HUNGARIAN JOURNAL
OF INDUSTRIAL CHEMISTRY
VESZPRÉM
Vol. 38(2). pp. 219-222 (2010)

AUTOMATIC ROBOTIC ASSEMBLY SYSTEM IN THE SERVICE OF THE VEHICLE INDUSTRY AND THE ENVIRONMENT

I. SZTANKOVICS

[1]Department of Production Engineering, University of Miskolc, 3515 Miskolc Egyetemváros, HUNGARY,
E-mail: sztanisti@gmail.com

I present an automatic assembly system in this article. I search out the main methods of assembly first. Than I describe the system found in the Department of Production Engineering at the University of Miskolc. Next I choose one of the used robots, and I describe it from the viewpoint of productivity and flexibility.

Keywords: robotic assembly, SCARA robot.

Introduction

Nowdays machine industry consists of 3 main sections: preproduction, component production and assembly. These three primary groups have the most considerable effect on the quality of the product although the product gets in contact with other areas, for example logistics or design.

Assembly grants the final form of the product from the 3 areas, althrough this section receives the least attention and it is not as advanced in most cases. So it is worth examining what kind of development we can observe in this area.

Before the examination of the topic it is useful to define the concept of the robot. This mechanism has an open kinematics chain, which is capable of directed motion, its part handler can be flexibly programed, and it has artificial intelligence functions. The difference between robots and manipulators can easily be seen. Robots can be divided into 3 main groups from the viewpoint of the provided task. There are logistical, functional and mounting robots. In addition, the tasks one robot can perform can be extended if the head of the robot is changeable and the machine is able to do this exchange according to program instructions.

The main area of the application of robots is the mass production lines or such areas where employees' health is endangered, the tasks are too monotonous and where a human worker cannot fulfil the quality expectations. Material handler robots are applied in the service of manufacturer or gauging machines, or they can carry the workpieces between positions. For robots, welding is a typical operation. They work more punctually and with the right quality, and they do not have to carry coveralls. Painter robots are applied for similar reasons since harmful substances get into the air during the operation.

It can accelerate the process of the operations or improve the quality if we apply robots in assembly areas. The monotony of mending operations would significantly influence the efficiency of the human workforce.

Methods of Assembly

In the next section I introduce the main groups of mounting methods. The designer needs this alignment at the time of planning so that he can decide whether to use robots and what kind of opportunities are available. We can group them according to the place of the mending operation and the degree of automation.

Classification according to the location of the Assembly

Mounting processes can be divided into two groups according to the location of the assembly. The operations can take place in one or more areas.

If mounting is performed in one place, the workpiece does not change its position in the course of the process. Components and mounted units are transported into a single area and the workers come to this location. The assembly of products mostly takes place in this group. There are difficulties to automate this process since the application of robots would be expensive.

Another solution is when the product changes its position. It is defined at the time of planning, what kind of operations should be executed in which position. They apply this method in case of small, light products. The opportunities of automation are big as single positions can be completely robotized.

Classification according to the Degree of Automation

Three main groups can be distinguished in automation. Mounting can be processed non-automatically, semi-automatically and in a fully automated way.

Workers perform all the operations in case of manual assembly. Small machines may assist them in his work.

In semi-automatical assembly, machines perform certain operations, but they have no automatic functions.

There is no need for human workers in case of an automatic assembly line; one man can handle the entire line, providing the proper conditions for the machines.

Presentation of an Assembly Line

I present the system located in the workshop of the Department of Production Engineering at the University of Miskolc.

To demonstrate robotized assembly, the line is able to accomplish the production of the following products:

- FLY 525 type mikromotor
- MCDC 35-S-1 type mikromotor
- TK 422 type plate horn

The most frequent mounting technologies and material handling operations can be demonstrated on these products. They can also present the main abilities of the robots that play an important role in the automation.

