PUMA-560 Robot Manipulator Position Sliding Mode Control Methods Using MATLAB/SIMULINK

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Abstract: This paper describes the MATLAB / SIMULINK realization of the PUMA 560 robot manipulator position control methodology. This paper focuses on two main areas, namely robot manipulator analysis and implementation, and design, analyzed and implement nonlinear sliding mode control (SMC) methods. These simulation models are developed as a part of a software laboratory to support and enhance graduate/undergraduate robotics courses, nonlinear control courses and MATLAB/SIMULINK courses at research and Development Company Computer modelling, simulation and implementation tools have been widely used to support and develop nonlinear control, robotics, and MATLAB/SIMULINK courses. MATLAB with its toolboxes such as SIMULINK [1] is one of the most accepted software packages used by researchers to enhance teaching the transient and steady-state characteristics of control and robotic courses [3_7]. In an effort to modelling and implement robotics, nonlinear control.

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I. INTRODUCTION

The international organization defines the robot as "an automatically controlled, reprogrammable, multipurpose manipulator with three or more axes." The institute of robotic in The United States Of America defines the robot as "a reprogrammable, multifunctional manipulator design to move material, parts, tools, or specialized devices through various programmed motions for the performance of variety of tasks"[1]. Robot manipulator is a collection of links that connect to each other by joints, these joints can be revolute and prismatic that revolute joint has rotary motion around an axis and prismatic joint has linear motion around an axis. Each joint provides one or more degrees of freedom (DOF). From the mechanical point of view, robot manipulator is divided into two main groups, which called; serial robot links and parallel robot links. In serial robot manipulator, links and joints is serially connected between base and final frame (end-effector). Parallel robot manipulators have many legs with some links and joints, where in these robot manipulators base frame has connected to the final frame. Most of industrial robots are serial

links, which in _ degrees of freedom serial link robot manipulator the axis of the first three joints has a known as major axis, these axes show the position of end-effector, the axis number four to

six are the_ minor axes that use to calculate the orientation of end-effector and the axis number seven to use to reach the avoid the difficult conditions (e.g., surgical robot and space robot manipulator). Kinematics is an important subject to find the relationship between rigid bodies (e.g., position and orientation) and end-effector in robot manipulator. The mentioned topic is very important to describe the three areas in robot manipulator: practical application such as trajectory planning, essential prerequisite for some dynamic description such as Newton's equation for motion of point mass, and control purposed therefore kinematics play important role to design accurate controller for robot manipulators. Robot manipulator kinematics is divided into two main groups: forward kinematics and inverse kinematics where forward kinematics is used to calculate the position and orientation of end-effector with given joint parameters (e.g., joint angles and joint displacement) and the activated position and orientation of end-effector calculate the joint variables in Inverse Kinematics[6]. Dynamic modeling of robot manipulators is used to describe the behavior of robot manipulator such as linear or nonlinear dynamic behavior, design of model based controller such as pure sliding mode controller and pure computed torque controller which design these controller are based on nonlinear dynamic equations, and for simulation. The dynamic modeling describes the relationship between joint motion, velocity, and accelerations to force/torque or current/voltage and also it can be used to describe the particular dynamic effects (e.g., inertia, coriolios, centrifugal, and the other parameters) to behavior of system[1]. The Unimation PUMA 560 serially links robot manipulator was used as a basis, because this robot manipulator is widely used in industry and academic. It has a nonlinear and uncertain dynamic parameters serial link 6 degrees of freedom (DOF) robot manipulator. A nonlinear robust controller design is major subject in this work .

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II.DYNAMIV AND KINEMATIC FORMULATON OF ROBOTIC MANIPULATION

one of the main concern among robotic and control engineers is positioning the manipulator's End-effector to the most accurate place and transparent the effect of disturbance and errors which will affect on manipulator's final result. As a matter of fact, controlling manipulators are hard and expensive because they are multi-input, multi-output, time variant and non-linear, so it has been a topic for researchers to design the most sufficient controller to help the manipulator to achieve to the desired expectation under any circumstance. PUMA 560 is a good instance for manipulators, because it is widely used in both industry and academic, and the dynamic parameters for this robot arm have been identified and documented in literature. One of the main parts of a manipulator's controller is its kinematics which can be divided into two parts; forward kinematics and inverse kinematics. Implementation of inverse kinematic is hard and expensive. In this work we will aim on implementation of PUMA 560 robot manipulator kinematics. Study of robot manipulators is classified into two main groups: kinematics and dynamics. Calculate the relationship between rigid bodies and end-effector without any forces is called Robot manipulator Kinematics. Study of this part is pivotal to calculate accurate dynamic part, to design with an acceptable performance controller, and in real situations and practical applications. As expected the study of manipulator kinematics is divided into two main parts: forward and inverse kinematics. Forward kinematics has been used to find the position and orientation of task (end-effector) frame when angles and/or displacement of joints are known. Inverse kinematics has been used to find possible joints variable (displacements and angles) when all position and orientation of end-effector be active
broadening. These effects depend mostly on Input power of the signal transmitted, which can be used as a threshold condition for the frequency chirp to occur. SPM is major limitations in single channel systems.

