ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

Improving Equipment Efficiency in Respot Line by Developing Backup System for NC Robot

Vijay S[1], Dr. Mir Safiulla[2], Upendra K[3]

P.G. Student, Department of Mechanical Engineering, Ghousia College of Engineering, Ramanagar, India[1]

R&D Head and Professor, Department of Mechanical Engineering, Ghousia College of Engineering, Ramanagar, India[2]

Assistant Manager, P2 weld maintenance, Toyota Kirloskar Motors, Bidadi , Bangalore , Karnataka , India[3]

ABSTRACT: Automotive assembly lines are often characterized by robots' failures that may result in stoppages of the lines and manual backup of tasks. The phenomena tend to impair throughput rate and products' quality. This project presents a backup mechanism in which a newly designed mechanism performs tasks of failed robots.
Maintenance is a very important part in production cycle and maintenance of machines in a manufacturing industry plays a vital role to reduce the fluctuation in production efficiency. Main objective of maintenance group is to reduce MTTR (Mean Time To Repair) and increase MTBF (Mean Time Between Failures). The main objective of this project is establishing a design which helps in backup of NC robot in case of break down. Instead of stopping of the line a backup mechanism is developed which replaces this NC robot and performs the job of NC robot. By this availability of backup it increases the production capacity, minimizes the line stop time and reduces down time.

KEYWORDS: Availability, Breakdown, Pneumatic Cylinders, Maintenance.

I. INTRODUCTION

High-volume body-shop systems in the automotive industry often consist of a series of assembly zones that are serially connected via automated material handling (MH) systems. A zone contains several robotic cells (also called stations), each of which consist of several welding robots that are working simultaneously. The automated MH system is used for feeding the stations with parts that are welded to the vehicle body. Weld spots are grouped on the basis of their location in the vehicle body and performed sequentially by a single welding robot. There are two types of weld spots: dimensional control welds (DCWs) and respot welds (RSPs). In DCWs, a new part is welded to the vehicle's body to define a new geometry of the vehicle. A station which performs DCWs is usually facilitated by an automated MH system. RSPs are performed on an existing geometry—no new part is assembled, and the sole purpose of the RSPs is to strengthen the vehicle's body. Each robot can weld a single group of spots or multiple groups of spots in a single work cycle. The welding task, performed by a spot welding-gun, consists of the robot motion from the ''Home position'' to the welding area and back to the ''Home'' position based on the signal given by Numerically controlled (NC) robot which lifts and holds the "body in white" (BIW) during welding process. The problem addressed in this paper refers to a situation, in respot line in which one of the four NC robot fail during the operation time. The proposed backup design should replace the failed one during the repair period. The backup design aims at minimizing the failures effects on the through put rate.

II. THE NC ROBOT

NC Robot is present in 5 stations of re-spot line. NC robot mainly consists of controller unit and Jig. The jig consists of servo motors, LM guide, and pin clamp cylinders. The objective of NC robot is to lift the incoming car body by certain height and clamping it so as there is no movement at the time of welding. This can be best understood by the following figure

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

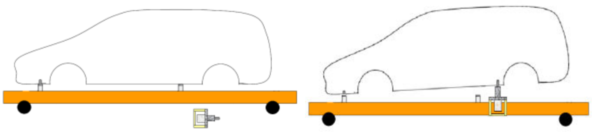


Fig 1: NC robot working

III. CONCEPT DESIGN PROPOSALS

a. Simple cylinder with fixture

The proposed design can handle only one car model at a time. For change in car models the fixture has to be positioned manually every time. This design was not feasible as it increases the downtime. The following figure shows the concept picture.

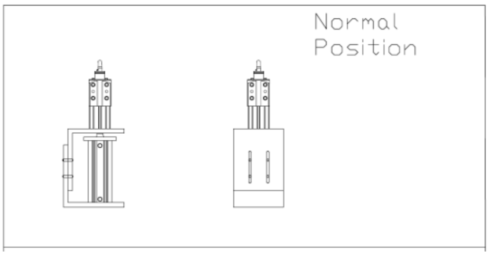


Fig 2: concept model 1

b. System with minimum human interference

The proposed design can handle two car models at a time without human interference. It is designed purely on mechanical system and powered by motor. This design was not feasible as it consists of many mechanical parts and it is a hindrance for mechanical maintenance. The following figure 2 shows the concept model no.2

