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Testing and Calibration of Gantry Type Robot

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***Abstract*: Increase in rapid growth of technology significantly increased the usage and utilization of automation systems in industries. The use of automations is to increase the efficiency and to reduce the human effort. The gantry crane is often used for carrying a load and its entire structure including gantry is usually wheeled often on rails. The project discusses the testing and calibration of gantry robot for CNC milling machine which is capable of 3-axis simultaneous operation. This system uses programmable logical controller used for automation of industrial electromechanical processes, such as control of machinery on factory assembly lines etc., The ladder program is used to control the movement of gantry robot. The testing process involves axis movement with varying load and velocity, precision and accuracy testing and time calculation. Varying these parameters will give a potential loading and unloading of components to the CNC router machine which will be cost effective.**

***Keywords*: CNC router, PLC programming, Gantry robot, Automation process, Clamping and de-clamping.**

1. Introduction

Industrial robot as defined by ISO 8373: An automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which may be either, fixed in place or mobile for use in industrial automation applications. An industrial robot does task specified operations based on specifications for defined motion. The most basic application of an industrial robot is pick and place operation in which it picks up a part at one location and moves it to another location. For pick and place operation, one of the major element in the specifications of task is kinematics. Now a days most of the industries are automated even in a small scale industries. Main aim is to fixing of robotic arm type is to set the object in the desired location and also place in the specified period of time.

A. Gantry pick and place robotic system

The development of manipulation system for different application purposes has been carried out at the department of electronics control and instrumentation of the University of Petroleum and energy studies. The system indented for the most general application scope ranging from industrial application to more specific application such as medical tasks. For the accurate analysis, the Cartesian coordinate robot has been chosen with 3 degree of freedom, working in X, Y and Z axis .Due to the need of a modular structure so that, the components of the robot can be easily substituted and removed without disturbing the whole structure. For instance in this system, we have added an end-effecter in Z axis which is now a pneumatic gripper for pick and place mechanism that can be replaced easily with some different actuator according to the requirement. The advantage of this pick and place gantry robot are its capabilities to move in X, Y and Z direction. It rigidly allows for more precision. It is easy to program and is strong dependable mover. Its payload is larger and fully supported. The main goal of this project is the implementation of a pick and place mechanism gantry robot which can load and unload the work once if completed after the machining process in a CNC milling machine. This is evaluated using the base gantry system, PLC.

B. Testing and calibration

Calibration is a measurement technology and comparison of measured values get by a device under test with those of a calibration standard of known accuracy.

C. Load testing

Load testing is a kind of Performance Testing which determines a system performance under load conditions. This testing usually identifies the maximum operating capacity of the gripper.

D. Position and accuracy in robots

The main characteristics of a robot whose position and accuracy are likely to be important to evaluate, path, position and orientation. These are the factors that achieving each and every time of robot and end effector in motion. The combination of position and orientation with the robot is called a pose. The position and accuracy is the ability of the robot to reach a specific programmed position with a minimum of error.

E. Objectives of this work

- To integrate, test and calibrate the gantry robot for pick different type of material and place them in their desired position in the CNC milling machine.
- To test the unit for loading and unloading operations in a CNC milling machine.
- To check the picking and holding capacity of gripper.

F. Scope of the work

- The system is used to do pick and place operation in industries like machining unit, assembly section and also in packing units.

- The system is flexible so that it can be used for loading/unloading time consumption.
- This system is used in precise material handling applications.

2. Methodology

The Gantry robot machine used in the testing, calibration process and also sensing units are mentioned.

- Integration
- Pick and place mechanism
- Sensing unit
- Calibration
- Testing procedure

A. Integration

Integration is the process of merging an industrial robot, peripherals and manufacturing machinery into a production system that functions as a single unit. Capable of handling components weighing up to several tonnes with extreme accuracy, speed and repeatability. The gantry robots have been developed as a standard robot line for easy integration with other automatic machining, welding or robot assembly equipment.

B. Pick and place mechanism

Robotic pick and place automation speeds up the process of picking parts up and placing them in new locations, increasing production rates. Moving large, small, heavy, or hard-to-handle products can be an easy task to automate in the factory line. Consistency is also a benefit of using a pick and place system.

