ROBOTICS AND AUTOMATION IN CONSTRUCTION INDUSTRY

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ABSTRACT: *The construction industry's contribution to the gross domestic product (GDP) in the developing countries like that of in India is about 10%. Under the Make in India scheme, it is expected that $1000 Billion investments for infrastructure sector would be accomplished in the next few years. Today the construction industry is one of the most un-practiced fields in terms of automation. The importance of construction automation has grown rapidly in developed countries. In developing countries like India, the construction industries need automation technologies such as new machineries, electronic devices, the automation of road, tunnel, and bridge construction; earthwork, etc. Robotics technology developed rapidly during the 1980s, particularly in Japan, to tackle labour shortages due to an aging workforce and younger workers being reluctant to do hard physical labour. Every developed country and region is now experiencing this aging problem. Injuries are more severe among older workers thus compensation costs increase with the age of workers. It is hoped that robots can do all the high-risk tasks (like demolition and working at height) and solve labour shortages in specific skilled tasks. The construction industry being labour intensive requires more numbers of skilled labour, good quality of work, and increase in productivity etc. The problems associated with construction work such as decreasing quality of work, labour shortages, and safety of labour and working condition of projects can be overcome by new innovative technologies such as automation which has the potential to improve the quality, safety, and productivity of the construction industry. Today, it is evident that the level of automation in construction is very low in comparison with current technological advances. That is why we must make new efforts to increase the automation level of this important sector.*

Keywords: **Automation, construction industry, automation.**

1 INTRODUCTION

Automation and robotics is the hot new trend in many different industries. Businesses are looking for ways of automating repetitive, time-consuming, and dangerous tasks to enhance efficiency and improve the safety of workers. The construction industry is no different. In fact, automation is an excellent solution for builders to increase operational efficiency and to cut down on costs.

The scope of automation in the construction industry is quite broad, extending from initial planning stages all the way to operating and maintaining the final structure.

1.1 Objective

To study the how much amount of Automation is utilized in current construction industry and its future trends , and study which barriers are highly affect to apply in construction and how it can be minimized. Intelligent and integrated control over all construction processes to optimize resource value. To improve and achieve ideal optimum value of construction quality, safety, profitability, productivity.

1.2 Need For Study

The reason for this study is to identify Benefits of automation, and future trends of automation in construction. To Analyse, which are the main obstacles to implementation on site and how it can be minimized.

2 DRAWBACKS OF CONVENTIONAL STRUCTURE

• It involves longer times of delivery.

• High cost of Social Security contributions.

• More expensive building method in relation with the composite construction. The market offers the conventional construction 30% to 40% more expensive than that of composite construction.

The cons of using traditional techniques of construction for housing and other building is that the process takes a long time. The construction process is more entangled and can demand hiring highly-skilled builders and designers. It can add significant construction costs; materials and labour are more expensive.

3 FIVE EXAMPLES OF AUTOMATION BEING USED IN THE CONSTRUCTION INDUSTRY

1. Autonomous Machines on the Construction Site

Perhaps the most common example of automation in construction is the use of autonomous machines. These are essentially self-driving machines that can be used to transport materials across the work site and to haul heavy items without posing a risk to workers.

For example, machines can be fitted with robotic technology solutions and sensors that enable forklifts, diggers, trucks, and other similar equipment to operate without a driver in the cabin. By creating relevant paths, providing GPS capabilities, and programming movement of the machine itself, construction site workers can

remotely operate machinery and enjoy more efficient processes.

2. Drones to Survey Working Areas and Employees

Drones are excellent for conducting site inspections, especially on mega projects like skyscrapers or shopping malls. An individual or a team of inspectors would spend days walking through the structure to analyse safety precautions and progress. Drones allow a single pilot to do the work of many inspectors from a safe, even offsite location.

Drones can also be used for inventory management. Surveyors currently use GPS coordinates to cross-section piles of materials and determine their quantity. Whereas a surveyor drone equipped with a camera and lasers can achieve the same thing in just minutes. The result is a significant saving in time and labour costs for the firm, a godsend in an industry where labour is already scarce.

