

Robotics in Civil Engineering

Atharva Jagdale, Viraj Mohatkar, Akash Rodekar, Subodh Datar, Mrs. Harsha Shinde

Department of Civil Engineering, Rajarshi Shahu Collage of Engineering Polytechnic, Tathawade, Maharashtra, India

ABSTRACT: Drip Robotics in civil engineering has emerged as a transformative technology aimed at improving efficiency, precision, and safety across various phases of construction and infrastructure management. The integration of robotic systems in civil engineering applications—such as automated bricklaying, concrete printing, surveying, structural inspection, and maintenance—has revolutionized traditional construction methods. These technologies enhance productivity by performing repetitive and hazardous tasks with high accuracy, reducing labour costs and minimizing human error.

Robotics also contributes to sustainable construction practices through optimized material usage and waste reduction. Additionally, the adoption of autonomous drones and robotic sensors enables real-time monitoring and data collection, facilitating predictive maintenance and improving structural health assessment. Despite challenges related to high initial investment, technical complexity, and workforce adaptation, robotics continues to pave the way for smarter, safer, and more efficient infrastructure development.

I. INTRODUCTION

Robotics in civil engineering represents a significant leap toward the modernization and automation of the construction industry. As civil engineering projects become increasingly complex and demand higher precision, efficiency, and safety, the use of robotic technologies has gained substantial importance. Robotics involves the design, development, and deployment of automated machines capable of performing construction-related tasks such as surveying, excavation, material handling, bricklaying, welding, concrete 3D printing, and structural inspection.

These robotic systems are equipped with advanced sensors, artificial intelligence, computer vision, and control systems that allow them to operate autonomously or in collaboration with human workers. In construction, robotics addresses key challenges such as labour shortages, project delays, cost overruns, and workplace hazards by performing repetitive, dangerous, and precision-intensive tasks with high accuracy and speed. In maintenance and inspection, robotic drones and crawlers can access hard-to-reach or hazardous areas, collecting data that improves decision-making and ensures structural integrity.

Moreover, the integration of robotics with technologies like Building Information Modelling (BIM), Internet of Things (IoT), and Artificial Intelligence (AI) is paving the way for fully automated and intelligent construction environments. While the adoption of robotics in civil engineering faces barriers such as high implementation costs, the need for technical expertise, and adaptation to diverse site conditions, its long-term benefits—including improved safety, productivity, and sustainability—make it a crucial innovation for the future of infrastructure development.



❖ OBJECTIVES

- 1) Enhance Construction Efficiency: Use robots to speed up building processes and complete projects in less time.
- 2) Improve Accuracy and Quality: Achieve precise measurements and high-quality workmanship with minimal human error.
- 3) Ensure Worker Safety: Reduce risks by allowing robots to handle dangerous or physically demanding tasks.
- 4) Reduce Labor Shortages: Fill gaps caused by a lack of skilled labour through automation.
- 5) Lower Costs and Waste: Optimize material use and minimize wastage, leading to cost-effective construction.

II. LITERATURE REVIEW

- 1) G Beni, S Hackwood (2003) the construction project's requires people of different skills, equipment, materials and machinery for each and every activity as result of which the construction process becomes complicated. Apart from the difficulties faced by the construction industry the two factors safety and quality have been the major determining factors for the outcome of the construction projects. Due to faulty construction works and unsafe working conditions, the works have to be demolished and rebuilt leading to loss in labour time and escalation of cost the project.
- 2) Oesterreich and Teuteberg, 2016: Understanding the implications of digitisation and automation in the context of industry; a triangulation approach and elements of a research agenda for the construction industry.
- 3) Warszawski and Navon, 1998: Implementation of robotics is building: current status and future prospects. Source Journal of Construction Engineering and Management
- 4) Yvonne Ludewig(2013)A service robot should provide useful features and be easy to use. As a social actor, a service robot should also demonstrate friendly and accommodating behaviour. This paper focuses on the socio-emotional requirements described above. A marketable shopping robot was equipped with an extravert personality to improve its social acceptability.

III. ADVANTAGES AND CHALLENGES OF ROBOTICS IN CIVIL ENGINEERING**ADVANTAGES: -**

- 1) Increases construction speed and efficiency.
- 2) Improves accuracy and quality of work.
- 3) Reduces human errors and rework.
- 4) Enhances worker safety by handling dangerous tasks.
- 4) Lowers long-term labour costs.
- 5) Enables work in hazardous or hard-to-reach areas

CHALLENGES:-

- 1) High initial investment and setup cost.
- 2) Requires skilled workers to operate and maintain robots.
- 3) Limited flexibility in complex or changing environments.
- 4) May reduce employment opportunities for manual labourers.
- 5) Needs regular maintenance and software updates.

IV. DISCUSSION AND CONCLUSION

Robotics is increasingly transforming civil engineering by improving efficiency, safety, and accuracy in construction and infrastructure management. Robots are used for tasks like bricklaying, concrete pouring, demolition, surveying, and inspection of structures such as bridges and tunnels. For example, robotic arms can automate repetitive construction work, while drones (a type of robotic system) are widely used for site surveying and monitoring progress.

One major advantage is enhanced safety—robots can work in hazardous environments (heights, confined spaces, or disaster zones), reducing risk to human workers. Robotics also improves precision and quality, minimizing human errors in measurements and execution. Additionally, automation helps save time and labor costs, especially in large-scale projects

However, there are some challenges, such as high initial costs, need for skilled operators, and limited adaptability in complex, unstructured construction environments. Despite this, advancements in AI and automation are rapidly overcoming these limitations.

Robotics is revolutionizing civil engineering by making construction faster, safer, and more accurate. Although there are cost and skill-related challenges, the long-term benefits outweigh the drawbacks. In the future, robotics will play a crucial role in smart construction, sustainable development, and modern infrastructure, becoming an essential part of civil engineering practices.

V. FUTURE SCOPE

- 1) Automation in Construction – Increased use of robots for bricklaying, concreting, plastering, and finishing work.
- 2) 3D Printing of Buildings – Robotic 3D printers will construct houses quickly with less material waste.
- 3) Use of Drones – Advanced drones for surveying, mapping, monitoring, and site inspection.
- 4) Smart Infrastructure Maintenance – Robots for regular inspection and repair of bridges, tunnels, and roads.
- 5) Disaster Management – Robots to work in hazardous areas like earthquakes, floods, and fire-affected zones.
- 6) Integration with AI & IoT – Intelligent robots making real-time decisions and improving construction efficiency.
- 7) Reduction in Labor Dependency – Less reliance on manual labor, solving labor shortage issues.
- 8) Improved Safety Standards – Minimizing accidents by replacing humans in risky tasks.
- 9) Sustainable Construction – Robots will help reduce material wastage and energy consumption.
- 10) Development of Smart Cities – Robotics will play a key role in building automated and technologically advanced infrastructure.

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