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The Impact of Automation in Painting Furniture Parts

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Abstract

Technology and Woodwork industries have been going through a phase of perfection over a period of hundred years, up until today, the wood work traditions are still exist and improving with the help of modern technology. Looking at history and current studies with regards to production of furniture, many factories are producing millions of chairs for entire continents and to maintain the market lead position requires a lot of human dedication and intelligent investments in technology. Using automation in painting means to automatically control the process including industrial machines like robots, conveyors and others which save time, money and also reduce human efforts. Most automation companies are specialized in industrial automation, industrial robots, communications, electronics, and software for developing complex projects to automate desirable task by integrating robots. This study is purposefully conducted to shed more light on the benefits or impacts of automation in painting furniture parts. One of the benefits that most of companies gain from automating the painting process with robots is the productivity growth. The recruitment process for specialized personnel in the painting processes has also been greatly simplified due to the fact that the robots have taken over the difficult' tasks and protection from areas with high risk inhalation of harmful substances is assured. In this research, Automation is shown to be efficient and effective in the painting system by reviewing different studies. Automated dyeing processes in factories have made progress due to the successful results achieved by automated painting robots. In that regard, the impact of automation in painting furniture parts is evident in the production of fitments that are in almost every home through the solutions offered by automation to the consumer.

Keywords

Painting Robot Vision, Automation Impact, Robot Imaging System

1. Introduction

As shown by historical accounts and the purpose of this paper is to show the impact and the concept of an automatic gadget to assist humans or do tasks for them that has existed for a very long time. Examples include concepts like automatically opening doors. Fast forward several hundred years leading up to the Industrial Revolution, this resulted in increased production quest and, consequently, impetus for automation. The introduction of (NC) Numerically Controlled machinery, the eminence of the computer (the 1950s), and the circuitry (1970s) all played a great role in the development of the first, but primitive, industrial robot. The earliest were capable of replacing people in heavy, risky, and tedious activities. They were not able to sense the external surroundings, and were just employed for tasks that are easy like pick and place [1]. Later, engineers were able to include more complex motions, exterior sensors, and operations like deburring, welding, grinding and assembling. Since then, industrial robots have helped replace risky or harmful operations while also lowering costs, increasing productivity, and improving quality.

The Unimate, created in 1954 by George Charles Devol, is widely referred to as the first industrial robot. A few years later, entrepreneur Joseph F. Engelberger and Devol were talking about mutual interests, and they founded Unimation Company [2]. How would you describe an industrial robot then? A mechanical system that can be programmed to perform a variety of jobs, is automatically regulated, capable of using an arm with a variety of tools, works quickly, and has different levels of flexibility [3]. Unimate, the first version, which was used at GM's factory for handling die castings and spot welding, was constructed in 1961. In 1967, the initial instance of a company successfully designing a particular robot to meet their demands was reported. This company developed a robot to complete a spray painting task and afterwards changed its name to ABB group. It is only in this particular case that big businesses started creating industrial robots on their own. By the middle of the 1970s, it was expected that the use of industrial robots would increase at a rate of around 30% annually. After officially taking off, the industrial robotics sector never looked back. The continuing inventive development and upgrading of industrial robots resulted in a significant increase in demand in 2010. Global sales of robots increased by 29% by 2014. As the world grows more and more aware of the great advantages of industrial robots, it is an exciting time to be a part of the robotics industry, most industrial robots are like this **Figure 1**.

A powerful workhorse of a high acceleration and speed robot with the ability to handle huge cargo allows shorter cycle duration and increased output which may position the process equipment near the applicator because of the large load capacity [4].

