Smart Pick and Place Robotic Arm Using Belt Drive

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Abstract: **Robotic arm plays an important role in industries. In this paper the smart robotic pick and place arm is a robotic arm with six degrees of freedom and enhanced control and feedback system to properly place the object at desired position and platform. The smart arm first confirms the existence of a surface and only then places the object on the surface. Optical Encoders, proximity sensor and Limit switch are used for feedback system.**

Keywords: *pick and place arm, enhanced control and feedback system, microcontroller, belt drive, gear drive, six degrees of freedom.*

1. INTRODUCTION

Robots are generally used to perform unsafe, highly repetitive and unpleasant tasks. They have many different functions such as material handling, assembly, welding and machine tool load and unload functions, painting, spraying, etc.

There are mainly two different kinds of robotic arms: a service robotic arm and an industrial robotic arm. Service robotic arm is a robot that operates semi or fully autonomously to perform services useful to the well-being of humans and equipment, excluding manufacturing operations [1]. Industrial robotic arm, on the other hand, is officially defined by ISO as an automatically controlled and multipurpose manipulator programmable in three or more axis [2]. Industrial robotics arm are designed to move material, parts, tools, etc.

In 2007 the world market grew by 3% with approximately 114,000 new installed industrial robots. At the end of 2007 there were around one million industrial robots in use, compared with an estimated 50,000 service robots for industrial use [3].

Due to increase using of industrial robot arms, an evolution to that topic began trying to imitate human movements in a detail mode. For example, a group of students in Korea made a design of innovations that robotic arm take account of dancing hand, weight lifting, Chinese calligraphy writing and color classification [4]. Another group of engineers at USA develop eight degrees of freedom robot arm. This robot is able to grasp many objects with a lot of shapes from a pen to a ball and simulating also the hand of human being [5].

In this paper, the smart robotic arm receives a command from controller for picking up a particular object and then place the object at pre-programmed location. Also before placing the object the existence of surface on which the object is to be placed is confirmed. Due to this the damages to the objects in case of absence of surface is avoided. For smoother functioning of smart arm timing based pulleys and belts are used instead of gear mechanisms.

2. MECHANICAL DESIGN

A. Free Body Diagram

The mechanical design of the smart robotic arm is based on a robot manipulator with similar functions to a human arm. As shown in Fig. 1, the gripper is not included in the design because a commercially available gripper is used. This is because that the gripper is one of the most complex parts of the system and it turns out it is much easier and economical to use a commercial one than build it.