A main viewpoint in the construction of the system was to plan a system layout that is mostly used in production. The line has its palette carrying-system in the middle, which increases the utilisation of the place. This is surrounded by the necessary positions. In this case it poses no difficulties to supply the components and tools for the system and the necessary maintenances are easy to perform on the line.

To sum it up we can divide the flexible robotic assembly system into these main units (presented in *Fig. 1*):

- workpiece handling conveyor system,
- 2 robotic assembly cells,
- 2 manual workplaces.

Workpieces are carried with palettes. Inaccuracy in the position of workpieces cannot be allowed if robots are applied and with a high level of automation. These problemes can easily be solved with the use of palettes. In addition, an identification system can be found on the carrying elements. The system reads it at defined points of the line so the computer knows which mounting operations were made on the workpieces carried by the read palette. This I necessary because the buffer of each position is created on the middle conveyor.

The auxilliary elements of the system are driven with pneumatics. This solution is safe enough, it does not pollute the environment, it can be built easily, and in case of a mistake it is simple to repair.

For a more detailed view, I itemize the main parts of the assembly system:

a) ORIMAT material movement system
   - 3 twin belt conveyor belts
   - 2 overband LINTRA-s transferer
   - 1 chain transferer
   - parts carrier palettes fitted with equipment
   - MECHATRONIKA PLC control
b) BOSCH SR 450 SCARA type assembly robot
   - DESOUTTER automated screwdriver
   - feeding system
   - construction capable of switching tools
   - tool magazine for 3 tools
c) POLY-P 42 SCARA type assembly robot
   - pneumatic cracking machine,
d) central computer

