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ROS and Moveit Based 6 DOF Manipulator

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ABSTRACT

In the modern society of 21st century Robotics has been increasingly popular, useful, and successful in the modern world. In a variety of human endeavors robotics has found applications in medical, education, the military, research, and, most notably, manufacturing. Especially manipulators are becoming the utmost important part in any big industries like automobile industries where they are deployed to carry out many tasks repetitively which are very difficult or dangerous for humans. Depending on the number of degrees of freedom robotic arm can have a wide range of motion, depending on the creator's imagination also. These robot's base is generally fixed at one place. That base can be moving if it is attached to different mobile robot. Generally, for large assembly lines or work floors they are programmed to do repeating tasks depending on the work required and end effector attached.

Keywords – *6 DoF, Manipulator, ROS, RVIZ, URDF*

1. INTRODUCTION

A 6-axis robot is desired for carry out tasks with smooth wrist action, multi-purpose tasking like carrying fragile objects from one place to another, spray painting, military operations [1]. This type of model makes it possible to control the manipulator in any reachable workspace, in any orientation in an unstructured environment [2]. Both forward and inverse kinematics techniques play an important role in any industrial or project robotic arm [2]. Calculating these equations can be tedious and rough by hand and any wrong procedure can result in wrong control signals for the manipulators [4]. ROS (Robot Operating System) comes into the rescue to make the work easier. It provides a URDF (Universal Robot Description format) where we can define a whole kinematic tree of links and joints [3]. Various physical parameters like gravity, friction and intended actions can be defined in URDF making process [3][5]. ROS which is a result of many individuals and organizations due to its open-source nature is a growing framework for developing software's for robot control of any type whether it's a stationary robot or a mobile robot [7]. On similar note moveit is a set of packages for ROS for motion planning of manipulators and easy calculations for the equations related to kinematics [2][6]. This paper proposes a 3D printed cost efficient robotic arm which can be used for research purpose by any robotics researcher or any college or school student. 3D printing was used for rapid prototyping of the arm. It is basically an additive manufacturing process works on the process of deposition of melted material layer by layer until the final product is finished [8].In the presented work a robotic arm was developed using 3D printing technology after designing in Catia and Solidworks software, then servo motors are used for acting as rotary actuators, Arduino as microcontroller for making communication between user and hardware through programming methodologies, a simple URDF was made and then finally hardware interface with ROS and Moveit was done. In our case trajectory will already be calculated in RVIZ visualization and the real hand will move accordingly as an end result. Fig.1 shows the workflow of whole project.

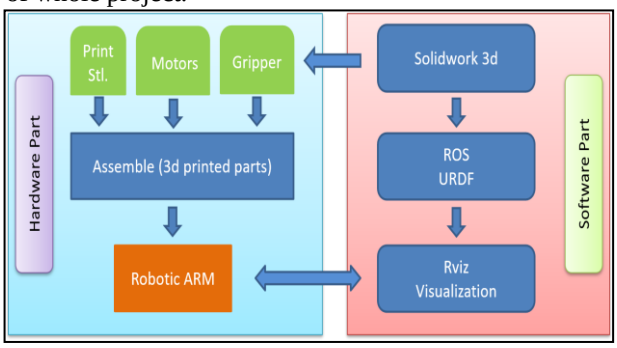

Figure 1: Project workflow

2. THE ARM STRUCTURE

Block diagram of robotic arm has been represented in Fig 2. The total arm length with closed gripper is almost

54.5 cm containing 6 joints with a fixed joint between world and link1 included as shown in Fig.3.