2. Impact of Visual Identification in the Painting Process

Racks are loaded onto the OnRobotics overhead conveyor via a load/unload robot,

Figure 1. Arm robot with control panel.

scanned and transferred to the PaintMate Robot for coating. The scanner will identify each part and validate its position in the rack. Once positioned in front of the robot the OnRobotics patented turning system synchronizes with the robot part path, rotating the parts individually as the parts are rotated. The racks are then conveyed back to the load/unload, where a robot unloads them. Allowing the workpiece to be mixed and hung without generating work chaos. Of course, planning ahead of time ensures that all workpieces to be hung have a corresponding spraying program [5].

The visual recognition system is installed on the spraying robot's front end as on **Figure 1**, and the robot will automatically invoke the trajectory program for the workpiece of this shape. If robotic vision is not introduced, robots will continue to operate as blind machines that follow their scripting. They rigidly adhere to the rules that govern their behavior, which makes them suitable for routine work that would be mechanically demanding and complicated for humans. Robots are changing as we approach the advent of Industry 4.0. It will enable companies to stay up with the fourth industrial revolution's needs and tendencies [6]. There is another method that where the painter holds the manipulator to teach according to the normal spraying operation. During the teaching process, the whole operation process is recorded and stored by the computer, and the computer automatically completes all the operation processes of spraying by imitating the manual teaching process by the manipulator according to the stored information [7]. The advancement of robotics depends on the development of an interactive robot imaging system. A key element of this advancement is machine or robot vision, which provides new accuracy and preciseness levels in intelligent computerized operations. Vision aids are useful. Collaborative robots can inspect, identify, count, measure, or read barcodes, among other things. Multi-operations in one process are made possible by ultra-high-speed imaging and high-quality lenses [8].

2.1. The Robotic Vision of the Painting Robot

One or more built-in cameras allow the collaborative robot to "see". At least one robot vision camera, acting as the machine's eye, will be installed on the robotic arm itself. Additional cameras are sometimes put at considered areas within the collaborative robot working space. This configuration enables the camera to col-

lect as much visual data as is necessary for it to work alongside humans to fulfill its function [9] [10]. Prior to deployment, the machine is taught how to recognize the things with which it should interact through programming. Within Figure 2 workspace and a close look on Figure 3, hanged objects are to be scanned in 2D or 3D by the collaborative robot camera. After that the image will be saved in the database for collaborative robots and configured to move and carry out the designated task. Once the programming is finished, the collaborative collaborative robot may be put on the assembly line [11] [12].

As new tasks such as making real-time decisions and triggering actions become more complicated, Accuracy must be increased, and cooperation with humans is essential. Visual feedback is an important aspect for such goals because it is the same thing that vision systems provide to robots [13].

2.2. The Process of Robot Vision

Hanging conveyor belt has hooks that supports the rotation function mounted on it and this carry different shapes of furniture as it is shown in Figure 4, it moves in front of a painting robot to be sprayed, first the robot with a built-in camera identifies an object moving in front of it in 3D then portray it in 2D send the signals for the program to be identified and be executed then the robot takes the command and starts spraying the part.

The vision system (C) on Figure 5 is an advanced one it detects the parts on the line in 3D and then in 2D, identify them and communicate their exact shape and position to ensure uniform paint coating for the parts produced and then the robot (R_b) start the process (P) painting. This is the immediate issue. Because it defines a set of values that categorize the modeling among 3D points in the world co-ordinate system and 2D image precise location, this method is also referred to as camera calibration. The pinhole camera model is commonly used to model world coordinates projected from a perspective onto an image [14].

