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Applications of Automation and Robotics in Construction Work

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Abstract

In India, the construction industry is one of the largest industrial sectors. The importance of construction automation has grown rapidly in developed countries. The infrastructure project requires more numbers of skilled labor, good quality of work, increased productivity, etc. Studying recent applications and projects for using robots and automation in the construction industry In today's world there is a lot of demand for investment in construction to support the economic development and social transformation with new homes, offices, industry, schools, hospitals, and infrastructure In this review paper automation and robotics construction is in our opinion an exceptional solution to build faster and more efficient civil designs nowadays. The emphasis is given to the effect of automation and robotics in construction technology.

Keywords: Automation • Robotics • Robotization • Construction industry • On-site construction

Introduction

Automation and robotics are hot new trends 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. Automation is the perfect solution for builders to increase efficiency and cut down on costs.

The scope of construction automation is large and involves the entire construction stages for instance production of construction material, prefabrication of construction components, on-site construction, operation and maintenance of buildings, and demolition and recycling of structures [1].

If automation construction is practiced, construction work will be continuous and consequently, the construction period will decrease and this will provide large economic advantages. Additionally, construction automation improves the safety of laborers and enhances the quality of the work.

Definition

"Automation is the technique, method, or system of operating or controlling a process by highly automatic means, as by electronic devices, use of control systems and information technologies, reducing human intervention to a minimum."

Advantages and Disadvantages

The advantages of automation

- Higher safety for both workers and the public through developing and deploying machines for dangerous jobs.
- Uniform quality with higher accuracy than that provided by the skilled worker.
- Improving the work environment as conventional manual work is reduced to a minimum, so the workers are relieved from uncomfortable work positions.
- Eliminating complaints about noise and dust concerning works such as removal, cleaning, or preparation of surfaces.
- Increasing productivity and work efficiency with reduced costs [2].

Disadvantages of automation

- Unemployment at the cost of modernization.
- Leads to drain from the country.
- Requires a high capital cost for setting up and maintenance
- Skilled and expert handlers or workers are required due to the need for high technical knowledge to operate the machines.
- Untrained workers cannot be employed which increases the initial cost of the project.
- Trained laborers are not available easily and trained laborers charges higher than untrained laborers.

Applications of automated construction and robotics

1. Automation and robotics in the construction sector and precast concrete industry
2. Automation and robotics in prefabrication of masonry and on-site masonry construction
3. Automation and robotics in the production of steel components

Automation and robotics in construction sector and pre-cast concrete industry

It has been a long time since almost 100% automation is achieved and applied in construction material production for instance cement, steel, glass, aluminum, and wood. Approximately partial automation robotics is used in road construction, tunneling, and earthworks.

Regarding concrete precast component production, a large degree of automation is utilized and the necessary number of precast components can be produced as per the buyer's demand.

The automation of precast components is very beneficial because it

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provides products whose quality is not changing and waste in the factory is declining.

This decrease in factory waste is made possible because of using the required amount of materials which is arranged with the help of computer planning and programming [3].

Stationary mixer plants are not an exception and a substantial degree of automation and robotics are employed for quite a long time.

As far as on-site construction automation and robotics is a concern, several apparatuses have been used for different purposes on the project site for example concrete screeding (Figure 1), finishing (Figure 2), scrubbing, and cleaning.

Automation and robotics in prefabrication of masonry and on-site masonry construction

Automation and robotics in masonry prefabrication play a significant role and has considerable advantages because they not only substantially raise the production of masonry blocks but also it decreases manpower and labor cost. Plants that produced masonry elements may be completely automatic or partially automated and individually designed masonry blocks can be prefabricated [4,5].

Prefabricating masonry blocks and bricks are not free from obstacles and difficulty, for example, installing such an automatic plant needs a huge amount of money which can become a considerable obstacle.

Apart from automated masonry elements, automation and robotics are also used to lay bricks such as shown in Figure 3 which can lay up to 1000 bricks in an hour [6].

Automation and robotics in production of steel components

Automation and robotics have been used to a great extent by steel companies that prefabricate building components according to contractor demand. The steel components will be transferred to the project site for erection. It should be said that automation and robotics are not used in the erection process to a great extent; manual welding screwing is used during construction [7].