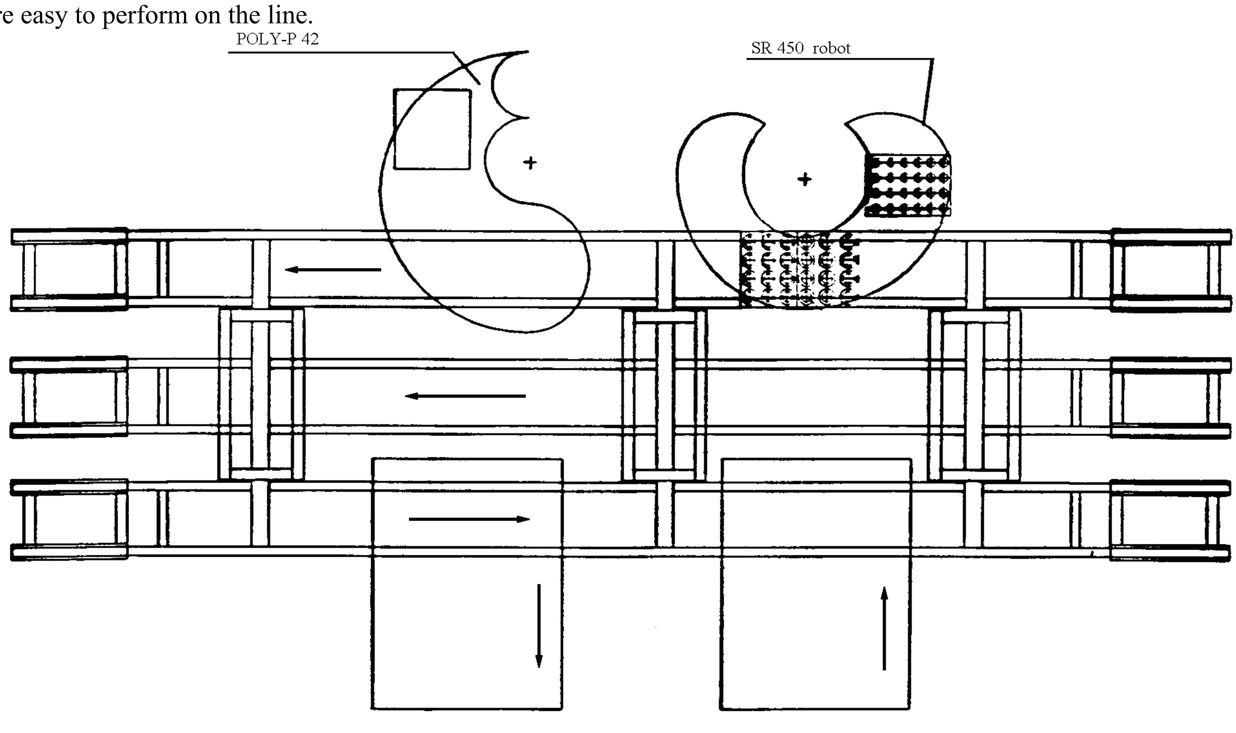

Figure 1: Sketch of the assembly system

Presentation of a Robot in the System

The most important element of the system is the BOSCH SR SCARA 450 type robot. The main operations are carried out with this, so I describe it in more detail. We can see the construction of the robot in *Fig. 2*.

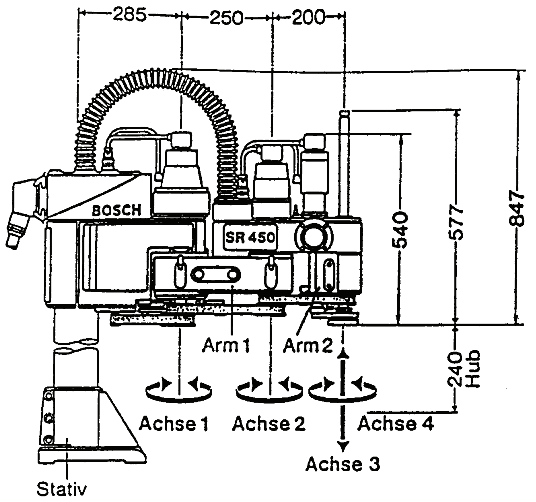

Figure 2: Structure of the Bosch SR 450

The SCARA type (Selective Compliance Assembly Robot Arm) robot from the SR family (SR450, SR600, SR800) is the smallest in the family. The construction of the arm matches the requirements of the assembly technology. It has a short cycle time and great accuracy. Its price-performance proportion is beneficial. Its design is adequatly robust and it is dependable. The construction ensures easy maintance.

The robot has 4 controllable axes with electric drives. It has the opportunity for PTP, circle and lineal interpolation. It has free plc in- and outputs. There is an M/60342/11 type paralel handler in the head. (Martonair product, with pneumatic operation, max. stroke 20 mm). It has pneumatic and electric connections for the installed units on the robot body (screwing machine, snatching tools…)

Technological parameters of the robot:

- repetition accuracy ±0.05 mm
- maximum speed by axis:
  A1: 1–325 mm /and, A2: 2–510 mm/s
  A3: 3–800 mm /and, A4: 4–600 mm/s
- turning capability around the axes, and linear movement capability along the 3rd axis:
  A1: ±90°, A2: ±120°, A3: 360 mm, A4: 1028°
- maximum liftable weight: 2 kgs
- maximum liftable weight at reduced speed: 5 kgs

Opportunities for Programming

The motion of the robot is possible in Descartes (X,Y,Z,C) and in mechanical (A1,A2,A3,A4) coordinate systems. The coordinates of the programmed dots can be taught.

It is programmable with the BAPS language. The program can be launched from the terminal, from the controller board or from the manual handler. It has a testing opportunity with or without robot motion. During operation the technical features (speed, acceleration, actual position) can be read. The work area can be determined from the software. It is possible to use different interfaces (video camera, printer) through the data distributor.

Screwdriver tool

With the help of its preferias, the screwdriver tool sorts the screws, moves them to the mounting positions and fastens them with the preset momentum. The phases of the operation are presented in *Fig. 3*.

