Design and Development of Sealant Dispenser as Low Cost Automation

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***Abstract*-In order to ensure integrity of the engine, a sealant is located among the two mating part's surface. Obviously, if the sealant stays intact and provide the leak-free for long period of time, which is imposed to harsh working environment. For attending these working conditions the sealant must maintenance-free and should consume the least cycle time along with the easiness and simple work process. In order to obtain such results the dispensary unit must be both simple and fast to accomplish the task. So, it can be affordable and efficient to perform the specific task within optimum time.**

Keywords:- Low Cost Automation; Sealant Dispenser; H-Gantry

I. INTRODUCTION

In the era of competition the autonomous systems may increase the operational cost for production which adversely would affect the profit. So, the low cost, flexible automation is required in an enterprise for manufacturing. In order to have profitability for an enterprise the low cost automation is the effective way to sustain the market. The utilization of the readily available system isn't cost effective and requires the customization at certain parameters. Therefore development of the automated sealant dispenser for oil-pan is necessary for obtaining the leak-free joint among the oil pan and the engine casing various process are used the most common is the pre-cut gasket, O- rings , cured in place in gasket ,application of adhesive sealant within low operational cost. The joint of sealant being static they have to encounter a small micro movement as an outcome of the vibration, shock, temperature change, change in pressure. In metal to metal contact no allowance is needed as of gasket in order to maintain the accuracy of the system, this is important since the assembly consist of the halves of the housing. So, there are various advantages of using the aerobic sealant for the flange along the design consideration in order to achieve the optimum result.

The current system utilized for the dispenser of the high end robots. Since the degree of precision for the system is moderate (scaled up to mm), the robot is not utilized up to its ability. Therefore instead of the high end robot the system is developed in ordered to reduce the cost of the process and process variable. The system would have ability to perform the given task alongside complying the safety for human worker and sync the cycle in order to avoid the error. The system would replacing the existing along the significant amount of cost reduction, without affecting the any of the parameters in the production, process engineering or design constrains. The system is designed for providing the task considering the cost to rated standards to accuracy of the work performed. During this process it is necessary to monitor the process control as pressure, temperature along with the synchronously driven and electronically control system, it is possible to have on-line control over the application to sealant within the cycle which would prevent the system to deviate or avoid accidental causes and to ensure the safety of the system.

The robotic system is available in various configuration provided difference in work ability, type of linkage & joint. Since the main motto is to keep the system simple in all aspect i.e. construction, electronics and programming [1]. A simplex and reliable system is developed so as to lessen the issues concerned with system and operation. So, H – Gantry system is developed and constrained according to the requirement. The configuration of the manipulator is complete specification at every position of the manipulator [2]. Since the design constrain are established according to the requirement; so, we are well aware of the joint variables of system and all constrain essential for analysis.

II. SYSTEM LAYOUT

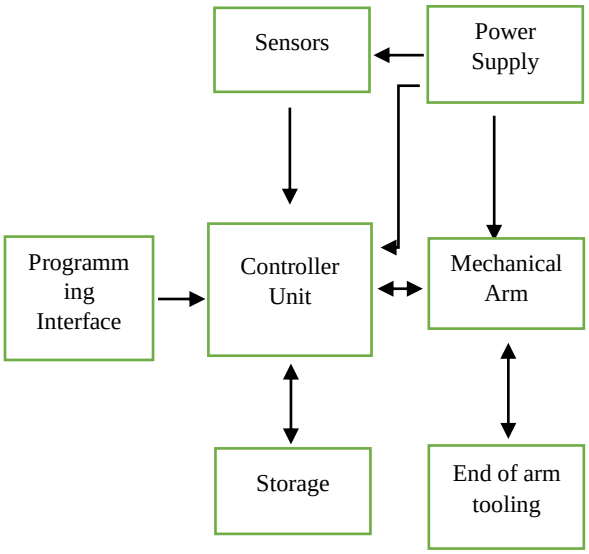

Fig. (a) System layout

A. Mechanical Arm

Since the robot is H – Gantry type the linear motion guide are used for the rectilinear motion[4] transfer through the belt and gear transmission driven by the stepper motor. The pitch of belt and gear are designed as per availability in locality. The length of each arm is 480mm respectively.

B. End of Arm Tool

The end of arm tool is the nozzle connected to the connected to high pressure pump through regulator. The sealing material is applied through the nozzle which has discharge diameter of 1.8 mm respectively.