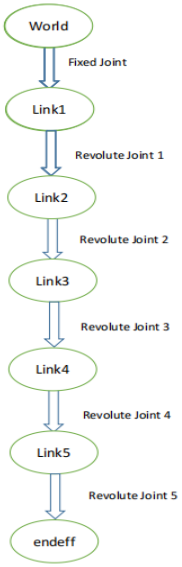

Figure 2: Robotic arm block diagram

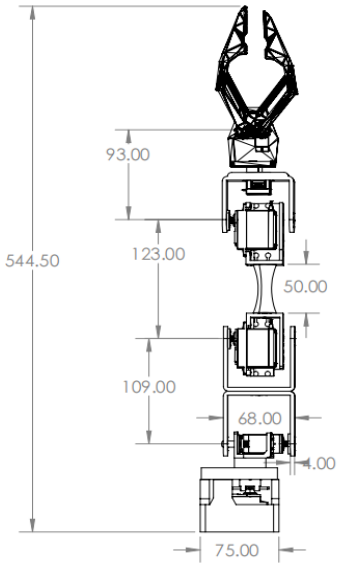

Figure 3: Arm measurements

The arm was designed using Catia software mostly containing 6 Degrees of Freedom. Like many other software's it allows to create the meshes of the design files which further imported in Cura for making gcodes and then finally the resulted gcode is feeded to 3D printer. Brackets are made and printed to hold the motors in place. Moreover, a bearing is connected between link 1 and link 2 to reduce the load on base motor directly. Link 2 connected with base link 1 has a rotary movement around z axis. On similar notes link 3, 4 and 5 has rotary movement around X-axis and finally link 5 has around Z-axis. Complete CADD design is similar to this only as shown in Fig.4. In the end there is an end effector as gripper is also connected, containing one motor and a geared gripper attached to it as shown in Fig. 5.

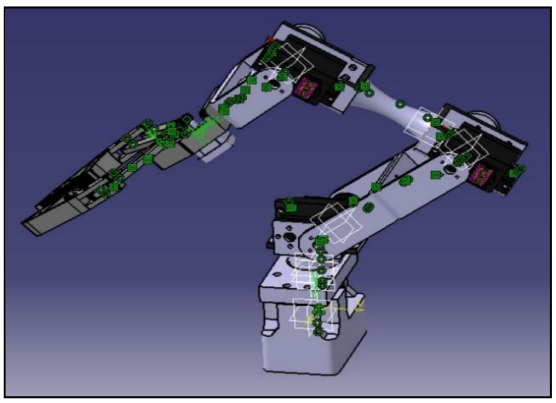

Figure 4**:** Arm CAD model

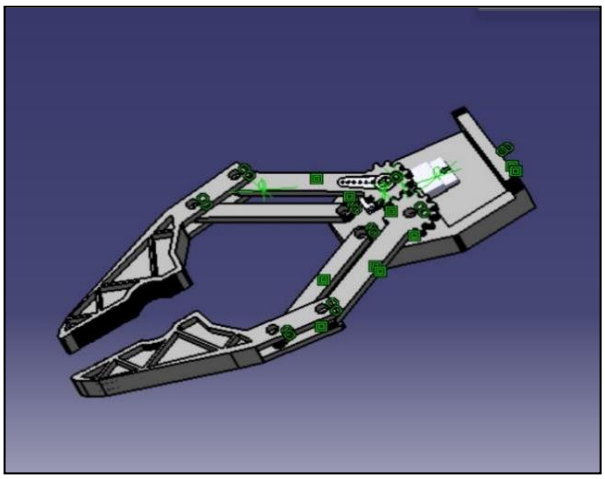

Figure 5**:** Gripper

3. ELECTRICAL COMPONENTS

The manipulator contains 5 MG996R servo motor having a torque of 11kg/cm at 6V for each link and a micro servo SG90 having torque of 1.2 kg/cm at 6V for the gripper operation. For communication purpose between our motors and our system an Arduino UNO microcontroller has been used. Arduino basically an open-source platform for programming and controlling purpose of electronics components like motors, lights, speakers etc. [9].

4. SOFTWARE AND PROGRAMMING

In order to achieve our manipulation, visualization and control of our robotic arm the framework which has been used is ROS (Robot Operating System). Due to its various library and it open-source nature. It is widely used and growing more and more for the use in many robotics applications [7]. It also provides features like hardware abstraction, low level device control and variety of other tools like gazebo simulation, URDF visualization, Rviz visualization [3]. In our case a simple stick URDF has been created with simple joints as per the dimensions of robot's link lengths. URDF basically consists of two languages as a base which is links and joints where we have to specify the coordinate position of each link and joint in order to achieve the movement like a real robot [5]. Fig 6 shows our URDF model as spawn in Rviz window. For communication between system and Arduino a ROS Serial package has been used. This library package worked on the principle of serial communication between devices which is particularly Arduino here. Basically, ROS Serial makes the Arduino board transparent to rest of the system [3]. Data acquired from system is converted in a ROS message to be sent to Arduino board directly at a baud rate of 57600 and accordingly actuators and other

electrical components work [10].

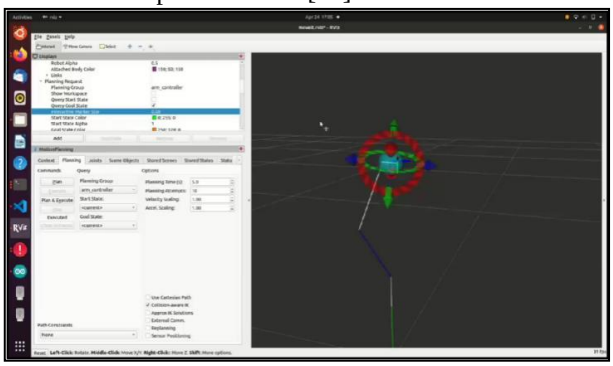

Figure 6**:** Rviz interface

ROS contained set of more packages as shown in Fig.7, in order to achieve a close to perfect motion.

