Modeling of an Automatic Positioner -A Mechatronics Approach

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Abstract: Now a day's application of Mechatronics in machines is necessary to improve accuracy, repeatability, decrease the lead time and decrease requirement of labor. This paper is mainly concentrates on development of a mechatronics product which consists of servo system for two axis position control of welding positioner using PLC and HMI. The system may increase accuracy and precision of welding in terms of position and welding speed with its direction. This paper first explores the current welding positioner model and possible improvements in the current system. The paper deals with the scope of servo scheme and PLC on welding positioner. The modifications which are done on welding positioner make it more suitable and powerful in context of conical and cylindrical jobs. The proposed model of this positioner will help industries a lot for increasing the productivity.

Keywords: welding positioner, servo motor, PLC, HMI

1.0 INTRODUCTION

1.1. Existing system

A positioner is a device with flat that rotates in circular and tilting motions. Flat allows 360° rotation to rotate circular and conical work piece. This allows worker to stand in one position and constantly work on a leveled surface. This prevents worker fatigue and increases productivity since the welder does not need to constantly move around the pipe to complete the weld. This method of work piece mounting also tends to ensure consistently high quality welds since no overhead or vertical runs are involved.

Fig. 1 positioner

The fabrication of large steel structures by welding is expensive and difficult whether such welding is done automatically or by hand. Automatic welding requires that some means be provided by which work can be brought to the welding electrode at a predetermined rate which must be variable dependent upon the Welding being done, and hand welding requires that the operator frequently change his position or the position of the work itself. When structures of the order of fifty tons are being welded, the usual use of a crane for positioning the work does not provide such control of movement of the work as permits the use of automatic welding and even hand

Welding must frequently be done in vertical or overhead positions and at great height from the floor when only a crane is available. The welding operation is therefore difficult and expensive because slow and it may be very dangerous to the operator. So, use of positioner will increase the safety and production rate.

This positioner can operate job of specific size with rotation speed 0.07 to 1.00 RPM and tilting speed of 0.6 RPM. For both rotation and tilting it uses induction motors and gear boxes with specific gear ratio. Gear ratio of gear and induction motor is depends on the capacity of positioner.

1.2. Application

- This machine is generally used for positioning of job for different application like welding inside cylindrical and conical job.
- Also useful in welding around circumferential joint.
- This is also useful in welding and inspection of casing of turbines like steam turbine, Francis turbine, pelton turbine etc.
- It also found its application in inspection of solid as well as hollow shaft having large diameter which is difficult to operate manually or by crane for ultrasonic test