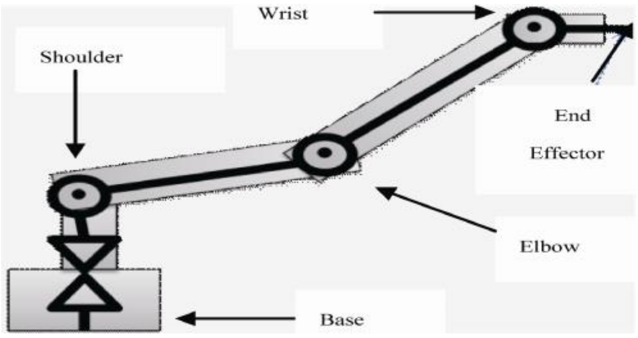

Fig. 1

B. AutoCAD Design

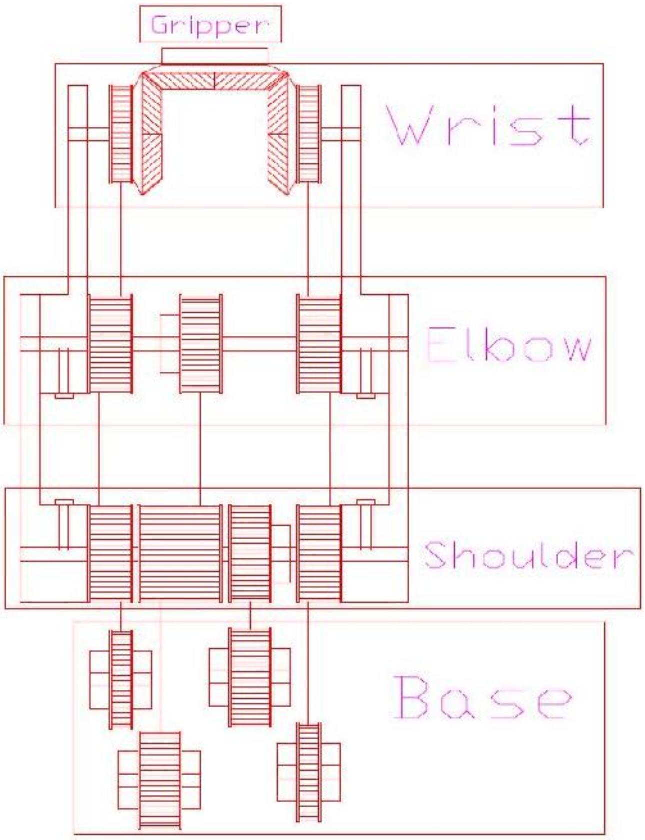

Fig. 2

As shown in Fig. 2, the smart arm consist of multiple timing based pulleys and belts. Each pulley having XL-26 teeth. Width of pulleys are variable as per the application. The smart arm is basically divided into Base, Shoulder, Elbow, Wrist and Gripper section. All movements of these sections are controlling via motors placed in base section. Base section consists four motors out of that two motors are for driving wrist movements. Shoulder and Elbow movements are also controlling by one motor each. These base motors are placed in a base station and below the base station there is another motor to rotate horizontally whole arm (not shown in design). Any pulley which is transferring the force to next stage is consisting bearing inside it to rotate frictionless on that particular stage.

In wrist section three bevel gears are used. Two of them are connected to base motors and remaining gear is placed between two bevel gears. So gripper is connected to this third bevel gear placed between two. When base motors of bevel gears rotate in same direction then gripper gets vertical movement and motors rotate opposite to each other then gripper gets rotational motion.

C. Belt Drive vs Gear Drive

Each drive serves its purpose, comparison between belt and gear drive are given in Table 1.

Belt Drive	**Gear Drive**
The slight misalignment is tolerated.	The misalignment is not tolerated.
Belt drives do not require lubrication.	Gear drives do require lubrication and that too on a regular interval.
The driven element in belt drives is isolated from the driving element so driven element stays safe from shocks, vibrations etc.	The driven element in gear drives is not isolated from the driving element.
Belt drives are quieter in operation.	Gear drive is not quieter in operation due to gear interfacing.
Belt drive can be used to transmit power between two shafts which are far apart.	In gear drive, both driving and driven gear should be touched.
Belt drive is lot smoother.	Gear drive is not that much smoother.
Easy, flexible equipment design.	Complicated equipment design.

Table 1[6]

Due to these advantages belt drive is preferred. Cost and weight of belt drive is also less as compared to gear drive. The biggest advantage is that it can be used to transmit power between two shafts which are far apart. Depending on the type of pulleys and belt the efficiency and power transmission can be adjusted.

3. CONTROLLING

Block diagram for controlling section is shown in Fig. 3. The motors are mounted with optical encoders which gives the feedback of rotation of motors. By pre-feeding the number of counts of encoders in the program the motor rotations are controlled. A gyro sensor is attached on the gripper to maintain the orientation of object. Also a proximity sensor is attached near the wrist of arm.

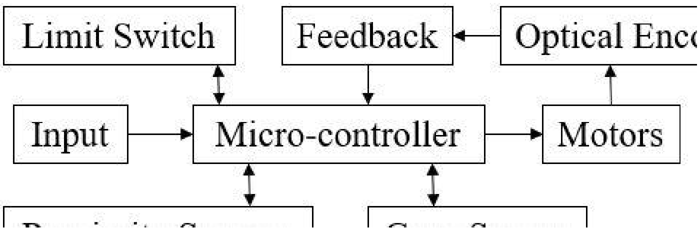

Fig. 3

A proximity sensor gives a feedback if a platform is present within the set distance. The distance can be adjusted according to requirement. While placing the object on the platform, the proximity sensor gives feedback as the platform comes within specified range. Then the speed of arm slows down. A limit switch is attached at the bottom of grippers. Now as the arm approaches the platform the bottoms of gripper and the object are touched to the platform. The limit switch at the bottom of the gripper gets pressed and a feedback is received to open the grip. In this way first it is confirmed whether a platform is present or not to successfully place the object.

4. CONCLUSION

The need of robotic arm in industry is increasing due to the increased need of efficiency and flexibility, innovation has begun in this field to imitate human arm details. In this paper a concept of smart robotic arm is kept forward. The arm maintains the orientation of the object and also confirms the existence of platform before placing an object on it. For smoother functioning and flexibility belt drive mechanism is used.

5. RESULTS

The smart pick and place robotic arm successfully traverses the defined path pick up an object and after confirming the existence of platform places the object.


Fig. 4 Picking up of object

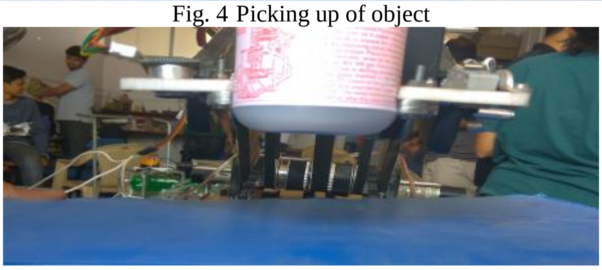
Fig. 5 Traversing the path


Fig.6 Determining the platform existence for lacing object

6. FUTURE SCOPE

The smart pick and place robotic arm can be integrated with a camera and through image processing it can be converted into a real time response system which can be implemented in nuclear power plants, chemical industry etc. where hazardous environment exists.

7. REFERENCES

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