Utilization of steel in the house construction is very low but some factories prefabricate components of houses using automation and robotics as shown in Figure 4.

It is reported that such a facility produces five to ten thousand houses per year and it produces 120 m^2 in just two and half a minute, and the house can be erected in four hours [8].

Lastly, Figures 5 and 6 shows a transformable automated welding robot in integrated automated building construction which led to a decreased workforce up to approximately seventy percent.

Scope for Future Work

It is important to know the real status of building robotics today to decide what future directions building robotics should take. In the light of this bleak present status, is there any future for robotized construction? The answer is, by all means, yes, but only if the subject is approached properly. Robots developed with due attention to these requirements will have a much better chance of survival. The robot has to be "site-friendly" i.e., well adapted to the particular conditions of the building site. This involves:

- Its performance as a system. All aspects of operation, movement, materials feeding, and transfer, and their adaption to the particular conditions of a building site must be taken into account in the development.
- Ensuring that its weight does not exceed the permitted level load.
- Its maneuverability, i.e., its ability to work capacity in restricted spaces.

Figure 1. Automatic concrete screeding machine.

Figure 2. Automatic concrete scrubbing and cleaning manchine.

Figure 3. Partially automated masonry element prefabrication.

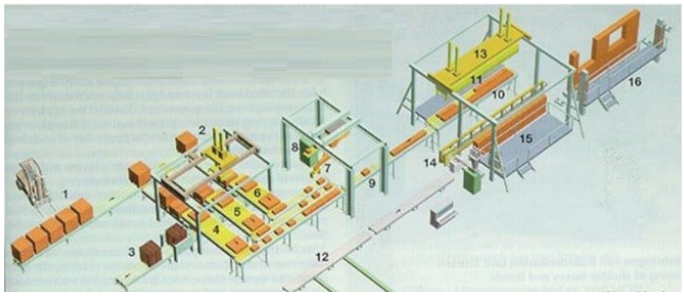


Figure 4. Automated manufacture of brick wall masonry blocks.

- Its versatility, i.e., ability to perform different tasks, increasing the extent of its use.
- Its independence with respect to power and materials supply.

Figure 5. Automated brick masonry laying robot.

Figure 6. Automated and robotic steel panel production facility.

Table 1. What is the implementation of automation and robotics-based technology on-site construction in India?

What is the implementation of automation and robotics-based technology on-site construction in India?	
The casting of concrete work	40%
Concrete pouring and bricklaying	20%
For the survey, Drawing estimating	50%
Demolition	40%

Table 2. If you have automation then what will be your preference?

If you have automation then what will be your preference?	
High accuracy	60%
Time-saving	60%
Labour replacement	40%
Environment sustainability	20%
All the above	40%

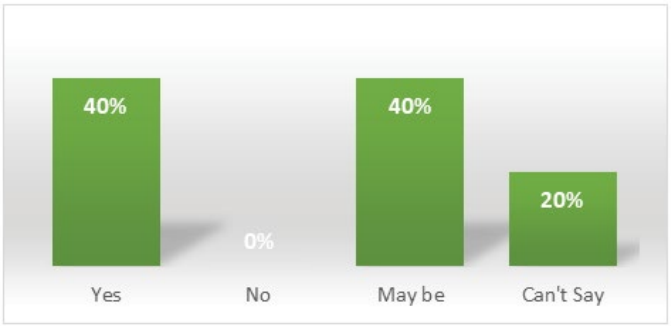
Table 3. Based on all qualitative parameters, can you recommend the automation as a need of the present & future?

Based on all qualitative parameters, can you recommend the automation as a need of the present & future?	
Yes	60%
No at present	20%
Never	0%
Difficult to say	20%

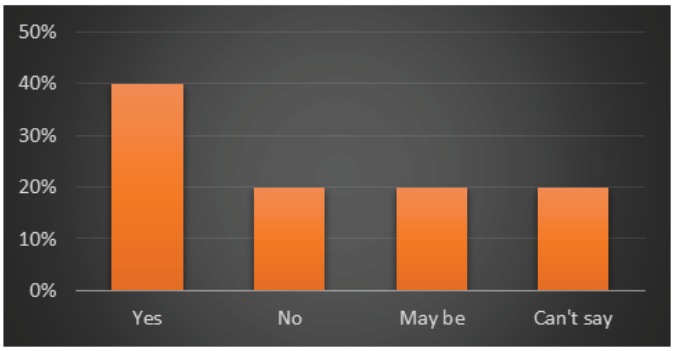
- Its sturdiness, i.e., the ability to operate in the rough conditions of the building site with minimum maintenance requirements.