C. Sensing unit

The sensing unit is otherwise called as sensors. In case of picking and placing the materials first the robot has to sense the presence of material. Clamping applications often rely on sensors to detect whether the jaws or grippers are in the proper position, open or closed. Though other technologies can be used in place of sensors to determine the open and closed conditions, sensor implementation can increase reliability and obtain data that only a detection device very near the application can provide. Among various type of sensors, Proximity sensors in these applications are used to ensure the part is in place or the position of the grippers.

D. Calibration

Calibration is the comparison between the standard measurement and the measurement taken using the instruments and then calibrating the taken measurement into a calibrating range. The universal laws show that for every 200 pulses 360orotation can be achieved. In some case 3600 cannot be achieved due to some external factors for that extra pulses are given to achieve full rotational movement. This process is known as calibration.

E. Testing procedure

1) Load test

The load testing of gripper involves finding the load capacity and gripping force required to the pick and place work piece. The robot gripper with two fingers is the type of gripper used for picking and placing the work piece material. The load testing is to be conducted to find the maximum load carrying capacity of the gripper and to check the maximum holding capacity of the gripper.

2) Position accuracy

The position accuracy of the gripper can be attained by selection of the ball screw and the stepper motor. The nature of gripper influences the position and accuracy. Often, gripper fingers for handling light plastic parts are made from aluminum or steel and are much stronger than necessary and, hence, overly heavy.

3) Testing of loading and unloading

The loading and unloading test involves checking whether the work piece is carried by the gripper or not by repeating the same operation for number of times to increase the efficiency of the gantry unit. For achieving maximum efficiency of the unit the proximity sensors are used to check the loading and unloading operations.

4) Speed test

The speed test involves in finding the speed and timing of transporting operation of work piece from one position to the clamping area of the milling machine. It is checked by varying the weight of the work piece. Based on shape and size of the work piece materials the testing is to be carried out and the time calculation for varying load and size of the material are to be noted based on the results.

Speed test procedure:

- Find the maximum load carrying capacity.
- Calculate the speed of operation by adding the load gradually from low capacity to maximum capacity.
- Note the time of operation and the distance travelled.
- From the above parameter the speeds of different load are calculated.

3. Testing

A. Pick and place robot testing

1) Technical data

The technical data implies the data that represents total number of axis, height and weight of the gantry robot. The gantry robot has the capability to move 3 coordinate axis, maximum height of 500mm and maximum weight of 1.5kg. The technical value is mentioned in the below given table 1.

B. Axis calibration data:

The gantry robot has the ability to move the work piece in all the three axis in linear motion. Each axis moves in linear motion with specific velocity and acceleration based on the inputs given in the PLC. The axis calibration data contain the value of movement occur in the ball screw with the speed value are

given for the movement of gripper axis and other axis movement

The Axis calibration result is shown in the table 2.

C. Accuracy and precision

Ball screw assembly describes structure and operation. Circuits, turns, lead, pitch are used to quantify various aspects of ball screw assembly. Ball screw are noted for effectively moving high load with the outstanding accuracy. Ball screw handle both compression and tensile load. One ends supported with double end bearing and other end is free. Ball screw has 5mm pitch and its move with the definite pulse and speed in the control box. It can move to the definite speed with respect to the revolution per minute.

Accuracy obtained in the axis of movement:

Accuracy = Set value – Received value

X axis =+0.1

Y axis =+-0.1

Z axis =+0.1

Theoretical calculation:

Screw pitch =5mm

Distance moved by revolution = 5mm

If 20 rpm given to the ball screw it move 100 mm/min.

D. Sensors

The sensor used in the robot is NPN-NO Inductive type sensors.

It has 24V input is given to sensors. If PNP Inductive sensor used. we get only 0 value. For further development we used electric type sensors.

1) Load testing

The load testing is the method to check the maximum load to be carried by the machine for the different size of different materials to be machined by the CNC milling machine. The test values are noted below

Load carried by motor = 25 Kg(Max)

Weight added in the motor = Ball screw+ LM rail +Aluminium block+ Gripper =15 (approx.)