3. Robotics in Concrete Works

Automation in construction has also found its way to concrete mixing. Control systems and robotics are being used to mix concrete, lay the cement, polish floors, and remove surface water. This also allows companies to prepare precast and ready-mixed concrete products that take a much shorter time to install. Automation reduces material consumption and eliminates the human error that would otherwise go into concrete works.

Another area of concrete work that is enjoying the benefits of automation is concrete floor polishing. Programmable machines are being used to polish soft concrete in both commercial and residential structures. These machines can be programmed to pour and level concrete in the right portions while avoiding obstacles near the work zone.

Demolition robots are also being used to bring down walls and to dismantle concrete slabs. This often results in lower operational costs and a safer working environment for employees.

4. Sensors to Collect and Process Data

Sensors are the key devices that make automation possible. These devices can take real-time readings of location, temperature, pressure and other conditions. Sensors allow construction companies to automate many different machines and robots according to their preferences.

Sensors can also transmit signals to machines to trigger a specific action. For example, automation is typically achieved in welding and fabrication machines through the use of sensors. These sensors collect important environmental data that can be used to trigger a relevant action in the welding machine.

5. Virtual Reality during Project Planning and Training

Virtual reality systems are another example of automation in construction. These systems allow for construction companies to plan for a project even before they lay down a single brick.

Virtual reality simulates a realistic environment that allows builders to interact with a particular structure using a series of scanned images. For example, builders can virtually crawl through pipes in the building to determine if they have enough room for repair and maintenance. Virtual reality is an important form of automation because it uses programmed 3D scans that are highly accurate and not prone to human error.

4 ROBOTICS APPLICATIONS PROMISE TO ENHANCE EFFICIENCY IN CONSTRUCTION

When we think about construction automation, we should think about robotics applications and whether we can use robots to ease work that humans have traditionally done. Investors are putting millions of dollars into developing robots for construction. These robots will enhance productivity in the construction sector. And leading firms are creating new methods that will revolutionize how the biggest players in the business process materials in the coming decades.

A company called "Construction Automation" recently released a robotic product called "SAM 100." The robot, whose name stands for "Semi-Automated Mason" is reportedly capable of laying over 2000 bricks per day, compared to a human that might lay just 400. SAM 100 is the first commercially available brick-laying robot and promises to accelerate jobs and enhance profits anywhere it's used.

Fig.4.1 Automation of Prefabricated Home Construction a Growing Sector

Clever housing development firms are pushing forward with the construction of prefabricated homes in special warehouses, where manufacturing know-how, including the use of assembly lines, is being used to enhance worker productivity and reduce costs. In Japan, 16% of

homes are built using prefabrication techniques, while in Sweden, the number is a whopping 40%.

Assembly lines proved crucial to enhancing worker productivity in the automobile industry, and the factory environment promotes consistency and quality in production, leading to a better and more consistent final product for the end user.

In addition, prefabricated projects require less materials and have less waste. It's easier for the factory to use the exact amount of material needed and recycle material that it didn't use rather than on a site. It provides one location to almost complete a project, only leaving the installation process. And even that is easier than building everything on site.

Factory production is one of the most promising ways of addressing worker shortages. A worker operating a machine that does the building is far more productive than a worker that does the building himself. Prefabricated parts are transported to the construction site and used to construct homes in record time, leveraging existing infrastructure for transportation and warehousing.

5 AUTONOMOUS EQUIPMENT

However, they're no longer the only firm building automation equipment for the construction industry. Companies are building automation equipment for many specific industries within construction as well as for general construct. These specific companies are innovators in the world of construction technology and construction automation.

Stiles Machinery – This firm builds a product called a multi-function bridge that automates wood-framed panel production. The machine can be outfitted modularly with a variety of tools and performs multiple fastenings at once. It promises to eliminate costly pre-cutting, staging and repeated handling of sheathing materials.

Hundegger – Revolutionizing timber engineering, the futuristic machines of Hundegger Canada will allow construction firms to prefabricate and process timber according to exact specifications. This firm built the latest SPM2 Machine Series to process OSB, Plywood, Drywall, Cement, Fibre Board, and expand their offerings.

Trimble – Trimble's innovation is making amateur excavator operators look like professionals, saving time, and reducing costs with their Earthworks Software. This program integrates with excavators and allows workers to "dig to design" and perform pipework accurately in 20% less time.

