AUTOMATION IN THE AUTOMOTIVE INDUSTRY

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ABSTRACT

The world is shifting towards automation because automation processes have proven to be fast, reliable, and accurate. Almost all automotive manufacturers use some kind of automatic processes including robot manipulators, object sorters, mobile robots, and 3D printers to increase the production of automotive parts. The increased production rate generates huge revenue for these industries. Major companies like BMW, Ferrari, Tesla, Honda, and Lamborghini are using automated processes in their plants to manufacture cars from cutting the materials to the final assembly of parts, paint jobs, welding, etc. The object sorting machine helps to sort small parts like different bolts, nuts, and screws of different sizes to put in the correct orientation to be easily held by the robotic arms. 3D printing machines are used to make different complex parts with a fully automatic process. The use of automation is the future of the automotive industry because of the quality output it provides. The biggest challenge for the implementation of automation is the high initial cost. **Keywords:** Robotics, Manipulators, Mobile robot, Process automation

I. INTRODUCTION

The world is changing from manual work to automatic work with the invention of modern machinery. There are various tasks, in which the machine works better than the human being [1]. The process of automation is fast, accurate, with a near perfect output. Various industries like the packing industry, bottle filling industry, PCB manufacturing industries, etc. use the process of automation to enhance the production line. The use of automatic machines not only increases the output time but also acts as a source of return on investment after a certain amount of time [4]. The initial investment for the implementation of an automatic system is high but it eliminates the salaries of employees and gives the same salaries as cash back after some time. The automatic process is widely used in the automotive industry. This technology saves time and money and works in the shortest period. In 2014, Japan’s industries utilized just over 1400 robot per 10,000 employees [2] and it continues to increase. Germany, the U.S., and South Korea each all utilize large numbers of robots, in 2014 each had about 1100 robots per 10,000 employees [2].

II. THE NEED FOR AUTOMATION IN INDUSTRY

The aerospace and automotive industry require automation because manual processes involve variations in quality and process time [3]. Casting processes, for example are challenging because they has minor details which cannot be obtained from the manual process. The automatic process works with high accuracy and precision to mold the specific parts without any dimensioning error. Automation processes can enhance the quality of the product and consumes less time for manufacturing. There are various complex parts which cannot be handled by a manual process due to a limited number of degrees of freedom. By using robots, as many numbers of DOF can be achieved as required. So, it can easily work in compact areas.

III. THE METHODOLOGY OF AUTOMATIC PROCESS

The automotive industry mainly consists of different assembly stations in which engine shop, welding shop, paint shop, and final assembly shop is included. The process of laser cutting is used to cut different shapes of raw metal and it is fed to an automatic process for welding. In the welding shop, autonomous robotic manipulators are used to weld different parts of the automobile. The process of welding in particular parts is predefined in the algorithms of robots. So, the robot uses this algorithm to analyze the metal and welds it at a particular place without any error. The robot can easily weld in complex places because it has more degrees of freedom. The next process is coating the metal parts with anti-rusting material to make the vehicle resistant to corrosion. The automatic assembly line takes the material into a tank. The machine dips the part into the tank so the chemical is fully exposed to every corner of the automobile part.

After applying coating the robots are used for painting various parts. These robots are task-specific and provide a smooth layer of paint on parts. These parts are sent to final assembly stations. The engine is assembled in the shop and sent to the final assembly shop. Here all the components are assembled with the help of robots. Different sizes of screws, nuts, bolts, and rivets are used to finalize the assembly. The small parts used for assembly comes from automatic object sorting machines. The flow chart of this whole process is shown in figure 1.
IV. TECHNOLOGIES USED IN AUTOMOTIVE INDUSTRY

The process of automation depends upon the application, for which it is implemented. The machinery used for automation is specifically designed to perform a particular task. The automation process is widely used for those applications in which there is a risk of injury for human labor [6].

4.1 Robot Manipulators

Robot manipulators are used in various industries because these types of robots are compact, fast, and work with high accuracy [7]. In the process line, different parts are welded with the help of robots. There are some cavities where the human hand cannot weld with high precision. The robotic manipulators can easily weld those parts. For the paint job in the final assembly, the robots are used. These robots have complex degrees of freedom and paint the parts with perfection. The process of electroplating is used to provide a protective layer on the surfaces of different parts to avoid corrosion. Robot manipulators are widely used for this purpose. Different configurations are used in robot manipulators in which Sacra configuration robot, cylindrical configuration robot, Stanford arm configuration robot, articulated configuration robot, and spherical configuration robots are most commonly used.

4.2 Additive Manufacturing or 3D Printing

3D printing technique is the process of printing a 3D part with the help of computer-aided design. Formally plastic is used for the manufacturing of 3D products because it has a low melting point. The 3D model is divided into layers and fed into CNC machine to make the part. This type of manufacturing was limited to a small scale but different companies invested in this technology to print bigger parts. Even metal 3D printers are introduced now a day which print the part in 3D metal. This automatic process just needs a 3D CAD model in STL format to print the exact copy in the real world. This is a fully automatic process and many automobile companies are adopting the process for manufacturing.

The material used for and automotive side mirror is plastic filament such as ABS. In recent days 3D printing is limited to make parts like the dashboard, headlight covers, side mirrors, etc. Many researchers are finding ways to use a metal 3D printer for the manufacturing of engine parts of the car. Because the molding process is very time consuming and extra labor is required.