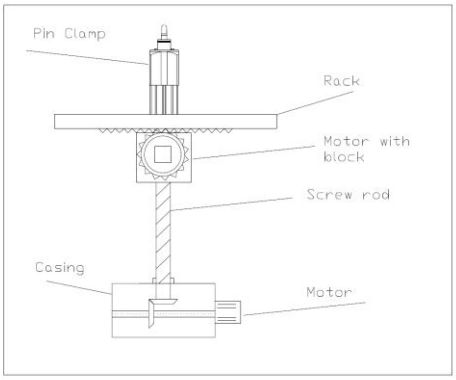


Fig 3: concept model 2

c. Automated system

The proposed design can handle all the 4 types of car models at a time without any human interference once backup is installed. Due to complex nature of problem the design and operation has been based on simulation tools. Several different types of simulation software packages have been used for this purpose. In general, the design process consists

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

of the model design and the system design. For the former, 3D simulation software can be used (e.g. SOLIDWORKS, CATIA, IGRIPs, ProE) and for later programming tools can be used (e.g. Automation Studio, SCADA).

The final model is as shown in figure 3. The figure shows all the view of the model.

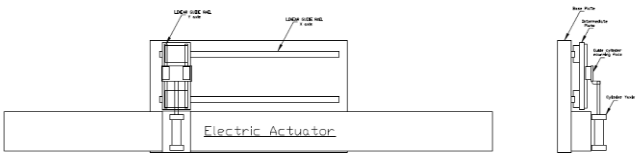


Fig 4: Final NC robot backup model

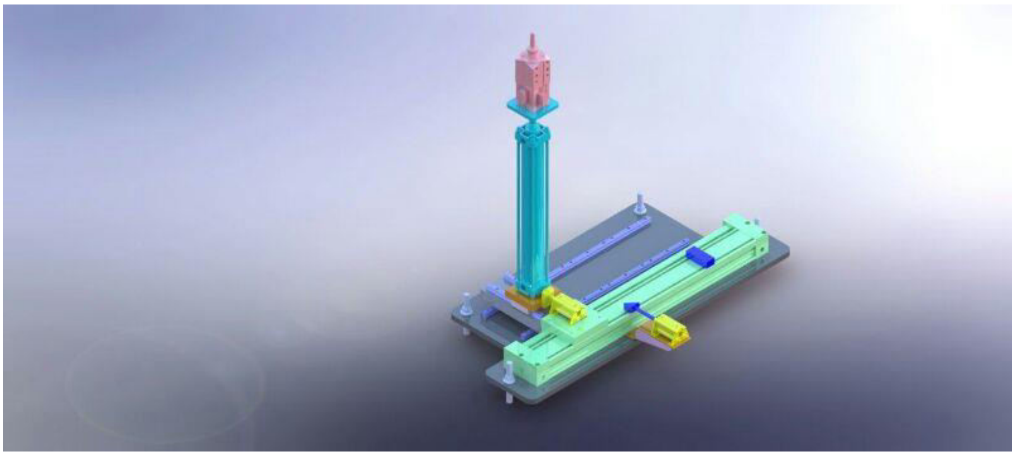


Fig 5: Final NC robot backup 3D model (SOLIDWORKS)

The above model as shown in figure 4 consist of
1. Cylinder mounting Plate, 2. Intermediate plate,
3. Connecting Plate, 4. Cylinder X axis, 5.Cylider Y axis,
6. Cylinder Z axis, 7. Guide Rail and Block for X axis,
8. Guide Rail and Block for Y axis

IV. MATHEMATICAL CALCULATIONS

1. Selection of LM guides

For selection of LM guide ways for X axis motion. Initially the total load it has to be carried is to be known.

The total load = Weight of (Car one support+ pin clamp cylinder + Z axis cylinder + Intermediate plate + axis Lm guide + Cylinder mounting plate+ Y axis LM guide)

Total load = 60 + 1 + 2.841 +0.23 +0.4 + 1.5 = 68kg
= 680 N

IJIRSET

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

2. Selection of Y axis LM Guide ways

Equivalent load $P_E=P_R(P_L)+P_T$

P_E =Equivalent load (N)
Radial direction
Reverse-radial direction
Lateral direction
P_R =Radial load (N)
P_L =Reverse-radial load (N)

PT=Lateral load (N)
Here $P_R=P_L=700$(N)
Hence, P_E= 700(700) =49000N

3. Load of Moment

P= KM

P =Equivalent load per LM Guide (N) = 49000/2
K =Equivalent factor of moment = 3.55×10^{-1}
M =Load moment (N-mm)