2.0 PROPOSED MODEL

2.1. Figure in 3-D

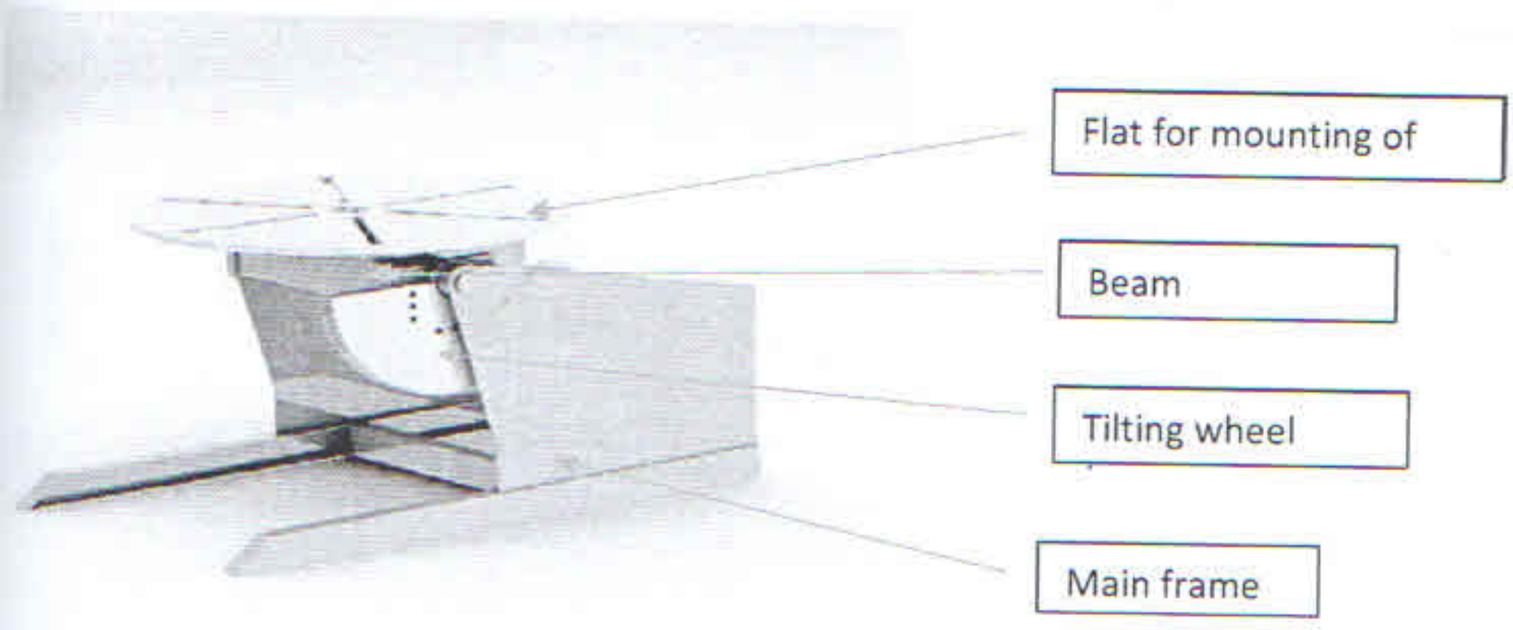

Fig 2 3-d model of positioner

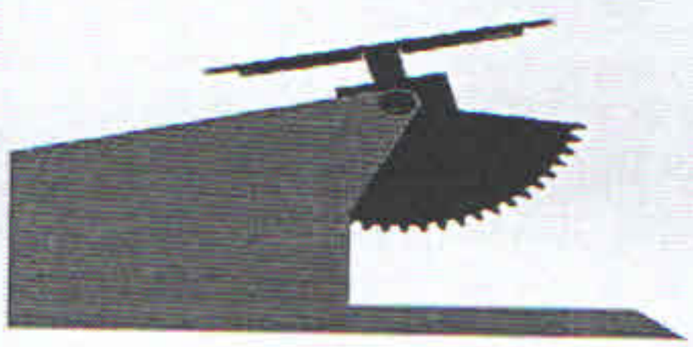

Fig. 3 side view -15° tilted

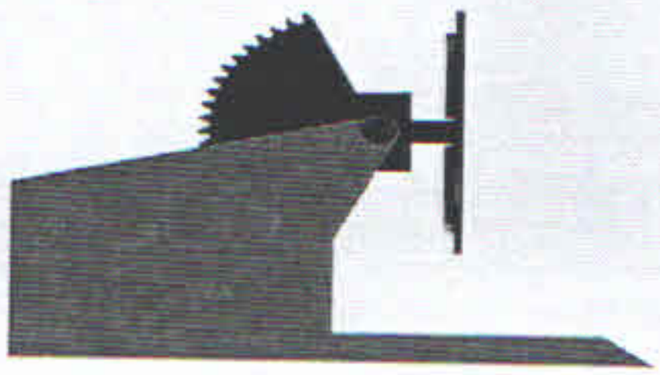

Fig. 4 side view 90° tilted

2.2. Drawing in 2-D

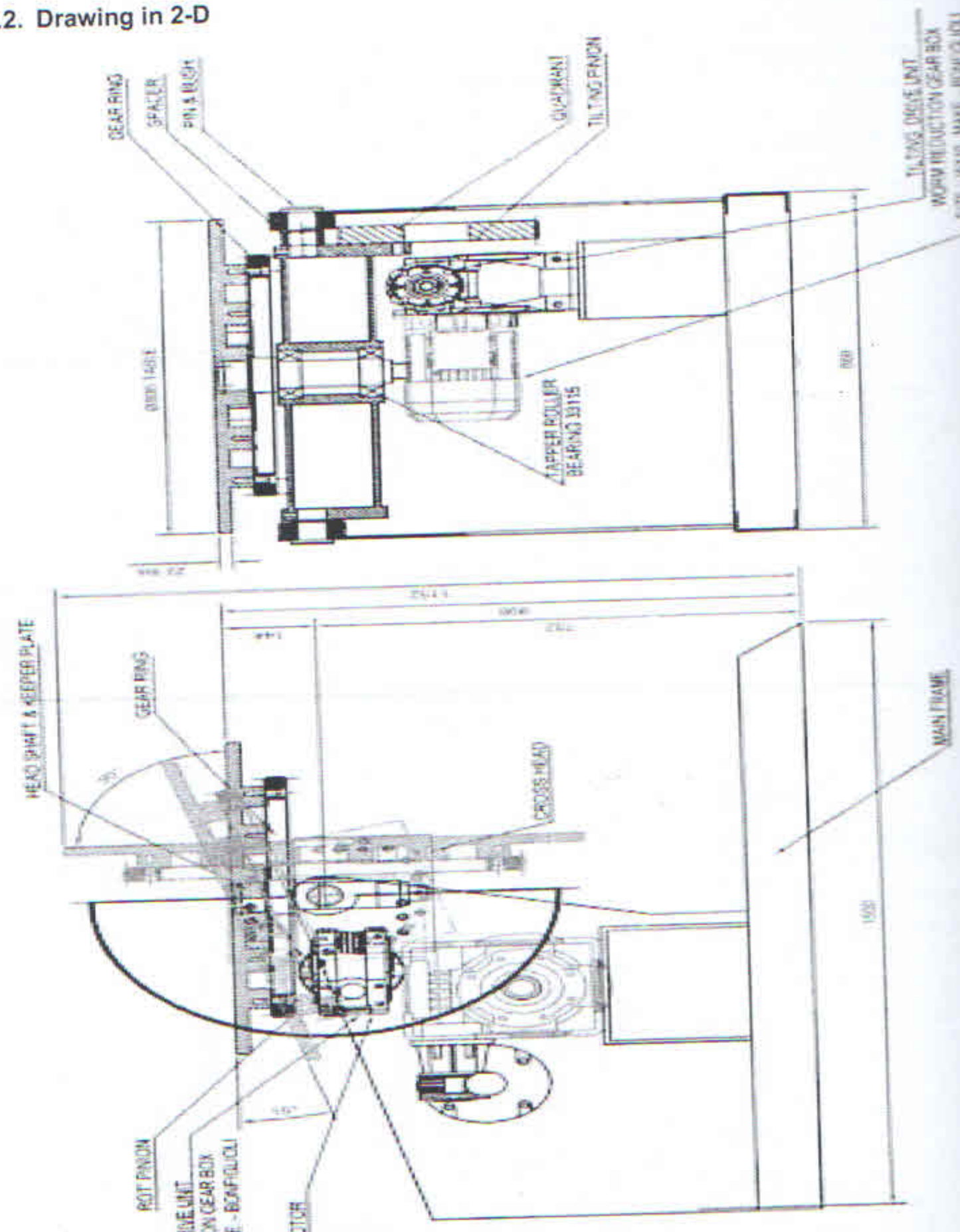

Fig. 5 2-d drawing of positioner

As per the existing system of positioner both operations tilting and rotations are done by the AC induction motor which can be replaced by servo and PLC controlled system which allows high precision and productivity of fabrication of large component.
Existing system should be controlled by remote manually while the system proposed will eliminate the need of remote controlling as it will allow interpolation and also eliminates the need of continuous surveillance of system. As a result one operator can operate more than one machine. How many machines one operator can operate that depends upon the capability of operator and complexity of work-piece.

