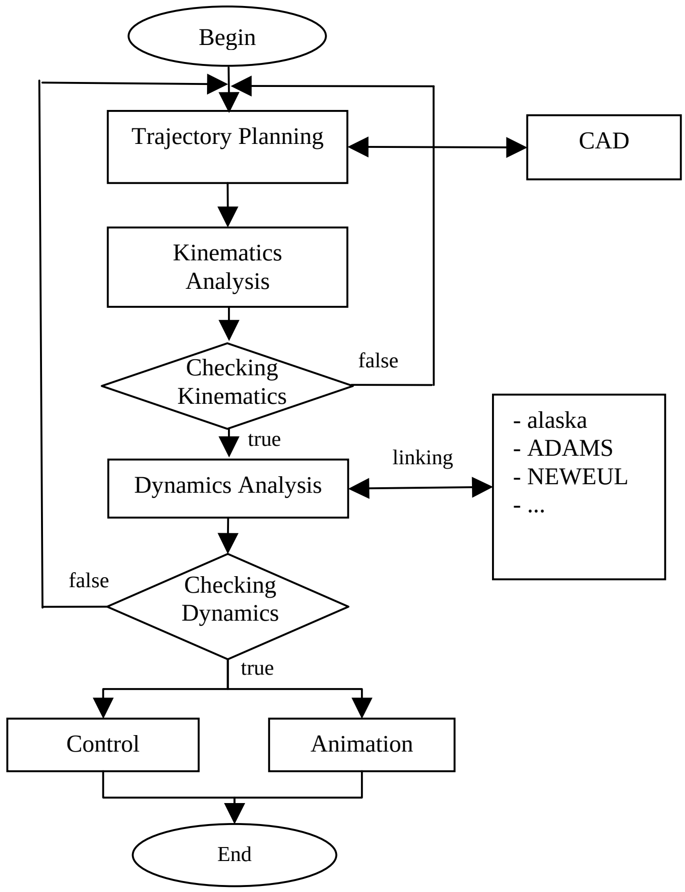


Figure 1: The flow chart of the SACR program

SACR has three modules as follows:

- ***Trajectory Module:***

It has functions to take trajectory planning obtained from geometric paths, given kinematic constraints. A given path can be imported in terms of analytical equations, numerical tables or data files generated by AutoCAD or other software [1]. The interface allows users to plan trajectory on planes or in 3D coordinate system from standard geometry objects such as points, lines, ellipses… And then the trajectory can be interpolated optionally to obtain new smooth curves appropriate to mechanical fabrication.