4.3 Mobile Robot

Mobile robotics is the modified form of robotics manipulators. In manipulators, the base is fixed and it is applicable for a limited area of the workspace. While In mobile robots, the base is movable and the whole robot can move from one point to another. This is a very complex robot and artificial intelligence is used in it for navigation, environmental guidance, and path planning. This robot can detect humans or obstacles in its path and intelligently plans its trajectory while working. This robot might be used for transporting or handling of
objects from one place to another. So, mobile robots have a manipulator on it that performs the same task as a robotic arm but in a dynamic environment.

These types of robots are less popular than fixed manipulators because of its high cost and complexity. The manufacturing of such type of robot is applicable after a vast study of the environment in which the robot will perform. This dynamic robot is based on probabilities and AI algorithms.

4.4 Automatic Object Sorting Machines

The assembly of an automobile with the help of robotic arms requires the parts to be in perfect orientation. So, the robot picks and places it in the required place. For example, for the fixing of the door, screws are used. In automation, a robot picks the screw and tightens it at a particular place. For this purpose, the screw must be in perfect orientation otherwise the robot will not be able to assemble it. So, automatic machines are designed for the sorting of different parts in required orientation so a robot can easily pick up the part and put it in a perfect place. The object sorting machine and robotic manipulators work collaboratively to perform the task. The most commonly used machines for the sorting of objects, are feeders. There are different types of feeders like vibratory feeder, reciprocatory feeder, belt feeder, and bowl feeder. The vibratory feeders use vibrations to sort objects of different sizes, reciprocatory motion is used in reciprocal feeders to separate different objects. Bowl feeders have a complex mechanism to feed the part in only one orientation to the assembly line which is required. All other orientations are neglected and the neglected part is falls again in the feeder to start its journey again. The bowl feeder is shown in figure 2.

![Bowl feeder](source: Wikimedia Commons)

V. APPLICATIONS

There are various applications of automatic process including robot vision, spot and arc welding, paint, sealing, coating, and transportation. Some of them are given below.

5.1 Robot vision

The robot uses camera vision to generate a trajectory environment. This vision gives an array of points which is used by the robot to reach complex cavities. Various sensors are linked with camera vision to intelligently control the movement of the robot which works better than a human being. In modern robotic, artificial intelligence systems are used to intelligently detect the parts and to perform operations on it.

5.2 transportation

For the assembly of a vehicle different parts come from different workshops and are gathered in the final assembly shops. The transportation of these parts is very time consuming if it is done manually. Automatic production lines are used which have conveyor belts or chain mechanisms, used to transport from one manufacturing shop to another in no time.

5.3 welding, painting and coating
The welding process is used to joint one part with another. For accurate joints, the welding must be precise and accurate. The human hand is not so stable during the welding process and it results a bad joint. Machine controlled welding is very stable and the resultant joint has good stress-bearing capacity. Similarly, the process of painting required an evenly distributed layer of paint.

The use of a robotic arm can provide an accurate layer of paint without any irregular bumps. The process of coating is also carried out by an automatic process because the body of an automobile vehicle is heavy and cannot be handled by a human being. The heavy machinery is used to pick the body and submerge it into an electrolytic tank for electroplating.

VI. ADVANTAGES

The use of the automatic process has great advantages. It enhances the quality of the manufactured products. Some advantages of automation are given below.

6.1 Increased production rate

By the use of an automatic process, the overall production rate can be increased. Usually, the throughput time of the automatic process is greater than manual operators which are responsible to manufacture more parts in less time. This not only increases the production rate but also reduces the labor cost.

6.2 High Accuracy and Precision

The parts manufactured from the automatic process have a high degree of precision. There are no dimensional errors; the output is refined and smooth. The process of welding, painting, and coating is done with more efficiently and perfection.

6.3 Reduce Labor and a Source of Cash back

The implementation of automation in industry helps reduce labor which saves the salaries and the system acts as a source of cashback. For example, three manual employees are working in the industry.

Their salaries are $500 and the initial cost of the automatic process is $10000. When the system is implemented, it performs the work of all their manual employees and saves the salaries. These salaries fulfill the initial cost of automation. After this time, the cashback period is started.

VII CHALLENGES

The main challenge for the implementation of industrial automation is the high initial cost [5]. The cost required for the implementation of this technology is very high and small companies do not have funds to implement this technology. The second challenge is that the automation process causes unemployment because many people may lose their jobs due to an increasing trend towards automation. Researchers and engineers should work collaboratively to make a cost-friendly system that has a low initial cost. Similarly, government officials should make a way out for unemployed labor to work and give them other work opportunities.

VIII. CONCLUSIONS

Automation is widely used in industries of automotive and aerospace. This is the future of smart industries for the manufacturing of a high-quality product. The process of automation increases the production rate which results in generating huge revenue at the end of the year. The process of automation involves robotic manipulators, 3D printers, mobile robots, and object sorting machines. Robotic manipulators are used most commonly now-a-day because of its high efficiency. The output achieved by the robots is of good quality and precision, but the initial cost for the implementation of automatic plant is high. This cannot be achieved by manual process. There is a risk of unemployment due to the implementation of automation. The government should take the necessary steps to give other opportunities to employees affected.

XI REFERENCES