2.3. Block diagram of proposed system

Generally there are two type of controlling system are possible
1. Open loop system(Existing system)
2. Close loop system(proposed system)

Existing system is an open loop system which operates by AC square cage induction motor which will be replaced by close loop system with the help of PLC and HMI.
Servo motors are provided with encoder which generates the feedback signal that can be sent to drive to control the speed of servo motor.
If positioner is used for welding purpose then the strength of weld-bead depends upon the speed of rotation of work-piece.
If positioner is used for inspection then accuracy of inspection depends upon the speed of rotation. A block diagram of proposed system is given in figure 4 shown below.

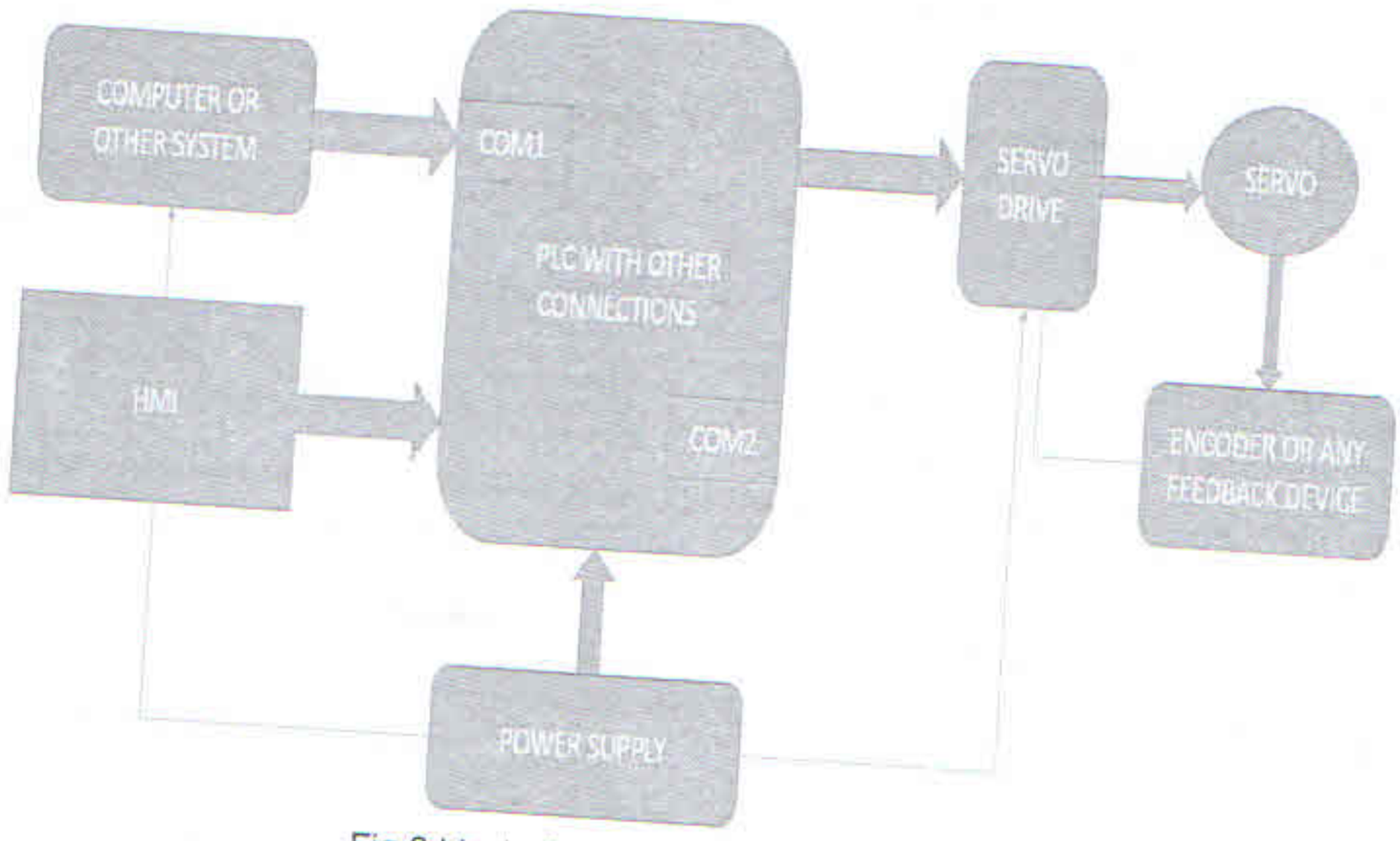

Fig 6 block diagram for control of system

2.4. How system works?

Human body is controlled by brain. It means that all the activities of human body are controlled by brain. So, brain is the main controller of all the organs of human body. To control any system there should be one controller which controls the all the parts of system. In our system that controller is PLC. Main function of system is to control the speed of rotation and tilting which will be done by servomotor. Servomotor are provided with encoder which can generates the signal. This signal should be sent to servo drive to control the servo motor. Servomotor can only be controlled by servo drive. To control and modify the speed of rotation and tilting signal must be sent to servo drive by PLC.
PLC can be programmed by computer and small changes can be made with the help of HMI. So, PLC will take input from the computer system or HMI.
As per the instructions from the computer system or HMI it will change the speed of rotation and tilting which will allow interpolation.
Feedback signal will be sent by the encoder which will help to control the speed of rotation of both the motors
Power supply must be provided to computer system, HMI, PLC, servo drive.
Interfacing of computer or HMI with plc to be done with 8-bit input port (COM1) of PLC.
Interfacing of servo drive with PLC is to be done with 8-bit output port (COM2).
It is possible to control more than one positioner with the help of one PLC. To increase the output port of PLC padding of output port can be done.so, with the help of PLC, HMI and computer

