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Automatic Patient Injection Robot With 6 Degrees of Freedom by 3D Simulation Using Webots Software

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Abstract

The manipulator robot is one of the most widely used robots in the industry. The movement of the robot manipulator in this sector is a mechanical system that requires a mathematical modeling method to represent its geometric aspects and manipulate its dynamic parts. One of the most critical industries is healthcare. In this paper, a simulation is carried out on one of the factors, namely patient injection. The research results from this simulation used Webots software and was successfully simulated using a 6-degree-of-freedom robot. The positions simulated in several movements include: gripper position opens to take the needle, gripper closes to take the needle, the needle is held and directed to the patient, the needle is inserted into the patient area and pulled out again, returning to its initial position by placing the needle. However, this simulation does not add a needle so that only the 3D simulated robot movement can move by entering the expected position value to inject the patient according to the target.

1. INTRODUCTION

Industrial robots are the main components of automation technology that can function as human workers in a factory but can work continuously and tirelessly (Pitowarno, 2006). One of the robots often used in industry is the robot manipulator, as evidenced by the 59% increase in sales of industrial robots, namely 183,000 units in 2016 for the Asian region (Olawoyin, 2018). The manipulator is a mechanical system that requires a mathematical modelling method to represent geometric aspects and manipulate dynamic elements (Nurhakim, 2010). One of the obstacles that often becomes a problem in studying robot manipulators is analyzing and deriving the kinematic equations of robot manipulators (Almurib, 2018).

Richard P. Paul managed to derive a kinematic equation for each manipulator determined from the position in the Cartesian coordinates. The orientation of the end effector has given from the coordinates of each joint in the manipulator (Paul *et al*, 1979). Then Jin Xuang, in 2012, simulated joint motion in the manipulator using the kinematic inverse method, which is more efficient and accurate than advanced kinematic techniques (Huang *et al*, 2012) but has yet to be applied to the actual manipulator. So, in this Big Task, a simulation of the forward kinematic, inverse kinematic, and jacobian methods will be carried out to move the 6 DOF (Degree of freedom) manipulator robot. The simulation uses webots software which performs a 3D simulation to facilitate the injection process for patients.

Webots is an open-source, cross-platform desktop application for simulating robots. It provides a complete development environment for robot modelling, programming, and simulation. Create various simulations, including two-wheeled desktop robots, industrial arms, bipedal robots, multi-legged robots, modular robots, automobiles, flying drones, autonomous underwater vehicles, tracked robots, aerospace vehicles, and more. Set up an interactive indoor or outdoor environment. Use webots for prototyping robots, developing, testing, validating AI and control algorithms, and teaching robotics to students (Cyberbotics, 2023).

2. METHODOLOGY

Figure 1 is a flowchart on webots (Cyberbotics, 2023). The methodology used in this simulation uses the webots application. The simulation starts by opening the application (Cyberbotics, 2023). Then select the new project directory and select the node by clicking PROTO nodes (Webots Project) with the robot node type. After that, do the control as expected (Cyberbotics, 2023). Control is carried out by positioning the end effector with a set position on each joint. This is done by changing the type of control in the sub ned section (Cyberbotics, 2023). Perform code control and build storage. Then, click on the keyboard in the form of letters and codes that have been entered (Cyberbotics, 2023).