Questionnaire survey

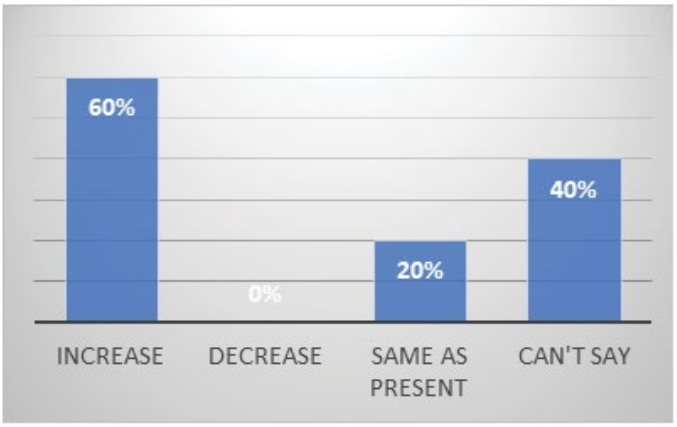
Table 1: There was a level of automation and robotics technology in our country that the participants could agree or disagree with.



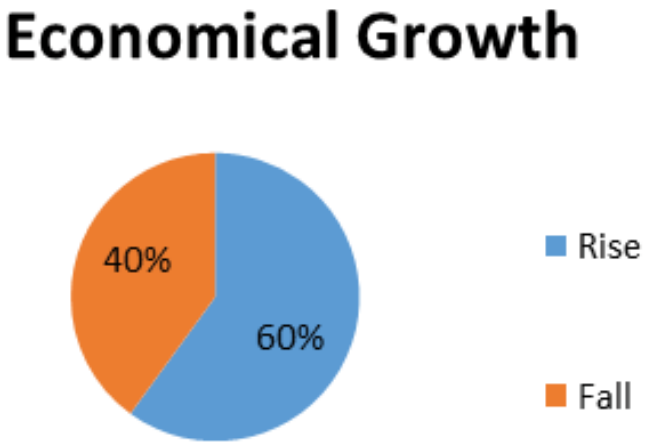
Graph 1. Cost efficiency.



Graph 2. Automation improves safety.



Graph 3. The effective cost of construction.



Graph 4. Economic growth concerning rising and fall.

Table 2: There was a preference for automation that the participants answered.

Table 3: Based on all qualitative parameters, can you recommend the

automation as a need of the present & future?

Graph 1: Automation is expensive but gives great accuracy is it acceptable?

Graph 2: Whether automation helps to improve safety?

Graph 3: How will this affect the construction cost?

Graph 4: What will be the impact of automation on the economic growth of the country?

Conclusion

In our questionnaire for subcontractors, most respondents were very realistic in hoping for robots manipulated and monitored by human operators and expressing their expectations of robotics development specifically for the improvement of safety and for labor-saving.

In the survey for architectural designers, on the other hand, respondents expressed broader visions regarding the future development of construction robotics, reflecting their position upstream in building production. In general, they were very positive about the robotization of construction work, pointing out the necessity for comprehensive systems covering the design and planning process with robotization as a precondition, a well-defined planning period, extensive information collection from builders, closer communication among designers, builders and robot developers, standardization and systematization of construction methods, mass production methods and consistent functionality with CAD/CAM applications. They shared a common idea that the construction industry should earnestly deal with this issue as an industry-wide project.

This survey provided us with several issues and obstacles that we have to discuss and overcome to develop and introduce robots into construction work. We at the Building Contractors Society will conduct an in-depth analysis of factors inhibiting the use and diffusion of robots in the construction industry and prepare guidelines for the development of robots.

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