Acta Mechatronica - International Scientific Journal about Mechatronics
Volume: 1 2016 Issue: 2 Pages: 27-30 ISSN 2453-7306

THREE AXIS LINEAR PORTAL MANIPULATOR

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Keywords: mechatronics, manipulator, actuator, sensor
Abstract: Three axis portal manipulator is nornally designed with four portal comception. This paper describes special type of three axis manipulator with only two portals. Designed manipulator are designed for educational purpose and practical training for students. RC servos are used as acutators for moving of all axis. Resistive sensors are used for sensing of movement in *x, y* axis.Rotary encoder is used for *z* axis movement sensing.

1 Introduction

Development of manipulators has been started from 70ties years of last century and it is coupled with substitution of human hand work. New technologies enable rapidly development of new generations of manipulators which are applied in various area of industry as metallurgy hard manipulator, automotive industry manipulator, montage manipulator, medical manipulator, space flight manipulators etc.

Characteristic attribute of linear manipulators is linear movement in all axes. Very often are used acronym cartesian or portal robots. Applications of these types of manipulators are mainly in manipulation with objects, mounting process and they are often also called as pick & place robots.

Solved manipulator has been developed as didactic aid for educational purposes. Almost all these type of manipulator has four pillars and it can be as problem for inserting of handled objects etc. Our solution (Figure 1) has only two pillars, so that is better for insetting of handled objects.

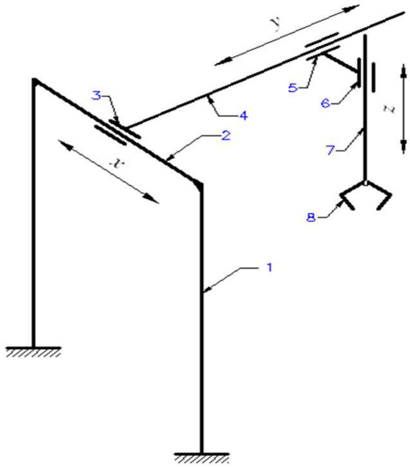

Figure 1 Conception of two pillar cartesian manipulator

It consist (fig. 1) of two pillars (1), x traverse (2) with guiding (3) connected to y traverse with guiding (5) connected to z guiding (6) with steering pivot (7) in axis z. End-effector (8) is connected to steering pivot (7).

This conception (Figure 2) is ambitious, because the main problem is stiffness and stability of all parts, which can be as source of oscillating of end-effector.

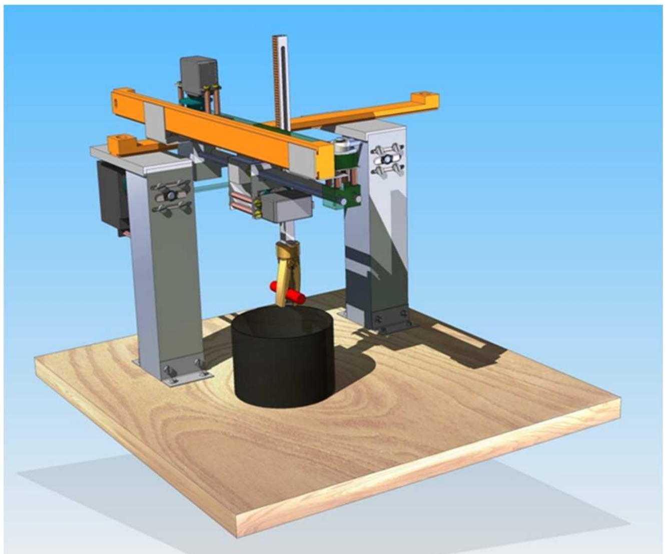

Figure 2 3D model of conception of two pillar cartesian manipulator

2 Construction of two pillar manipulator

Robotic servos have been used as drive units for generation of motion in all axis and they converts electrical energy to mechanical works. These types of servos are controlled with pulse with modulation signal. The servos are modified to continual rotation. It means that desired value of velocity rotation is defined via using of duty cycle.

