EL 5223 - SENSOR BASED ROBOTICS

[Semester Project]

PICK AND PLACE ROBOT IN AUTOMATION INDUSTRY

PROJECT REPORT

Submitted in partial fulfilment of requirements of course EL5223 – SENSOR BASED ROBOTICS under the guidance of Prof. Farshad Khorrami

Sagar Panchal
N18051845
sap586@nyu.edu

NYU

Abstract:

A Robot is defined as a mechanism that can move and bring about changes in physical world. Robotics is a field with equal contributions from the Engineering Fields like Electrical Engineering, Mechanical Engineering and Computer Science. With the advancements in the fields of Computer Science, Electrical Engineering and Mechanical Engineering gives rise to a new field, Automation, which can thus be defined as implemented of control on the mechanism.

While Mechanical Engineering deals with the design and dynamics of the robot body, Computer Science deals with the controller, or the brain of robot. Likewise, Electrical Engineering acts as nervous system of the robot, i.e. – it connects the brain to the body of the robot to make it operable.

Moreover, the with the implementations of the sensors like force sensors, proximity sensors, light sensors, etc. and with the recent researches in the fields like Artificial Intelligence and Machine Learning, we can make a machine or a robot, as smart as human.

The applications of such smart machines are countless, and the number of the applications is increasing with lightning speed. I therefore intend to simulate such a robot by learning the science behind the field and show a simple example that how a robot can be used in modern industries.

Introduction:

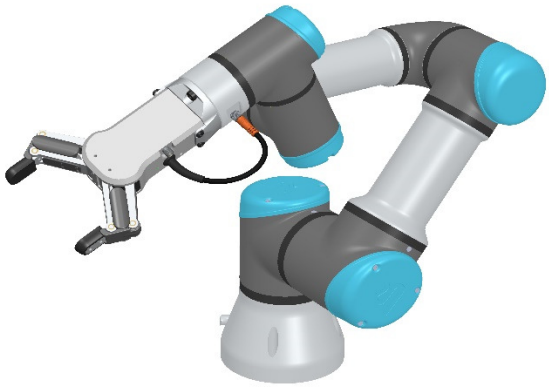
Any mechanism has many significant parts, and each of them contributes to the implantation of a task given to the machine. One such important part is a robotic-arm. A robotic-arm is kind of mechanical arm that is programmed to perform the tasks in a similar manner as a human-arm. A well-developed robot arm can be a total independent mechanism or a part of a more complex robot. The links of such a robot arm are connected by either a revolute joints or prismatic joints, based on applications and morphological constraints. To make the robot-arm, work like a human-arm, some emulation of a human hand is desired.

Like all activities in the human body is controlled by the brain, the activities of a robotic hand is also controlled by brain of the machine. As the human-brain gives the signal to the human body parts, the controller gives the signal to the parts of the robots. Thus a robotic-hand is said to be controlled by the program written in the brain, or the controller of the robot.

Moreover, the creator has provided the human hand with natural sensors that can sense the forces, temperature and other parameters, so that the human hand can perform accordingly. Similarly, applying the sensors into the robot arms, the robot arms are then made to work like the human arms, i.e. - they can now be considered as a part of a “Smart Robot”.

Experimental Techniques and Methods:

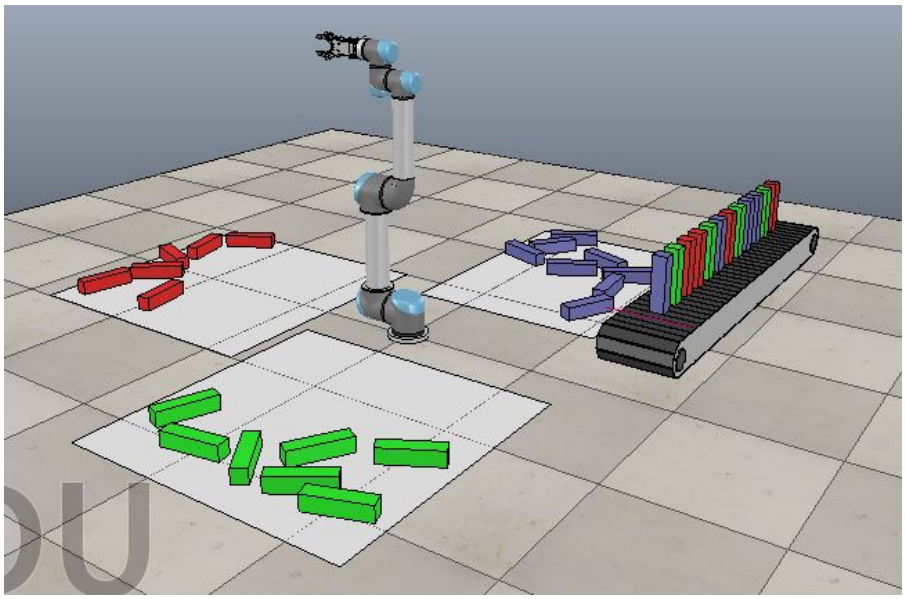
In my project, I have used “UR5”, a robot-arm manipulator developed by Universal Robots Inc., for the simulation in V-REP. Also, a gripper “RG2” is attached on the end-link of the manipulator.