C. Controller Unit

The controller unit has the microcontroller Mega2560 which provides the PWM signal for driving the stepper motor. The controller is optically associated to the sensors and actuators so which ensures its own safety in case of any event. The microcontroller is associated to end switches to ensure the safety of the driving and driven system. Safety systems are deployed in order to ensure the safety of the operator. In case of malfunction the system is capable to reset and restart the task, which minimizes the risk for false calibration [3] and errors

D. Sensors

Sensors are used in order to avoid the any false alarm by the operator and prevent the system and the operator safe. Inductive sensor is used to verify the object before executing the cycle, which prevents wastage of the sealant material. The end switches are used in case of malfunction for the safety of the components and controller. The final safety curtains are used the safeguard the human intrusion in the operating process.

E. Power Supply

The power supply provides the respective supply to all driving member. The system uses 35-40W of energy for functioning.

F. Programming Interface

The programming uses basic microcontroller programming the algorithm used is Bresenham's algorithm along CoreXY theory for the motion of axis and interrupt base for the sensors.

III. MODELLING

A. Hardware

The robotic system employs the linear motion guide for motion and the transmission is achieved though the gear and belt mechanism. The moment of the system is considered though the motion of stepper motor and its transmission to the end effector. The y axis is the pneumatic axis due to its limited moment and reducing transmission mechanism. The system is plan and established considering the factor of the safety as 3

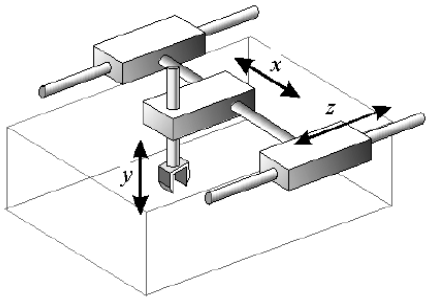

Fig. (b) Block diagram for mechanism

B. Electronic

The steppers are controlled by the microcontroller through the driving circuit. The stepper are controlled via switching through microcontroller the driver circuit is the MOSFET/BJT based driver the power unit is 12VDC. The system consumes almost 15W of power which implies its low power consumption.

The motor driver works with an effectiveness of 50% or even less. In order to maintain precision the countermeasures are improvised. The circuit is made so that it would not experience any issues related to excess of energy consumption and heat dissipation to function smooth and effectively.

The below is the schematic block diagram of the electronics component

IV. ANALYSIS

A. Kinematic Analysis

The kinematic analysis is an analytical study of the geometric motion of the robotic system, which deals with co-ordinate system as a time function lacking concern to forces /moment that are accountable for the motion. It's concerned with the spatial displacement of the robotic system as time function responsible for the relation between joint – variable space and position and orientation of the end effector of the arm.

– variable space and position and orientation of the end effector of the arm.

In the robotic system it is frequently essential to 'map' the joint coordinate to end effector coordinate. Thus, in order to acquire this map the direct kinematics is done.