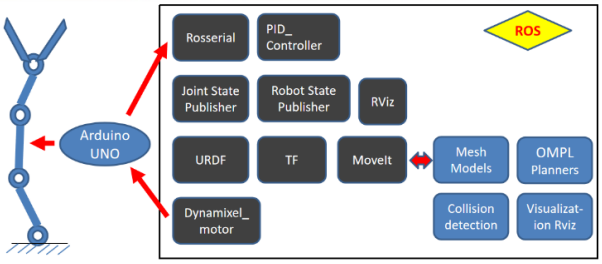

Figure 7**:** ROS packages and working

Moveit interface was done for robot joint movement plan from one point to another, basically the position of end effector is given and using planner it automatically calculates the joint position and angle of each link i.e., solving inverse kinematics in order to achieve that end point and to avoid collision between joints and objects in the environment [11].

5. TESTING

The end effector position is given in our URDF visualization on Rviz window, when executed the plan it calculates all the possible trajectories using OMPL planner and choose the optimal position in order to achieve a parabolical and smooth trajectory of our manipulator. The calculated trajectory is achieved in both simulation and real robot simultaneously as shown in Fig 8.1 and 8.2.

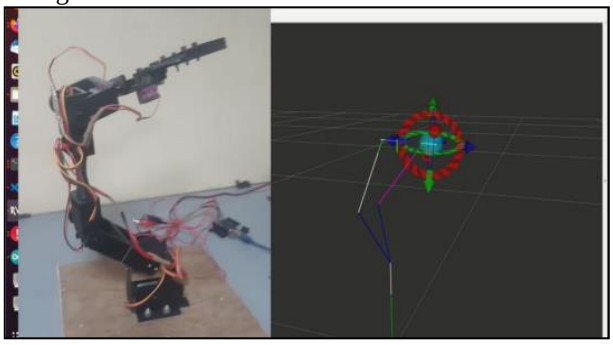

Figure 8.1: Simulation and control 1

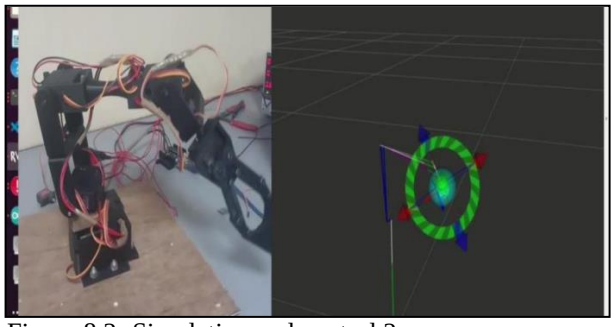

Figure 8.2**:** Simulation and control 2

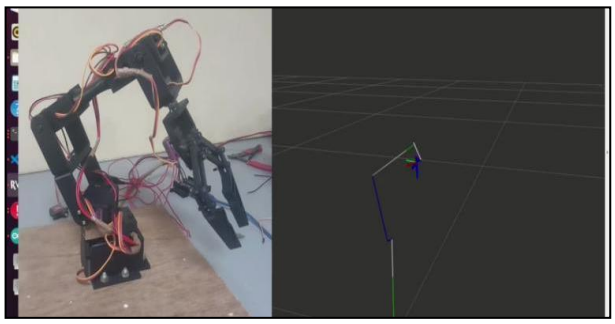

Figure 9.1**:** Gripper close position

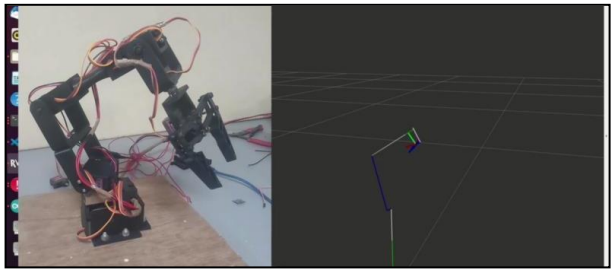

Figure 9.2**:** Gripper open position

6. CONCLUSION

Due to modernization manipulators are in great demand in various industries thus various researches are being conducted to make this field of robotics more friendly and convenient for usage at various levels. Due to the growing technology and advancement in this field various applications are available for manipulators, even for the educational purpose too. We have successfully designed a low-cost system, where a user can test their own programming methodologies and also successfully integrate it with new generation software of ROS which is rapidly growing in industries for making and programming robots.

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