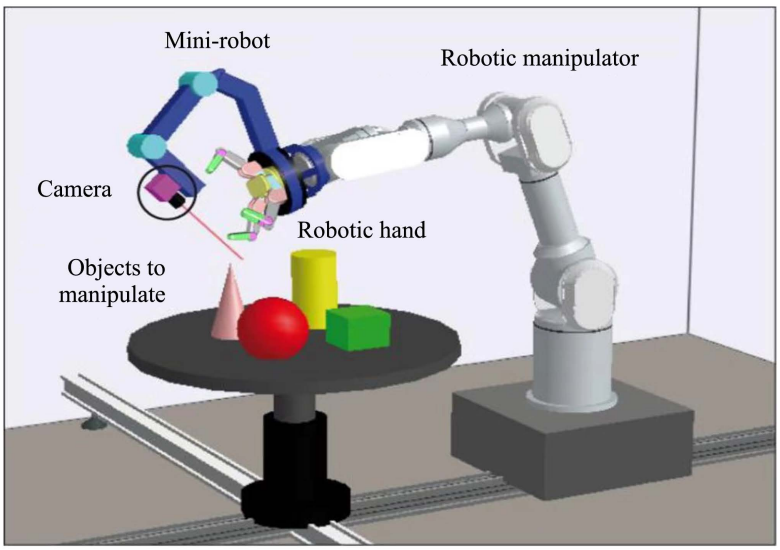

Figure 2. Robotic system.

Figure 3. Robot workshop.

Figure 4. Robotic system with hanging conveyor belt.

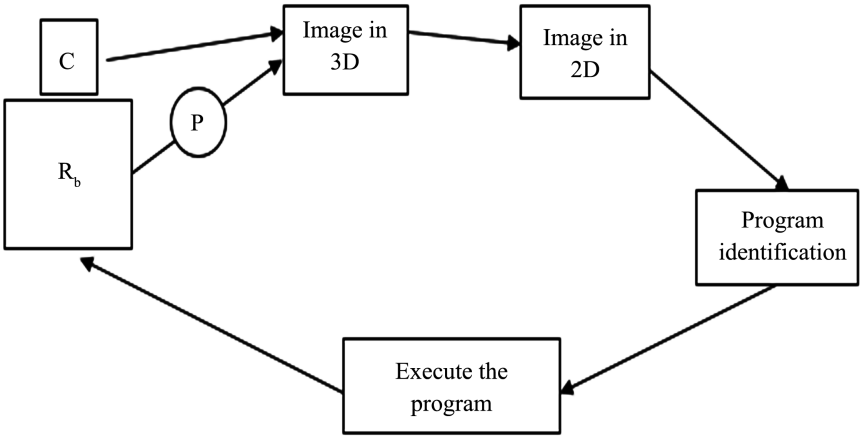

Figure 5. Painting process by an arm robot.

2.3. Significant Sectors of Robot's Imaging System

➢ **Footage capturing**

Cameras record images of things entering the collaborative robot's workspace. Conveyor systems are likely to deliver the items before the robot if the setup is midway through the assembly line. At a predetermined distance, camera will begin collecting data visually. The machine will then assess the video or film and make necessary improvements to create a detailed image.

➢ **Image treatment**

Images will be processed further and examined pixel by pixel. The framework will compare the colors and observable shape of the object to the image stored in

its directory.

➢ **Connectedness and reaction**

When the device specifies that the item in the image corresponds that which was programmed before, it will take the appropriate action on the object in front of it.

This whole process occurs in a matter of trice.

3. The Influence of Automation in the Painting Process of Furniture Parts

The above is a rudimentary illustration of how collaborative robot with vision systems may be integrated into a manufacturing line. Automation in the painting process is not only efficient but also represents a technological innovation by applying a liquid paint on wooden surfaces using a robot. Automated dyeing processes in factories have made progress due to the successful results achieved by automated painting robot. Among those successful results there are also some examples that can be illustrated as the automation advantages in the painting process:

✓ **Increases efficiency**

Images captured by a robot vision camera may be used to train your personal AI model, and the picture data may be gathered automatically. Robots in factories may then utilize the training module to better recognize various furniture flaws.

✓ **Assures consistency of the product**

Although employees are able to frost a cake, however it would be unreasonable to anticipate that anybody could maintain accuracy for an extended period of time say, six to eight hours. This is an illustration of a repetitious work that robots are a great alternative for. Additionally, industries may benefit from the visual recognition function and be more adaptable in the production lines using robot vision. If they let Collaborative Robot respond to elements that come into their places of vision, they can generate more.