Hence, M= 69014 N-mm or 69.014 N-m

4. Selection of cylinders

For x axis
A Rodless cylinder is selected because of space constraint in workplace area.
The specifications is as follows
Operating pressure = 06 Mpa (Pressure in line)
Stroke = 500 mm
Mean Piston Velocity = 100mm/s
Load mass = 3 Kg (Mass of Y axis cylinder and connecting plate)
Terminal buffering mechanism with air cushion at both LH and RH.
Mounting load centre of gravity positions are L_x = 31mm L_y = 24mm and L_z = 24mm
Hence, MY3M25-500HS is selected.
For Y axis
Load to push and pull = Mounting plate + Z axis cylinder + Pin clamp
= 0.3kg+ 3 kg+ 1kg
=4.3kg~5kg
P=F/A
0.6Mpa= 50/4
Hence, d= 10.8mm for single acting cylinder

For Double acting cylinder

$$F = p\pi\left(\frac{{d_1}^2 - {d_2}^2}{4}\right)$$

50N = 600 $\pi\left(\frac{{d_1}^2-10^2}{4}\right)$
Hence, d_1= 14.4mm ~ 20mm bore cylinder is used.
Hence, Cylinder CDQ2L20-50D is used.
For Z axis Cylinder
Load to lift = 61kg
Taking factor of safety and to thumb rule, let load be 80kg

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

$$F = p\pi\left(\frac{d_1{}^2 - d_2{}^2}{4}\right)$$

d1= 25mm bore is used

Hence CDA2B50-400 is selected.

V. PLC LOGIC

To position the pin clamp cylinder for different car models.

Taking car model HBK as reference the position of pin clamp cylinder for different models is as follows,

Table 1: Position of pin clamp

Position	X direction	Y direction	Z direction
HBK	0	0	1271
SDN	88	0	1271
367A	438	50	1271

The below circuit diagram of cylinder indicates the different solenoids and sensors used for automation. This is further integrated to a PLC ladder circuit, so that there complete automation of the sequence of operation.

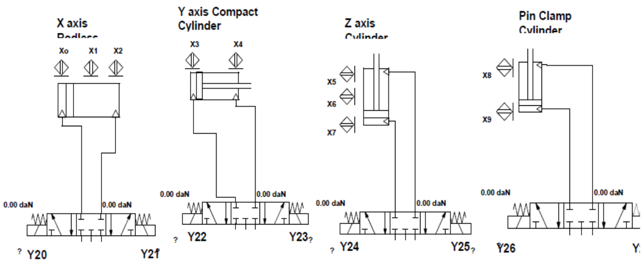
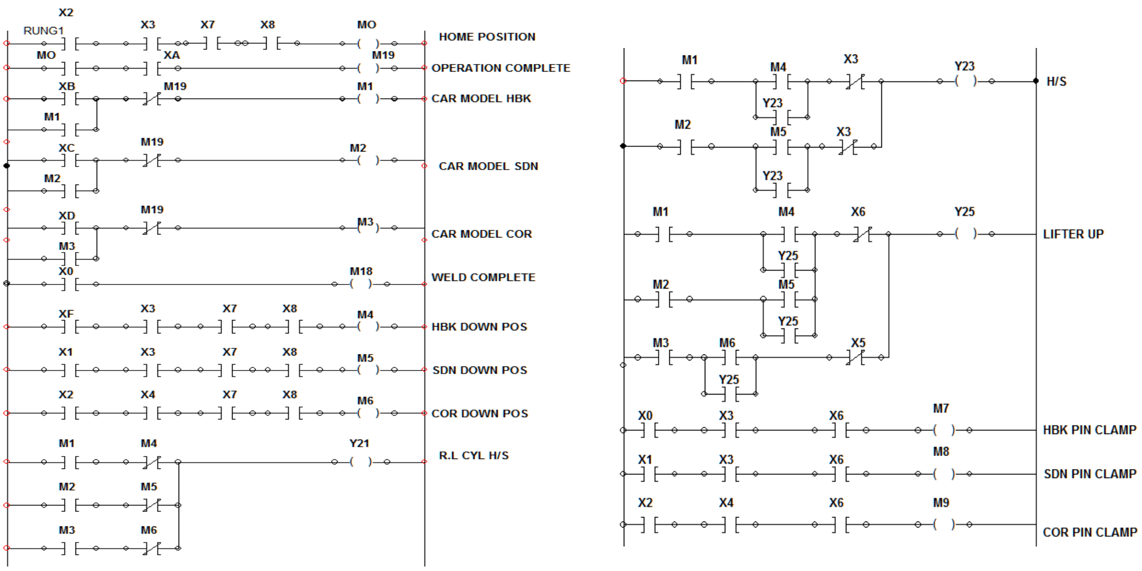
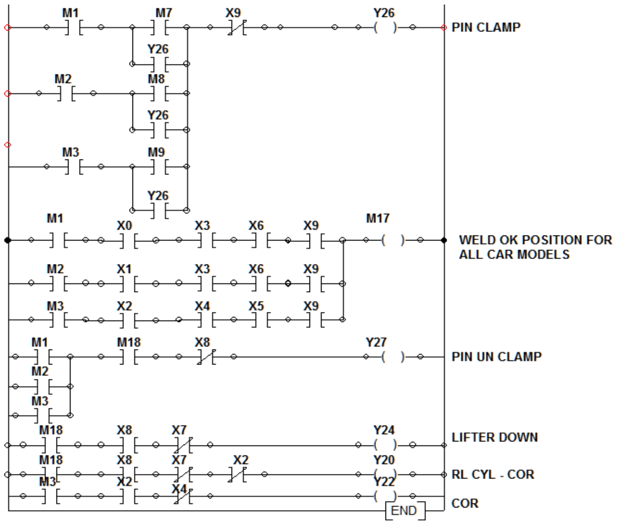