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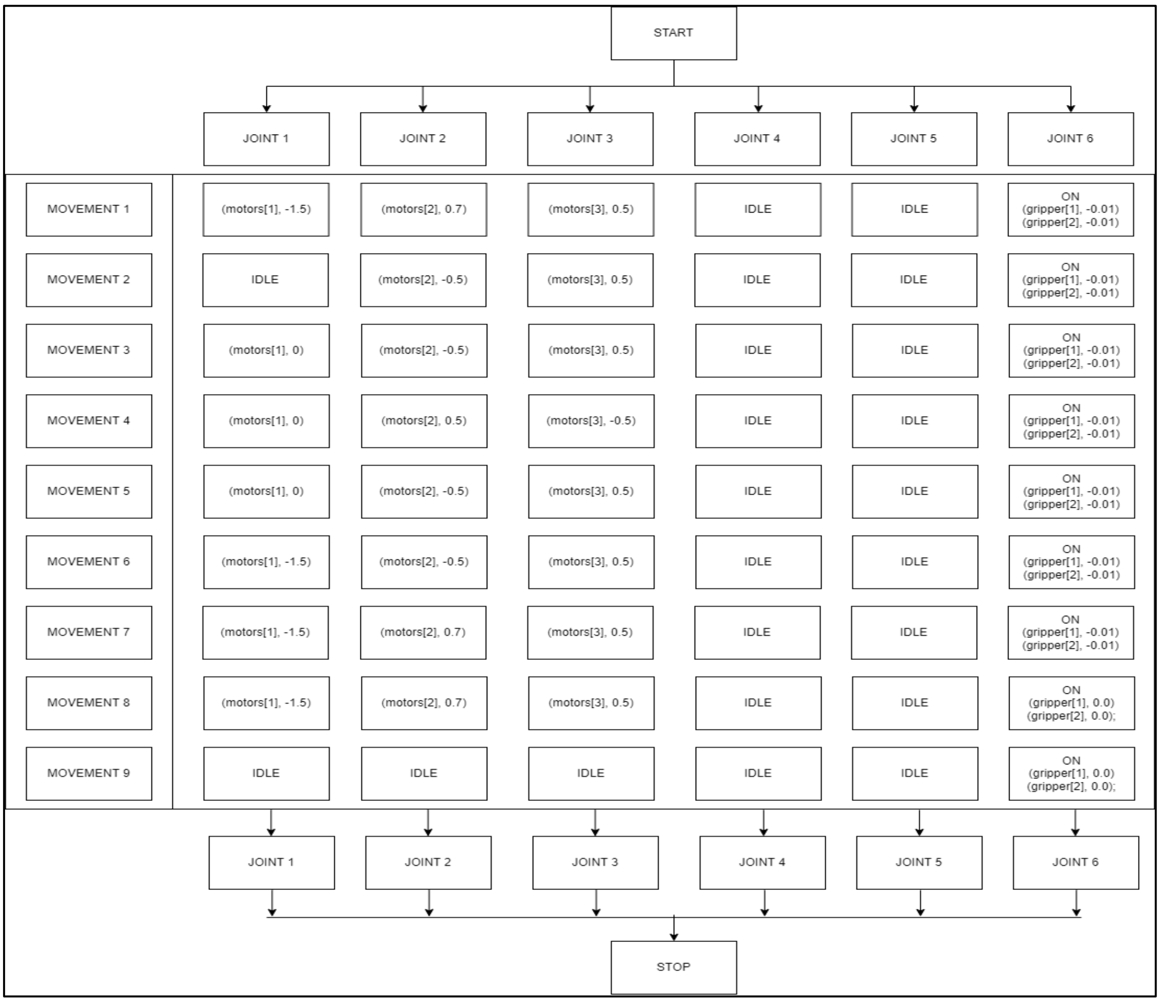

Figure 1.
Flowcharts on webots

3. RESULT

Figure 2 is an open gripper position on a robot with a simulation that will be assumed to take a needle for a patient. The gripper accepts the needle as an end effector in this simulation. The needle is at the point of being handled by the robot.

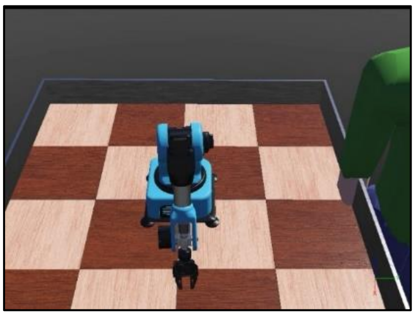

Figure 2.
Opened gripper position to pick up the needle

Figure 3 is a closed gripper position on a robot with a simulation that will be assumed to take a needle for a patient. In this position, the robot picks up the hand by closing the gripper to hold the needle injected into the patient.

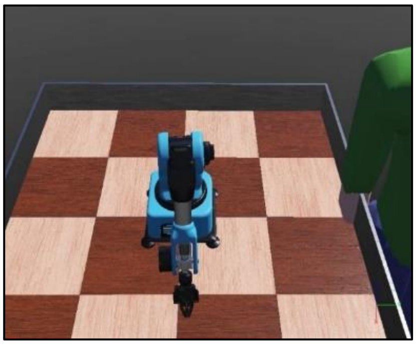

Figure 3.
Closed gripper position to retrieve needle

Figure 4 is the position of the gripper holding the needle on the robot with the simulation that is assumed to be taking the hand of the patient. In this position, the end effector position moves 45 degrees by moving joints 3-6.

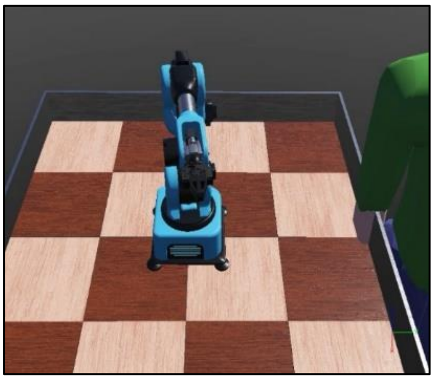

Figure 4.
First position with the needle towards the patient

Figure 5 is the position of the gripper holding the needle on the robot with a simulation that is assumed to be taking the hand of the patient. In this position, the end effector position moves 45 degrees by moving joints 1-6. This position of the needle leads precisely to the part of the patient to be injected.