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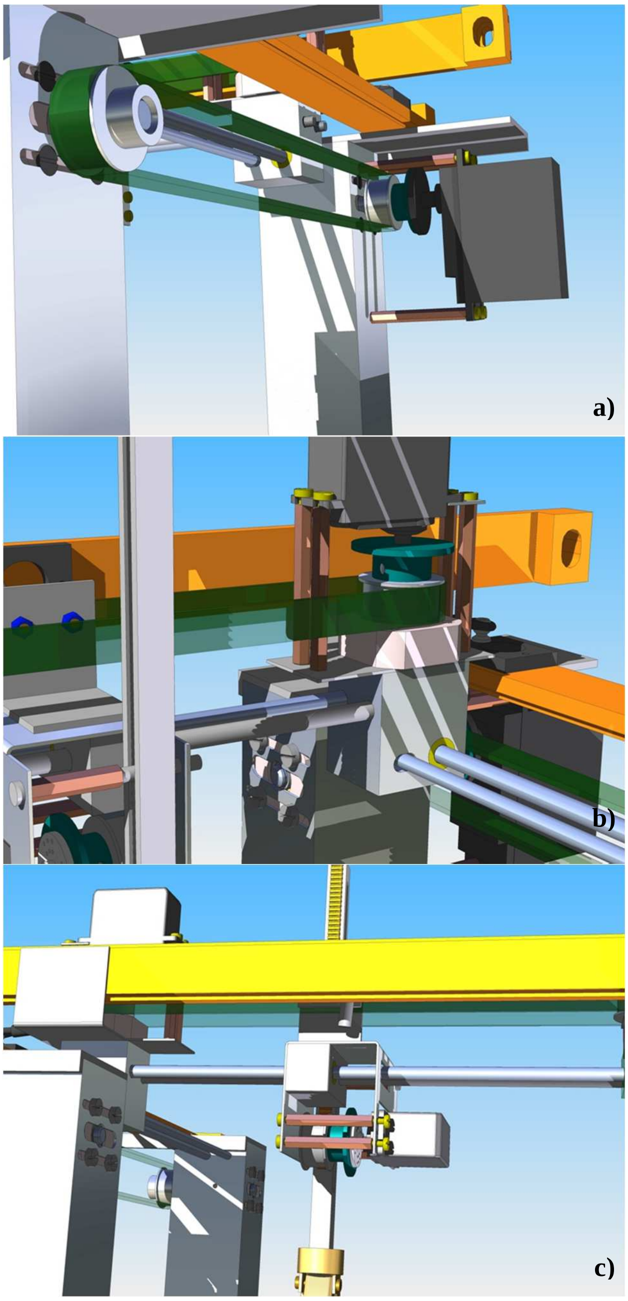
Position resistive sensors are used for measuring of actual position in all axes and this information is used for feedback for position control. These types of sensor are not preferred but several last years' research and development in this are growing up and new type of resistive elements and wiper have been introduced. Also this type of new sensor has very long life up to 50 million cycles.

Used servos are rotational actuators and it is necessary to convert rotation to linear motion. Toothed belts have been used for this conversion (Figure 3)



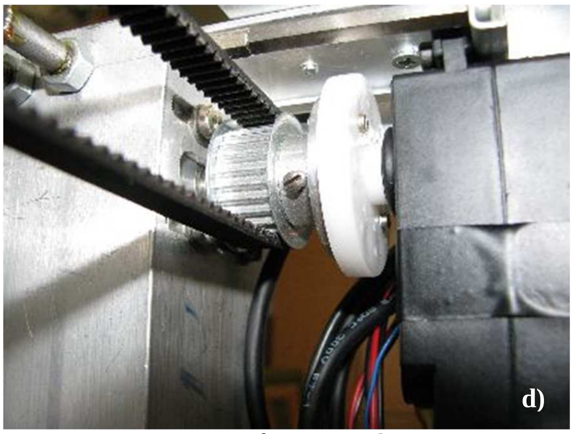


Figure 3 Conversion of rotation to linear movement

Main advantage of toothed belts is power transmission without belt creeping but tightening mechanism is necessary for right function of belts. Tightening mechanism causes additional load to construction of manipulators. This additional loading has to be considered into design and calculation of manipulator for both X and Y axis.

