



AUTOMATION IN CIVIL ENGINEERING

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Abstract: This paper investigates the potential for automation of masonry work. A brick-laying robot was designed and the robot's design criteria were such that it should be able to construct a wall using cinder blocks autonomously. The paper out-lines considerations for the entire process of implementing the robot, from material input and stock management to construction process by the robot itself. The design included the functioning of the brick-laying robot's head. Finally, comparisons were made in terms of cost and time efficiency between the robot and traditional methods for masonry assembly. The results revealed that the designed robot optimized time and cost deliverables with a noticeable waste reduction and an increase in productivity.

Subjects: Applied Mechanics; Automation; Robotics; Mechanical Engineering Design; Architecture; Building and Construction; Building Techniques

Keywords: automation; industrialization; bricks; construction robot; masonry

I. INTRODUCTION

Automation in construction is the combination of methods, processes, and systems that allow for greater machine autonomy in construction activities. Construction automation may have multiple goals, including but not limited to, reducing jobsite injuries, decreasing activity completion times, and assisting with quality control and quality assurance.

The building construction industry has always been labor-intensive. It demands a significant amount of physical labor for activities such as digging, mixing, and carrying heavy materials. Traditional ways of construction are time-consuming, high-risk, and expensive. Despite these drawbacks, the construction industry has been slow to embrace new technologies that could help automate many of these laborintensive tasks. While the adoption of machinery and equipment have somehow helped to modernize the industry, there is still a long way to go.

How can Automation in Construction be Beneficial?

In recent years, several new construction technologies have emerged that have the potential to revolutionize the industry. Automation in construction can greatly increase productivity and efficiency on job sites. By using automated equipment and processes, AEC companies can complete projects much faster than with traditional labor-intensive methods. This means that projects can be completed on time or even ahead of schedule, which can lead to cost savings and increased profitability. Additionally, automation can improve the quality of work by reducing human error and ensuring that tasks are performed consistently and accurately.

1. SAM 100 (Semi Automated Robot)

Construction. Sam100 was made to assist with the strenuous task of lifting and placing brick, increasing the masons productivity by 3-5x what they could do before while at the same time reducing lifting by 80%+. Sam100 wasn't designed to replace construction workers, just enhance their capabilities, and lower the risks of their health and safety. The mason will still do the bulk of the site setup and final wall quality check. This semi-automated mason robot launched back in 2015 at the World of Concrete trade show where it won The Most Innovative Product Industry Choice Award. Sam100 debut at the World of Concrete again in 2017 but the new 2.0 version is much faster than the previous model.

Benefits to Sam100

- Lower installation cost – up to 50% in labor savings
- Increase productivity 3-5x
- Reduce lifting by 80%
- Designed to work side by side with the mason
- Continuous improvements through production data
- Lower health and safety concerns



Image 1. Brick laying robot

SAM100 was the first automated bricklaying robot available for commercial use for on-site masonry construction. It works in collaboration with trained masons. One mason is required to maneuver it, load it with bricks and mortar, while another mason is needed to conceal wall ties, remove excess mortar, and lay bricks in corners or other inaccessible areas. SAM100 is embedded with multiple sensors to measure and track velocity, incline angles, orientation, outside and enclosure temperature, humidity, run hours, GPS, safety, and many more. It can also measure the slump and quality of mortar. **The initial cost of this robot is 4,00,00,000 rupees (4 crore)**

2. Automatic Wall Plastering machine

The DERUTU Plastering Master series automatic plastering machine can be done the plastering work for once time, reducing labor intensity for 70% and improving work efficiency for 200% and construction quality

1. The latest automatic alignment system. Adopts PLC – Auto Tilt sensor – Bidirectional linear actuator technology to plastering, make a smooth wall surface with an error not exceeding 3 mm.
2. Pole system, aluminum-magnesium alloy material, the foldable design is easy to move, and support customized height to do different project.
3. The plastering board is widened by 20cm. Manganese steel chrome plated has abrasion resistance. And upgrade the vibration motor prevent hollowing and cracks.
4. The power system uses the latest servo motor to provide more rapid and stable power.
5. New material mudguard, More wear-resistant casters, Teflon paint more anti-corrosion.

Specifications

MODEL	D4.0
Max Height	600m
Plaster Thickness	0.2-3.5cm
Plastering Width	110cm
Efficiency	8m ² /min
Voltage	220V / 380V
Motor	Servo motor
Position	Automatic PLC
Hopper Capacity	80L
Size	120*80*185cm
Weight	>110kg

Image 2. Automatic wall plastering machine **The initial cost of this robot is 8,00,000 rupees (8 lakh)**



3. *D60 Plaster plastering machine*

D60 is a three-phase plastering machine ideal for dosing, mixing, pumping and spraying dry mix materials from bag or silo. Built with a modular bent trolled steel body and a highly efficient geared motor. Equipped with high-quality components that make this plaster sprayer the top of its category.

1. Worm pump, better pitch design, provide stable and efficient working efficiency.
2. Nord motor, German technology reducer, high performance and long life.
3. KOELLMANN air compressor, oil-free mute air compressor, can work continuously without stopping.
4. DERUTU special nozzle spray gun is durable and has a 37% longer service life.
5. Schneider Electric to protect the motor from damage and safety.
6. Modular design. Easy to move, install and maintain.

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Image 3 D60 Plaster plastering machine

The initial cost of this machine is 2,15,000 rupees

4. *Spray painting robot*

The choosing of modern robotic spray painting arm differs much more in size and payload to reach many painting item of all sizes. spray painting robot have five to six axis motion originally, three for the base motions, while they have also up to three for applicator orientation.



Robots can precisely control spray angle, speed and flow intensity for complete and consistent coverage over complex surfaces. Robot master simulates coverage using spray parameters to automate the programming of optimized paths, ensuring precise coverage over all surfaces with minimal effort. Robotic spray painting arm are mostly used by vehicle manufacturers to do detailing works on their vehicles in a systematic way. Some of this robotic spray painting has arm that enable them to move vertically and horizontally, to spray paint to vehicle from every direction and on all parts of the car.

Advantages for robot painting and spray-coating applications

Spray-coating programs for robots can be generated automatically from the CAD model and subsequently modified with minimal effort to adjust for:

- i. Change of spray shape
- ii. Nozzle diameter
- iii. Nozzle to part distance
- iv. Depth of passes
- v. Number of coats
- vi. Entry/exit can be managed to extend automatically beyond the CAD model
- vii. Automatically manage and change the distance between steps without re-programming
- viii. Even step distances ensure spray consistency
- ix. Tool orientations can be managed automatically to optimize the program for minimal wrist rotation and maximize robot reach



Image 4. Spray painting robot The cost of this robot is 10,00,000.

II. CONCLUSION

- Overall, the use of automation in construction can improve productivity, reduce costs, increase safety, and improve the quality of construction projects. As technology continues to advance, the use of automation is likely to become even more prevalent in the construction industry.
- The use of automation in construction can provide significant cost savings and financial benefits. By reducing labour costs, minimizing material waste, and minimizing project delays and overruns, construction companies can improve their bottom line and achieve greater profitability.



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