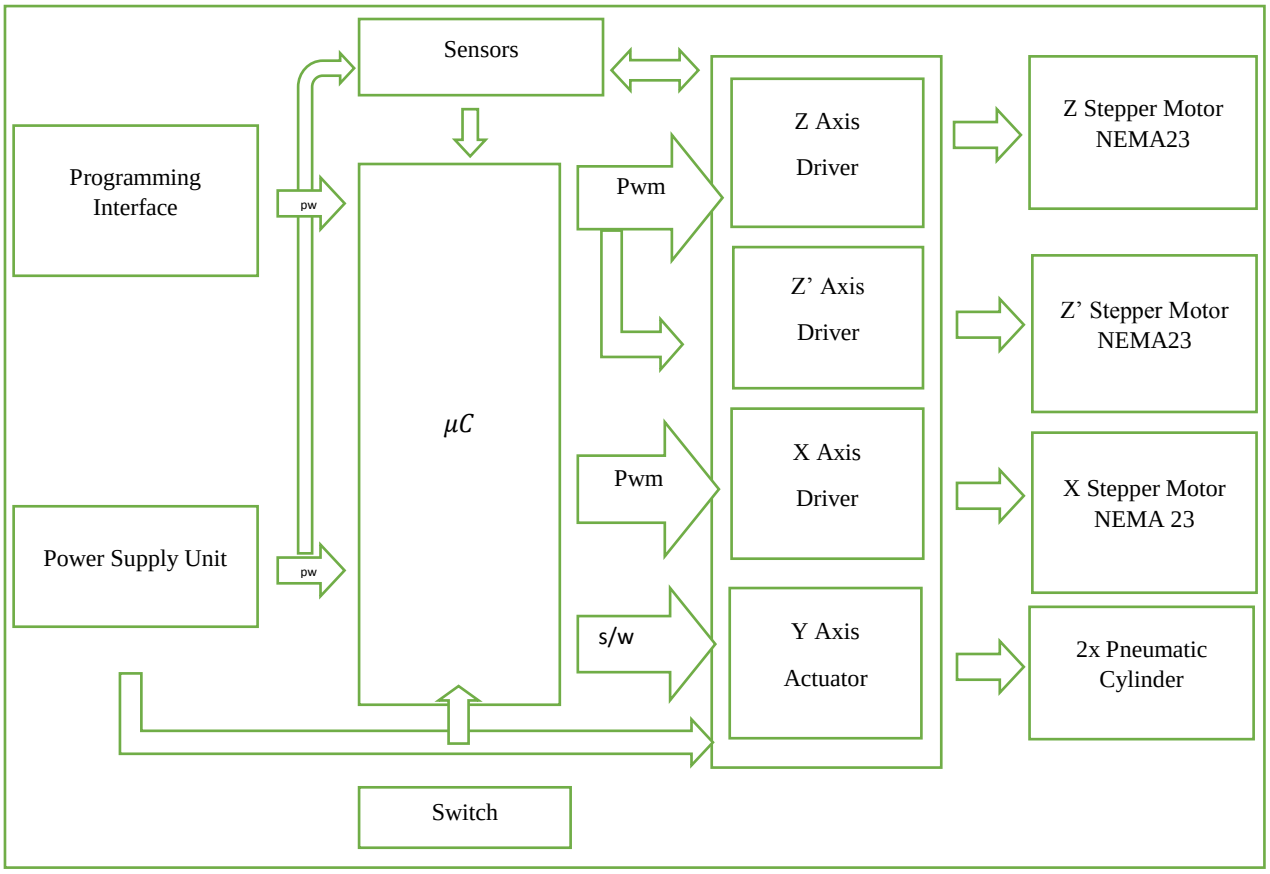

Fig. (c) Block diagram for electronics (3.2)

a) 3 DOF's Of H – Gantry Robot

The system has 3 degrees of freedom along X – Axis, Y – Axis, Z – Axis respectively. The motion X, Z – Axis is Compelled Electronically whereas the Y – Axis is compelled pneumatically with electronic actuation. The following represents the schematic diagram for the Sealant dispenser.

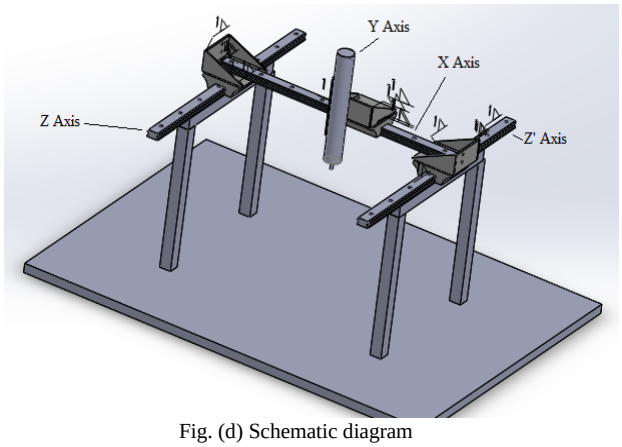

Fig. (d) Schematic diagram

b) D-H PARAMETER

Table I. D – H Parameter for robot

Link (i)	ai	di	αi	θi
1	a_1	d_1	α_1	$\theta_i = 0^o$
2	a_2	d_2	α_2	$\theta_i = 90^o$
3	a_3	d_3	$\alpha_3 = 0$	$\theta i = 0^0$

D – H Parameter: Homogeneous Transfer Matrix [6]

$$^{i-1}A_i = \begin{bmatrix} Cos\theta i & -Cos\alpha i.Sin\theta i & Sin\alpha i.Cos\theta i & ai.Cos\theta i \\ Sin\theta i & Cos\alpha i.Sin\theta i & -Sin\alpha i.Cos\theta i & ai.Sin\theta i \\ 0 & Sin\alpha i & Cos\alpha i & di \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \ldots\ldots \quad (1)$$

From Table I. and Equation 1 we can obtain $^0A_1$, $^1A_2$, $^2A_3$. And so, we can obtain the position of end effector (q_3) with respect to base coordinate (q_0) by,

$$q_0 = {}^0A_3 . q_3 \quad (2)$$

The dynamic analysis is to be done after acceptable alteration of the system.

V. CONCLUSION

Inferring from above since the robotic system is simplex yet, effective or even better since it reduces the cost of the process and variables. There is significant amount of cost saving and optimum usage of resources which is helpful to small and medium enterprise.

VI. RESULT

As a consequence the low cost automated system is developed with significant cost saving to achieve the task. As a part of the development the system would be made more simplex and with the GUI to maintain its versatility and workability by further improvement in degree of accuracy.

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