The manipulator is simulated and is programmed to pick-up the things and place them at the desired locations. In the simulation, an environment is developed to show the working in an actual industry. The manipulator is shown to pick-up the different types of objects, (defined by different colours in the simulation), and after identifying them, they are placed at their respective desired positions.

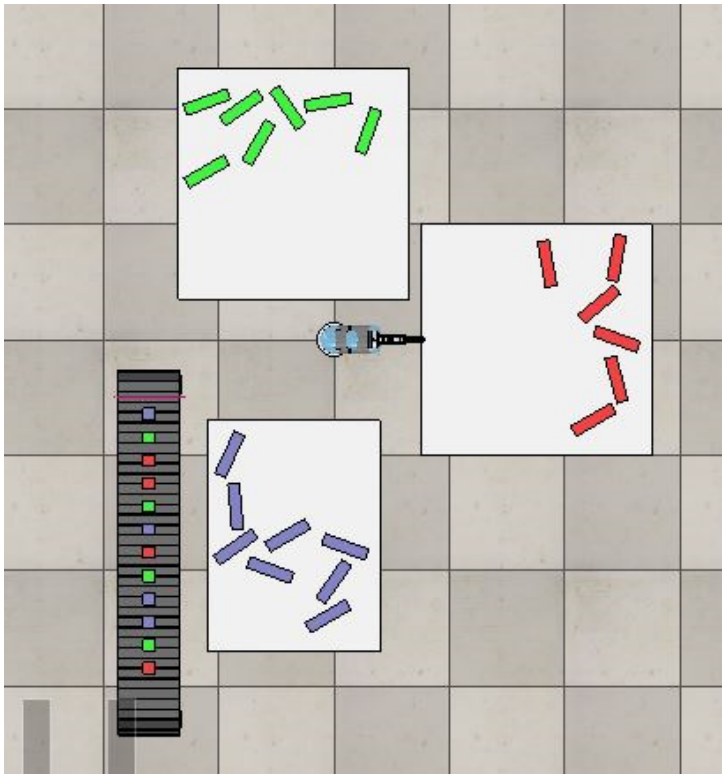
For all these things to be done, it becomes necessary to have a study on the fundamentals of robotics, including forward kinematics, inverse kinematics, path planning, velocity control, etc. It is sure that more fundamental theories we study about robots, the more our robot becomes smart, and it can perform its tasks more effectively.

For my semester project, I have started with the study and application of forward and inverse kinematics in my simulation. It all starts with the Inverse Kinematics. I have a robot arm with a gripper attached to it. I want the robot arm to go and pick a certain objects (objects are differentiated as the cuboids in simulation). To pick up the object, all we need is to know the position from where the object would be available for pick-up. This would be done by solving the inverse kinematics for the manipulator, or implementing the Dummy Object. The logic behind the dummies is that when we add two dummies, and link them together, the target dummy will attract the initial dummy. Thus, I have placed the dummy on the end effector of the manipulator and attached it with the last link of the robot. Let’s call it as “Tip Dummy” for instance as it is located on the tip of the robot arm. Then I placed another Dummy, and let’s call it as “Target Dummy”, as it is to be followed by the Tip Dummy. Once both the dummies are linked, then running the simulation on, the Tip Dummy will follow the Target Dummy and so does the robot arm.



I have used a conveyer belt on which different boxes are placed and a proximity sensor is placed on one of the end of the conveyer belt. Thus, whenever the object sensed by the sensor, the conveyer-belt would come on rest, and then the robot gripper will come and pick the object up. The use of conveyor-belt, had helped me to fix a single position for the pick-up.

Once the robot reaches the pick-up position, and the object is picked up, the next task of the robot is to decide where to place the object. In my simulation, I have chosen different coloured boxes and the task is to place them along with the same types of the boxes. The target positions of the robots are found by using the dummies again. The target dummy is placed at the desired position and the orientation and positions of each links and joints are noted. Then the angles of each joints are altered in the code to bring the manipulator in the desired position where the object is to be placed.



Discussion and Future:

The implementation of simple sensor like the proximity sensor and basic study of the fundamental theories in Robotics made the repetitive task to be done by the robots. Sometimes, the tasks are dangerous and thus the humans are saved from doing the dangerous tasks in the industries.

With the further implementation of different sensors, the robot can be completely converted into the smart robot, which can think of itself. For example, the application of force and pressure sensors can make a smart decision about the force implementation of on different objects. The Theoretical study about Force Control can further be used to control the torques and forces on each joints, and thus finally control the forces on the end objects. Additional implementation of the Computer Vision gives robots, the ability to see the objects and distinguish between them. So the damaged objects can be sorted off and thus resulting the improved the efficiency of the product. Moreover, the advancement of Artificial Intelligence can bring the decision making ability in the robots. For example, the robots can decide what to do with the objects. It would be the robot's own decision once the program is written on the robot CPU.

Thus, we can bring more and more smartness in the robot by applying more and more sensors and conditions to the robots.

Conclusion:

The report has discussed the development of a simple manipulator, resembling a robotic arm-gripper set. The set-up is simulated using the simulation tool, "V-REP". Simple technique of implementing forward and inverse kinematics, dummy-dummy linking and application of proximity sensor and conveyer belt is presented and a complete work environment of Automation in Industries is simulated.

A discussion over further development of the robots and the contribution needed for the development is done in the report.