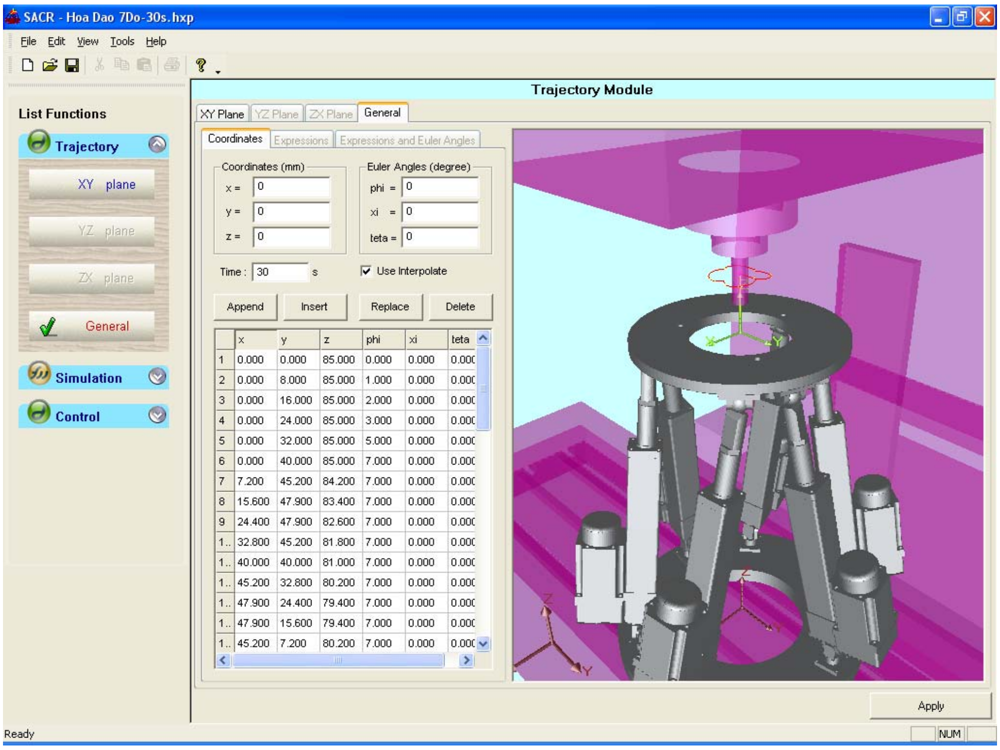
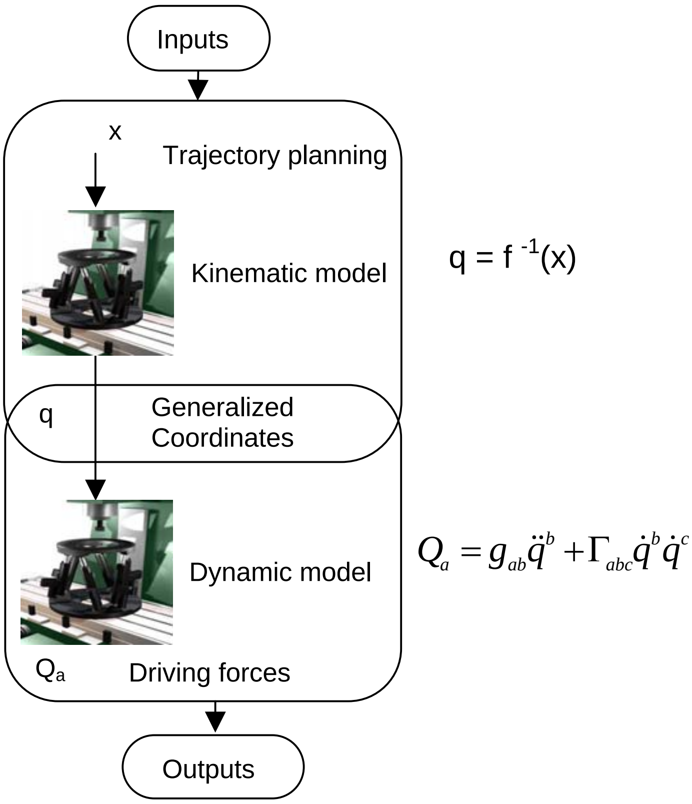


Figure 2: Trajectory module in SACR version 1.0

– ***Simulation Module:***



$$Q_a = g_{ab}\ddot{q}^b + \Gamma_{abc}\dot{q}^b\dot{q}^c$$

Figure 3: Kinematic and dynamic simulation flow chart

Based on the required trajectories, the simulation module analyses immediately the kinematics and dynamics of robot by solving equations of the motion of robot or linking to other well-known dynamic simulation software as alaska [3], ADAMS, NEWEUL... After having kinematic and dynamic parameters such as displacements (q), velocities ($\dot{q}$) and accelerations ($\ddot{q}$) of actuators, driving forces of joints (Q), they are compared with their critical values. The SACR program also examines the workspace and singularity points of the robot. The results will be displayed in different modes such as table, diagram, and 3D view to pretest. The user stores the results in files too. Finally, the valuable parameters are used for the control process [2].

- ***Control Module:***

This module gets the control data from the simulation module to control Hexapod. The control data are processed, organized in structure messages and transmitted from the SACR to the Hexapod's control unit via communication port, by RS232 standard. This module also gets the feedback data of Hexapod from the control unit to monitor the working process of Hexapod. So users can control accurately through computer screen in real time.