3D-Printing Concrete – This past year, the United States Marine Corps used 3D printers to print a pedestrian foot bridge. Additionally, the USMC built a 500 square-foot barracks in 40 hours, making it a possible investment. And the Tennessee based construction firm, Branch Technology, will build the world's first free-form 3D-printed house this year. 3D-printing in construction is an automated technology that shows great promise for the future.

6 ADVANTAGES AND DISADVANTAGES OF ROBOTIC AUTOMATION

• The robots can improve the construction project, they save more lives and have now proven to be very successful, they are programmed by the human, they never get tired & can literally work on certain tasks 24 x 7.

• Robots offer more precise & uniform quality product compare with the products produced by the experienced workers, they can replace the labours in those tasks that involve difficult physical work, they can carry out jobs much easier which is hardly done by the labours.

• Automation can decline costs, it increases the efficiency & productivity, it conducts labour tasks at dangerous locations at substantial height places, Robotics enhance work environment because the workers will be distanced from uncomfortable work position.

• Nearly 100% automation is applied in the production of construction material such as cement, steel, glass, aluminium, and wood, approximately partial automation robotics is used in road construction, tunnelling, and earthworks. Automation of precast components is very useful as it presents products of high quality, The quality is not changing & the waste of the factory is declined, You can decrease the factory waste because of using the required amount of materials that is arranged with the help of computer planning & programming.

• Engineers within the automation industry need to replace the manual workforce and replace bricklayers, joiners or ground-workers with robots & operators, it can address the shortage of skilled labours, by collaborating with automation & robotics, the construction industry can reduce the waste, and increase the demand for housing.

• Automation can be used for concrete precast component production, Number of precast components can be produced as per buyer's demand, many apparatuses can be used for different purposes on the project site such as concrete screeding, finishing, scrubbing, and cleaning, partially automated overhead construction system is used for the construction of high rise reinforced concrete frame.

• The construction industry is a slow & monotonous field, if the robotics get incorporated into the construction process, they can reduce the overall cost of the construction process, They can minimize the project delays in conjunction, They can limit the expenses & this can lead to more affordable housing options.

• Autonomous Mining Trucks do a great job in construction, they will be a serious game-changer in the upcoming years, their use allows for higher productivity on site and lower operating costs, they increase safety for people working on site.

• Remote Control Bulldozer can be controlled remotely, the ability to remotely drive your bulldozer offers a lot in terms of safety, it can offer to the person who controls it a better sense of space, it prevents any serious accidents and 3D Printed Bridges will be a superb component of construction's future.

ADVANTAGES:

• **Cost Effectiveness**: There will be no lunch breaks, holidays, sick leave or shift time allocated for robotic automation. It can be set to work on a repetitive cycle, and as long as it is maintained correctly, it will continue to do so until programmed otherwise. The increase in production at a lower cost produces obvious benefits for any contractor.

• **Perform the tasks faster:** They can perform the tasks faster & with higher precision, this can lead to more enduring construction structures that can fit perfectly to their surroundings, robots will offer more long-term building solutions and they will promote new building forms.

• **Improved Quality Assurance:** Labours do repetitive tasks and after a certain period of time they get tired and makes mistake and can often lead to costly errors and sometimes serious injury to the project. Robotic automation eliminates these risks by accurately producing and checking items meet the required standard without fail.

• **Increased Productivity**: The introduction of automation into the construction process has many different productivity_benefits. Robots are designed to make repetitive movements. They can increase the precision of the whole procedure that will allow all the agents working within construction to stick to the given deadlines and save both time and financial resources.

•**Work In Hazardous Environments:** Aside from potential injuries in the project, members in construction industries can be asked to work in unstable or dangerous environments. Automated robots can minimise material waste and remove the need for humans to put themselves at unnecessary risk.

DISADVANTAGES:

• **Potential Job Losses**: One of the biggest concerns surrounding the introduction of robotic automation is the impact of jobs for workers. If a robot can perform at a faster, more consistent rate, then the fear is that humans may not be needed at all. While these worries are understandable, they are not really accurate. The same was said during the early years of the industrial revolution, and as history has showed us, humans continued to play an essential role.