Fig 6: Electro pnuematic circuit for NC robot backup

The PLC ladder is as follows





VI. INFERENCE

The Concept Backup model can handle 3 different models at the breakdown of the NC robot. It can be used at least till the NC robot can be repaired or replaced. The backup helps in reducing the line stoppage and increases the efficiency of the line.

V. CONCLUSION

In this iterative design process, an attempt to is made to make the optimum utilization of available ready to procure (bought out parts) resources through the new design of the backup model, which in fact consumes less time to fabricate and to install in all remaining stations of respot line.

The primary objective of this backup system is to reduce the breakdown time of NC robot and to reduce the line stop time and thereby increase productivity, with the provision to accommodate the three different car models.

REFERENCES

[1] Kusiak A., "Modelling and Design of Flexible Manufacturing Systems", Elsevier Science Publishers, 1986.
[2] Kusiak A., "Computational Intelligence", John Wiley & Sons, 2000. [3] The Welding Institute, UK, http://www.twi.co.uk
[4] Eddon and Eddon, "Inside DCOM", Microsoft Press, 2000.
[5] Marshall, D., "ActiveX Programming: Building Stable Components using the Microsoft Foundation Classes", Miller Freeman editors, 1998.
[6] Englander, R, "Developing JAVA Beans", O'Reilly Editors, 1997.
[7] KirkPatrick, JM, "The AUTOCAD Book: Drawing, Modeling and Applications Using AUTOCAD 2005", Prentice Hall, 2005.
[8] Pires, JN, "PCROBNET2003, An ActiveX Control for ABB S4 Robots", Internal Report, Robotics and Control Laboratory, Mechanical Engineering Department, University of Coimbra, April 2004.
[9] ABB IRB1400 Users Manual, ABB Flexible Automation, 2005.
[10] ABB RAPID Programming Manual, ABB Flexible Automation, 2005.
[11] Pires, JN, "Interfacing industrial robotic systems with manufacturing tracking and control software. A choice for semi-autonomous manufacturing systems.", Volume 32, nº3, Industrial Robot, An International Journal, MCB University Press., 2005.
[12] Pires, JN, Ferreira, P, Godinho, T, Correia, R," Desenvolvimento de uma aplicação para programação de robôs com interface com ficheiros CAD", Ibero-American Mechanical Engineering Association Journal, Vol. 8, N.3, November 2004.
[13] Pires, JN, "Complete Robotic Inspection Line using PC based Control, Supervision and Parameterization Software", Elsevier and IFAC Journal Robotics and Computer Integrated Manufacturing, Vol.21, Nº1, 2005.
[14] Pires, JN, "Handling production changes on-line: example using a robotic palletizing system for the automobile glass industry", Assembly Automation Journal, MCB University Press, accepted and will be published in the July 2004 issue (Volume 24, Number 3), 2004.
[15] Pires, JN, and Godinho, Tiago, "Force Control on Industrial Robotics: using a fuzzy PI approach", 24, nº1, Sensor Review Journal, An International Journal, MCB University Press, 2004.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 6, June 2014

[16] M. BrianThomas, Gary P. Maul, and Enrico Jayawiyanto "A Novel, Low-Cost Pneumatic Positioning System", , Manufacturing Automation Laboratory, The Ohio State University, Columbus, Ohio, USA
[17] Tomer Kahan , Yossi Bukchin, Roland Menass, Irad Ben-Ga "Backup strategy for robots' failures in an automotive assembly system",. Department of Industrial Engineering, Faculty of Engineering,Tel-AvivUniversity, Israel Manufacturing Systems Research, GM Research &Development.