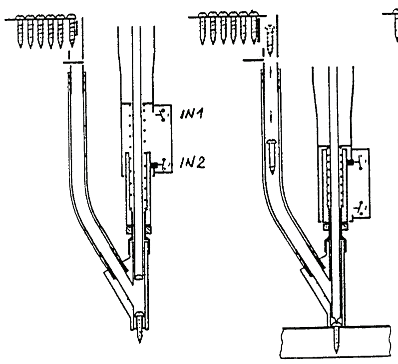

Figure 3: Phases of the Operation

Summary

The opportunities in the automation of assembly can be observed from this article. Mounting operations expectedly head in this direction of development, mainly in mass production.

With the usage of an automatic system we can eliminate the chances of error due to the human factor. Subjective errors in case of calculations are completely negligible.

Productivity grows significantly with the use of automation. Nowdays this is very important because in the production of a component, a few seconds mean a lot. With shorter production it is possible to reduce the environmental load caused by one product.

Robots can perfrom work with adequate punctuality so they can live up to the strickest quality requirements. Continuous supervision is not needed so one worker can handle several machines.

A system with a robot has great flexibility. We can write the program far from the machine, then just upload it into the machine and we have already taught a new motion cycle to the robot. This way a robot can be easily switched to new products. Nowadays this is an important requirement as it is necessary to respond to the customer demands promptly.

Besides, robots are safe enough. With suitable programming they cannot possibly damage the surrounding equipment as inappropriate motions can be banned.

They can control the auxiliary equipment which are found next to the robot with their inbuilt controls. So the PLC of the whole system can be a smaller version. This increases the flexibility and new assembly positions can can be easily built in the system.

REFERENCES

1. I. DESZPOTH, J. KUNDRÁK, J. SZŰCS, T. PAPP: Robotos szerelőcellában alkalmazható szerszámok. Proc. on the VIIIth International Conference on Tools, Miskolc, Hungary, 1993, 648–653.
2. J. KUNDRÁK, T. PAPP: Fine Mechanical Assembly in a Robotized Cell. Proc. on the 2nd International Scientific Conference MTM´93, Cugir, Romania, 1993, 12–14.
3. J. KUNDRÁK, T. PAPP, L. KOVÁCS, L. PAP: Lehre und Forschung zur Montage-automatisierung an der Universität Miskolc, Gép, 8, 1992, 25–33.
4. J. KUNDRÁK, T. PAPP, L. KOVÁCS, L. PAPP: Lehre von der Automatisierung in der Ausbildung von Maschinenbauingenieuren. Proc. on the 3th International DAAAM Symposium, Budapest, Hungary, 1992, 103–104.
5. J. KUNDRÁK, T. PAPP, L. KOVÁCS, L. PAPP: Szerelésautomatizálás oktatása és kutatása a Miskolci Egyetemen. Proc. on the Mechatroninfo'92 International Conference, Budapest, Hungary, 1992, 233–244.
6. L. KOVÁCS, J. KUNDRÁK, J. SZADAI, J. VARGA: Flexible Assembly Model System at the University of Miskolc. Proc. on the 2nd International DAAAM Symposium, Strbske-Pleso, Czecho-Slovakia, 1991, 128–131.
7. T. PAPP, L. STRELECZ, J. KUNDRÁK: Flexible robot control system with image processing. Proc. on the 8th International DAAAM Symposium, Dubrovnik – Croatia, 1997, 251–252.
8. J. KUNDRÁK: ROBOTIZED ASSEMBLY SYSTEMS: research and education. Proc. on the microCAD´97 International Computer Science Conference, Kharkov, Ukraine, 1997. I. 312–314.
9. J. KUNDRÁK, T. PAPP, L. STRELECZ: Flexible automatization by robots and vision system. Proc. on the RAAD'96 5th International Workshop on Robotics in Alpe-Adria-Danube Region, Budapest, Hungary, 1996, 265–268.
10. J. KUNDRÁK, T. PAPP: Die Flexible Automatisierung der Montage in Einem Mustersystem. Proc. on the 6th International DAAAM Symposium, Krakow, Poland, 1995, 199–200.