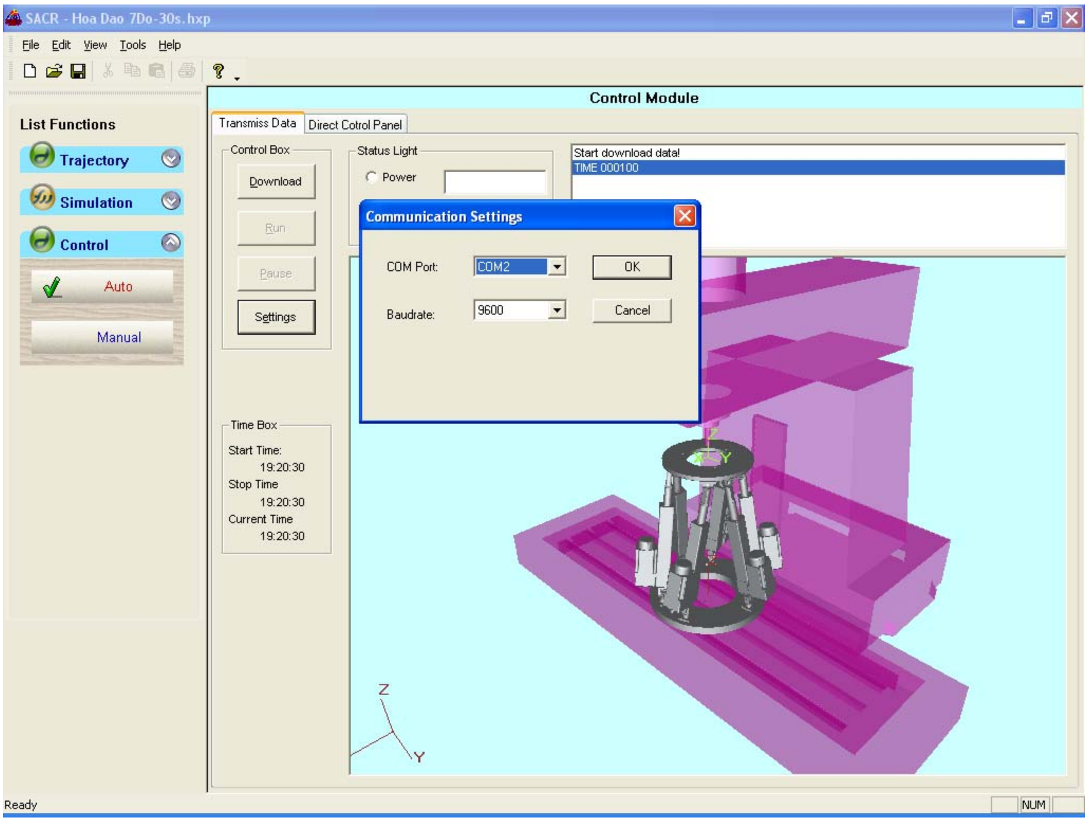


Figure 4: Kinematic and dynamic simulation flow chart

3. APPLICATION EXAMPLES ON HEXAPOD PR6-01.

The SACR program version 1.0 has been tested and applied for Hexapod PR6-01, which is developed by the Mechatronics Department, Institute of Mechanics.

Hexapod PR6-01 is working as a clamping table applying to conventional machine-tools, which is popular in Vietnam, to expand fabricating capacities. Work pieces will be clamped on moving platform and smooth motion of moving platform in six-degree of freedom with a static cutting tool will make the trajectory of cutting process.

It is economic and effective because of high cost of modern fabrication machines such as CNC machines.

The SACR program can be applied for different kinds of robot (serial robots, parallel robots...) to plan and control those robots to move accurately according to desired trajectories. Furthermore, the open structure of SACR program make users utilize modules developed themselves or use other well-known software tools in the world.

Figure 5: Hexapod PR6-01 as a clamping table

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