Total weight carried by gripper is 5 Kg (Min) and up to 8 Kg (Max).

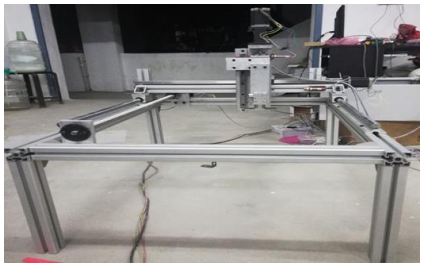

Fig. 1. Pick and place robot

4. Benefits and future development

The integration of milling machine and Gantry robot provide the advantage of large work areas and better positioning accuracy. Position accuracy is the ability of the robot to place a part correctly. Gantry robots are easier to program, with respect to motion, because they work with an X, Y, Z coordinate system. The gantry robots are designed with high precision as only simple and cost-effective sensors are used. This robot can be easily fixed to and detached from the frame on the field, thus ensuring effective.

Table 1
Technical values

Parameters	Values
No of axis	3+Gripper
Height	600mm
Weight	40Kg
No of input sensor used	5
No of output used	8

Table 2
Axis calibration result

Axis	Set value(mm)	Set speed(mm/min)	Received value(mm)
X-axis	100	100	99
	110	110	110
	150	150	151
	200	200	198
Y-axis	100	100	102
	110	110	101
	150	150	150
	200	200	199
Z-axis	10	10	11
	25	25	25
	50	50	50

It is planned to scale up the prototype of CNC milling machine in terms of size, use more powerful motors, strengthen the frame and worktable with materials like aluminium or mild steel and augment the CNC control software .For instructional purposes as well as for more precise operation ,it is preferable to build CNC machines with servomotors and encoder feedback using motion controllers. It is planned to implement the servomotors in industrial applications, robotics, in-line manufacturing ,pharmaceutics and food services. Stepper motors can operate with or without feedback, with the rotation of the motor moved up into small angular steps. When power is removed, a permanent –magnet stepper motor generally remains in its last position. Multiple stepper motors can be maintained in synchronization by driving them from a common source.

Large gantries are overhead structures for heavy loads often featured in automotive factories, aerospace facilities, shipping yards, and assembly plants. These larger gantries are more likely to use rotary motors with wheels, gears, or pulley systems instead of linear motors. Depending on size and application, gantry systems can be operated with start/stop controls or with intelligent control features.

Gantries that are supported by LM rails on two sides and prevent binding. servo motors can be implemented to coordinate their motion. Beyond this, servo drives can assist large vertical axes in handling regeneration. The servo motors are controlled by a signal better known as a pulse width modulator (PWM). A servo motors at every “joint’’ of a robot is used to actuate movements, giving the robot arm its precise angle.

5. Conclusion

With the increasing demand for small scale high precision parts in various industries, the market for small scale machine tools has grown substantially. Using small machine tools to fabricate small scale can provide both flexibility and efficiency in manufacturing approaches and reduce capital cost, which is beneficial for small business owners. In order to overcome the manpower and production rate and also increase the efficiency the robots and automations machines are used. In this project, a small scale three axis gantry robot is designed and integrated with CNC milling machine.

References

[1] B. O. Omijeh, R. Uhunmwangho and M. Ehikhamenle (2014) "Design analysis of remote controlled pick and place robotic vehicle", Vol 10, PP 57-68.
[2] Modi Akshay Kumar Mahendra Kumar, Pravin Kumar D Patel, MS vahut Trushnaben Bhagubhai (2017) "Design and development of pick and place robotic arm using PLC SCADA". SIETCON 1st International conference on current research in Engineering.
[3] Samson Khoo Hockchye (2018) "Design and analysis of robot gripper for 10kg payload". University Teknikal Malaysia Melaka.
[4] Shubi Thatere, Yajush Sharma, Roushan Kumar and Parbbhpreet arora (2016) "Design and implementation of a gantry robot for pick and place mechanism with obstacle detection using programmable logic controller. Vol 20, 2016.
[5] Vishnu R Kale and V. A. Kulkarni (2014) "Automation of object sorting system using pick and place robotic arm and Image processing", 2014.