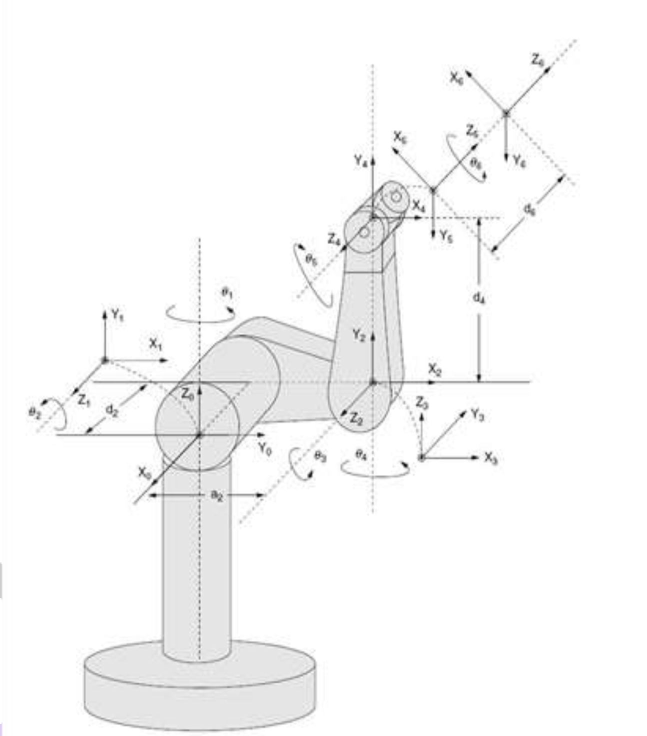

FIGURE 1: notation for a six-degrees-of-freedom PUMA 560 robot manipulator

III.MATLAB OUTPUT

After running the code in MATLAB software ,we get a windoe og Graphical user interface (GUI) .
In which the picture of PUMA robot with its slides is shown (FIGURE 2).

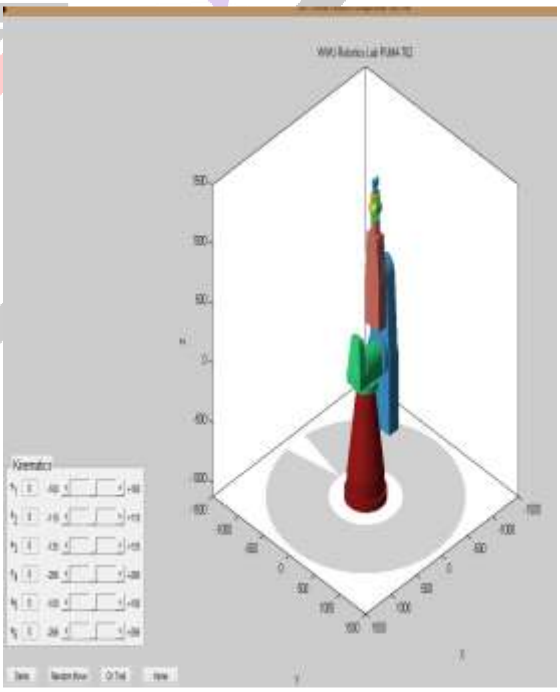

FIGURE 2: window of MATLAB after running the code.

In this window. With the help of six slider we can mive the robot arms in any direction. Six joints of this robot can be controlled by adjactly six slider. Every slider has their own range of angle of Rotation.

With this rotation we can draw anything or we can pick a thing into one place gto another place.

IV. CONCLUSION

PD-sliding mode controller (PD-SMC) and PID-sliding mode controller (PID-SMC) were tested to Step and Ramp responses. In this simulation the first, second, and third joints are moved from home to final position without and with external disturbance. The simulation was implemented in MATLAB/SIMULINK environment. It is noted that, these systems are tested by band limited white noise with a predefined 40% of relative to the input signal amplitude which the sample time is equal to 0.1. This type of noise is used to external disturbance in continuous and hybrid systems.

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