Z axis (Figure 4) has been more complicated. Beam for Z axis with endeffector cannot be carried via using the same way as X and Y axis.

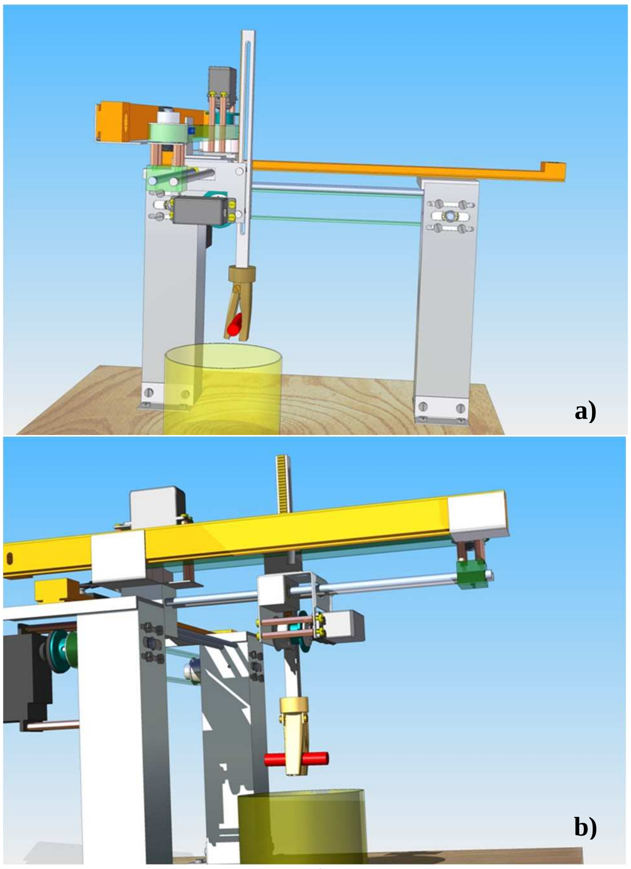


Figure 4 Design of Z axis movement

Beam for Z axis has attached piece of tightened toothed belt. Belt pulley is attached to output horn of servo. Position of Z axis can be counted via using of optical encoder rotational sensor connected to servo. Final design of axis movements defines the manipulation work-space of end-effector (Figure 5). Simplicity of manipulator construction also enables the simple programming than joint manipulator with large number of degree of freedom.

All sensors and actuators can be connected to microcontroller or data acquisition card. This manipulator is designed as didactic tool, and students can train data acquisition of signals and feedback controlling. Also results obtained from inverse kinematic can be included into program. Other special task is the solving of dynamic effects for manipulating with hanged weights. That is the similar problem like weight manipulating via using of crane.

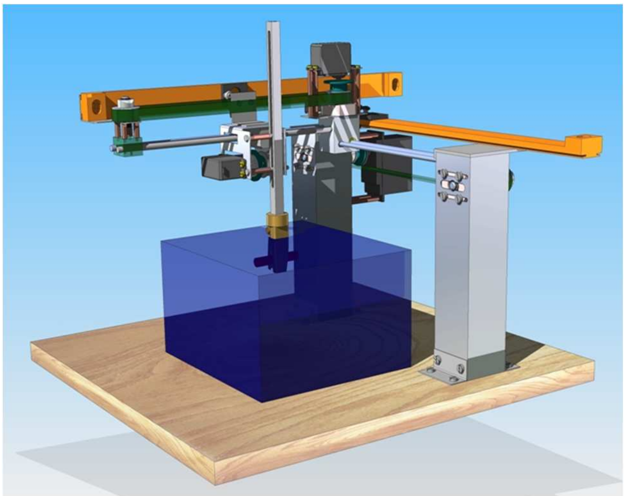


Figure 5 Work-space of manipulator

3 Conclusion

This concept of manipulator helps to understand various problems from several areas of science. Stiffness of construction is another problem, which can has impact to control process. Also used mechanisms have any disadvantage as tooth backlash, backlash of bearings, friction forces etc. All these effect cannot be neglected in design of control [1]-[15].

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Review process

Single-blind peer reviewed process by two reviewers.