• **Initial Investment Costs:** It include the high capital expenditure required to invest in automation (an automated system can cost millions of dollars to design, fabricate, and install), a higher level of maintenance needed than with a manually operated machine, and a generally lower degree of flexibility in terms of the possible products as compared with a manual system.

• **Hiring Skilled Staff:** Robotics automation opens up further opportunities for existing employees to be trained and expand their own skill set. An automation company can assist with the initial installation and set-up process, and with the right expertise, staff can learn and adapt to manage the robots in the long-term.

7 CASE STUDY

The existing glass ceiling glazing process is complicated and hazardous, relying on a scaffold (or aerial lift) and a human labour. This process exposes operators to accidents of falls or vehicle rollover, and so on. Moreover, inappropriate working postures are major elements in increasing the frequency of accidents by causing various musculo-skeletal disorders and decreasing concentration on work. That is to say, it becomes causes of decreasing productivity and safety in construction
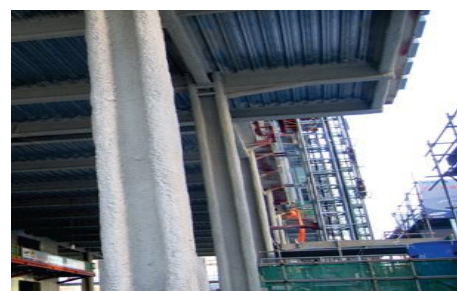
The existing handling method		The HRC handling method
Working time	Avg. 28min/piece(including finishing and break time)	Avg. 26min/piece(including finishing)
Labour intensity	High momentary labour intensity	Generally low labour intensity
Convenience	Profoundly dangerous work under obstacle interference	Generally convenient work
Safety	Generally dangerous; scattered accidents	Reduction in danger; fewer accidents
Labourer	13(deck:12(2groups), aerial lift:1)	3(deck:2, aerial lift:

Table.7.1: Comparison and analysis of existing (depends on manpower) glazing method and robotic glazing method

Field test

The proposed robotic system is developed to construct the soffit, an exterior (a glass ceiling) as shown in Figure 13. The installation positions of glass ceilings are 15m, and the size and weight of glass ceilings are 3000mm×1500mm and 150kg. Based on the task planning, the proposed handling process can be described as below:

1. The deployment of an aerial work platform on which the proposed robotic system is mounted.

2. Loading the glass ceiling on the deck.

3. Lift the glass ceiling near the frame in which the glass ceiling is laid.

4. Install the glass ceiling and finish the work.

Before lifting the deck, one piece of glass ceiling is loaded on the deck. Then, according to the deployment plan, the robot approaches to the installation position

Fig. 7.1 Field test of GCGR

Then, the installation begins according to the planned process shown in Figure.

The procedure of handling cannot be defined systematically because it depends on the workmanship of workers and the construction environment which is unconstrained or not repetitive.

Table 7.1 shows the comparison and analysis of the two glazing methods. Working time means the whole time consumed in moving the glass ceiling from the ground and fixing it on the building soffit, and labour intensity means the degree of manpower strength required of workers during the glass ceiling handling process. Convenience indicates the degree of difficulty of the handling work, and safety shows derived degree of safety.

In the case of handling building materials on smaller buildings, the work may depend on manpower. But according to the tendency of current construction trends towards larger and taller buildings, the presented expectations of the GCGR here provide a bright outlook.

8 CONCLUSION

With little hope of reversing a long-standing labour shortage, automation technologies are the way forward for the construction industry when it comes to enhancing productivity and boosting profits. The adoption and integration of automation, and the widespread use of prefabrication may be the best opportunities for the construction business to thrive in the next decade.

A robotic manipulator GCGR, is combined to suit various working conditions and building materials as module type. Therefore it is possible to handle a variety of building materials in various construction sites. To improve technology of human-robot cooperative manipulation, lightweight robot link, robust robot force control, flexible robot arm and teleoperation based on force feedback will be developed in the future.

By using of automation technologies in construction had a major influence on project performance with greater influence on improved work quality, time saving, improving working condition, safety improvement, and high productivity in work.

The benefits of executing automation technologies is the need of the present infrastructure project and development firms to increase the productivity great, increase the safety for workers, and good quality of work. Small and medium size firm are the need of automation advances to implementation in various areas.

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