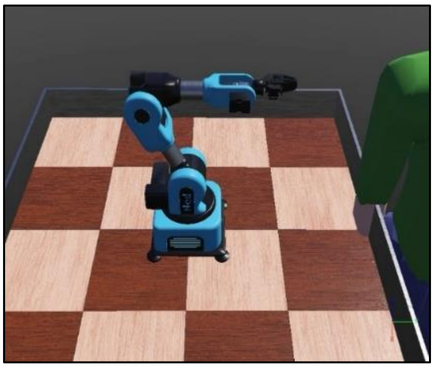

Figure 5.
Second position with the needle towards the patient

Figure 6 is the position of the gripper holding the needle on the robot with the simulation that is assumed to be taking the hand of the patient. In this position, move by moving joints 2-6.

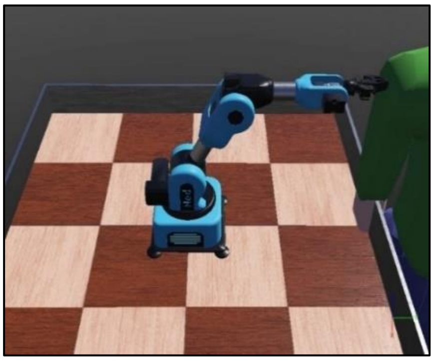

Figure 6.
Position of the needle to inject the patient

Figure 7 is the position of the gripper holding the needle on the robot with the simulation that is assumed to be taking the hand of the patient. In this position, withdraw the needle that has entered the patient by moving joints 2-6 backward.

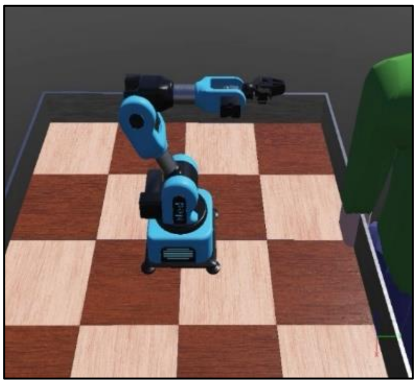

Figure 7.
The needle position was revoked

Figure 8 is the position of the gripper holding the needle on the robot after injecting a patient with a simulation. In this position, the end effector position moves 45 degrees opposite to moving joints 1-6.

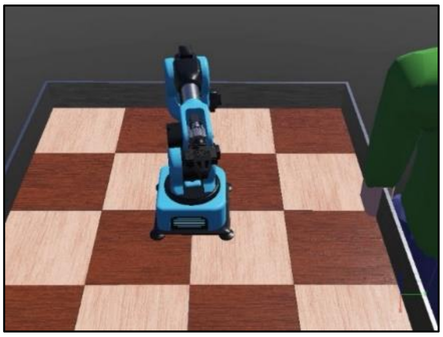

Figure 8.
Position the needle again in the opposite direction

Figure 9 is the position of the closed gripper holding the needle on the robot after injecting a patient with a simulation. In this position, the end effector position moves 45 degrees downward by moving the 3-6 joint.

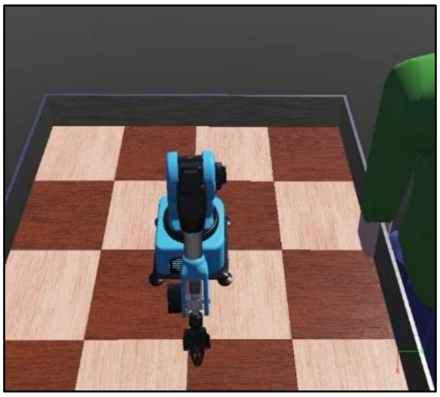

Figure 9.
The needle position is kept with the gripper closed

Figure 10 is the position of the open gripper holding the needle on the robot after injecting a patient with a simulation. In this position, the end effector position moves 45 degrees down by moving joints 3-6 and opening the gripper.

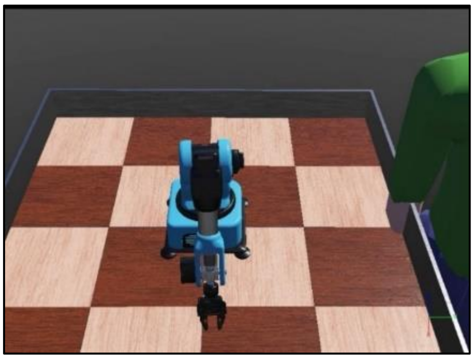

Figure 10.
The needle position is kept with the gripper open

4. DISCUSSION

The robot's position in this simulation can be done using the Webots software. This position needs further development to be implemented from the hardware side. This simulation has not added a syringe, only simulated the part of the robot. This simulation can be run with a total of 6 degrees of freedom.

5. CONCLUTION

Simulation using the webots application can be carried out for the robot manipulator application in 3D form. This application is intended or planned to facilitate injection in patients. A robot with 6 degrees of freedom can perform automatically on this paper. The positions simulated in several movements include: the gripper position opens to retrieve the needle, the gripper closes to retrieve the needle, the needle is held and directed at the patient, the needle stabs into the patient's area and pulls it out again, returns to its initial position by placing the needle. However, this simulation has not added a needle so that only the movement of the simulated robot in 3D can move by inputting the expected position value so that it can inject the patient according to the target.

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