✓ **Reliable**

Robots that are led by vision are more trustworthy than those that cannot sight. After all, they don't operate in a blind manner. They can be set to bypass an item that is significantly dissimilar from the pre-programmed 2D or 3D pictures in their system and continues to those that pass the initial quality assessment. Like this, manufacturers may increase productivity by using their components or raw materials on the conveyor.

✓ **Promotes workplace safety**

Outmoded, automatic machines operate in accordance with the directions and speeds set forth in their programming. If you put a human employee in its pathway, it won't stop whether they move out of the way or not. Collaborative robot with AI-enabled vision, moreover, have sensors that can identify obstacles in their pre-planned pathways and movements. Instead of starting up at full

speed, they stop when their sensors detect an object in their path. The danger of on-site accidents can be considerably decreased in factories with vision-guided collaborative robots.

✓ **Lowers operational expenses**

Collaborative robot with systems of robotic vision requires a significant financial funding. Despite the fact that returns on investments of any kind are never guaranteed, businesses can be certain of benefits like time and resource savings, increased rates of production, effective and more regular quality of the products, and more reinvigorated workers. Lower operating costs and higher sales are two potential long-term results.

✓ **Increase in productivity**

The vision system identifies the parts on the conveyor and continuously and automatically adapts the conveyor speed, the robots use the line tracking option meaning they follow the parts as they move and can paint a lot of parts in real-time. After there will be an evident reduction in the paint consumption.

✓ **Speed up the operation**

By automating this process it is easy to speed the process up. In fact, the study has proven that automation can handle about 45% of repetitive work [15]. That way the time is perfectly spent, the amount of time spent on the task can't be compared to the production result, means in a matter of hours you will accomplish more than it was going to be if you were using man power to do the task.

4. Discussion

Painting different furniture parts using an automated process, has proven to be more functional and beneficial in the companies and factories that has chosen this method, rather than the old fashioned way which was the use paint, brush and a lot of workers. Automation can bring many benefits to an industrial finishing operation that cannot be compared to the costs associated with it. Though most of the systems on today's robot can be programmed to identify several shapes or patterns designs which allows some variation in the painting procedure, when it comes to the programmable side of a robot then the programming process can be overwhelming and time consuming. On the other hand In order to avoid any mix-up, wastage of paint and time while using this automatic painting method, like any other device either automated or not automated it has to be kept under a consistent maintenance, to prevent any issues from arising, should this automated system have a breakdown it might cause unnecessary chaos, in that case an engineer is needed to constantly check if everything is running perfectly well. The biggest challenge for industrial companies today lies in improving productivity and operational efficiency, mitigating risk and reducing costs. Automating industrial finishing processes makes it possible to remain profitable in the market demand.

5. Conclusion

Automation is an important method to use in industry nowadays, besides the

fact that it can save you hours of time and a lot of money. Using automated system as a robot to spray or paint is one of the effective and efficient ways to accomplish the task given. Robots have emerged as a key component of Industry 4.0 and in order to attain more functionalities plus requirements of the applications that are new, sensor technologies and vision systems can be improved to reach certain flexibility. In companies that deal with the preparation of wood into the finished products like chairs, tables, beds and many more are evolving from a tiresome method to an automated technique, and the outcome has proven to be admired by users. Furthermore, Conditions in the industrial environment and robotics need to be taken into account because without proper environmental management systems and objectives, automation alone can have significant adverse impacts, especially on ecosystems and energy use or resource use. Robots and their applications require a particular vision solution. Robot executions are regularly subject to precise troubles, such as regulator and introduction of objects with different geometrical shapes to the ones that are already in the system. The concept of taking into account, automation systems as an indispensable piece in the manufacturing process is not novel and as time goes new techniques and inventions are still being unveiled to facilitate and speed up the painting process.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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