system one can control the positioner system semi automatically with advantage of very high accuracy and precision of close loop system.

2.5. Selection criteria for selection of component

2.5.1. Servo motor

Any motor has primary selection criteria is torque. Any selected motor must withstand against applied torque with specific speed.

Some selection criteria for selection of servo motor are given below.

1. Torque
2. Acceleration time
3. Speed
4. Inertia
5. Motion profile
6. Regeneration capacity
7. Resolution requirements
8. Environment
9. Power requirements
10. Physical size limitation
11. Mechatro link requirement
12. Oil seal and holding brake
13. Encoder
14. Profibus and devicenet
15. Pulse train and analogue voltage

2.5.2. PLC and HMI

PLC and HMI should be selected based on the number system to be controlled with the help of one PLC

2.5.3. gearbox

Gearbox can be selected from the manufacturer's catalogue as per the gear ratio required and self-locking from the output RPM required and input RPM available at the output of motor.

2.5.4. bearing

Bearing are selected based on loading condition whether it is axial or radial load and expected life in million revolutions.

2.6. advantage of proposed system

- In conventional system the speed of the rotation is available in number of step sand the direction of rotation and tilting of table need to change manually when it's required. This is very crucial for accurate positioning and maintaining speed of welding.
- The cycle time of the operation with typical jobs may be reduced..
- Interpolation of welding profile is possible which is not possible in conventional system.
- Worker's fatigue will decrease.
- Safety and reliability of system will increase.

3.0 CONCLUSION AND FUTURE SCOPE

After implementing proposed system one will able to achieve rotational speed of flat from 0.06 to 1 RPM(variable) with control resolution of 0.01 RPM and constant speed of tilting with 0.6 RPM constant for mass of 2 tone. Interpolation of welding is possible in two dimension.

Future scope of this system is that it is possible to do interpolation in three dimension by interfacing robotic arm with positioner

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