Construction automation

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Abstract. Construction industry is creating a lot of enthusiasm for the construction network throughout the most recent couple of decades. This incorporates with skilled work power, adequate cash, and time when it is finished by ordinarily. As these necessities are not constantly accessible in all circumstances, the industry is confronting issues like consistently declining profitability, low work productivity in construction, a high mishap rate, low quality, deficient control of the building site, and the evaporating of the talented work power. To conquer the previously mentioned issues the terms ROBOTICS and AUTOMATION presented. The robots utilized in the construction have followed a similar idea as those utilized in assembling. Building robots have been utilized in different errands including material taking care of, different inside and outside completing assignments and quality control. Be that as it may, this use of mechanical autonomy in the construction business is not completely embraced. The purposes behind this circumstance are distinguished as existing robots are not all around embraced to building construction, issues related with the routinely planned structure, hard to legitimize robot business financially and administrative hindrances. The construction business requests a profitability increment that cannot be achieved by methods for customary techniques that have just arrived at their framework confines and cannot add to advance viability. Further justification must be accomplished by the decrease of work and construction times. Maybe if no critical research advances, temporary workers will have the option to tackle their issues by bringing in mechanical technology and procedure-controlled machines from abroad. Consequently, there is a need to sustain the advancement of effective innovative work programs in construction mechanization and apply autonomy. This paper makes an endeavour to utilize robots in the construction business, recorded to diminish risks at work destinations, improve quality, and decrease the expense of construction. A contextual investigation has been considered to show the appropriateness of robots in the construction business.

1. Introduction

Directly from the presence of the humankind, the fundamental needs – nourishment, apparel, and sanctuary lead to progress. To fulfil these fundamental needs, construction of building, advancement of transportation, water system ventures and so forth., has occurred in the construction field as a piece of human advancement. The improvement in construction field utilizing innovative advancement made ready to construction industry. "Yesterday's innovation isn't the specific answer for tomorrow's concern". Along these lines, in the construction business mechanization through mechanical technology is presented as an answer. Improvement of automated frameworks for construction applications has progressed significantly in recent years.

Construction mechanization and mechanical autonomy have been producing a lot of enthusiasm for the construction network during the most recent two decades. The way toward dispersing the early outcomes from innovative work of construction robotization and mechanical autonomy into industry practice is presently gradually occurring and the quantity of automated models have been planned and assembled.
The construction industry requires a different kind of robots. Typically, in the manufacturing field, robots are stationary, and the product moves along the assembly line. Automation is easier to incorporate because each product is identical with repetitive tasks done over and over. However, construction robots must move about the site because buildings are stationary and of a large size. They require engines, batteries, or motors and drive themselves. Construction robots are also faced with the changing sites and must be reprogrammed with each new condition. Therefore, it requires digital control with manipulators using coordinate systems to direct three-dimensional motion. They also must be able to function under adverse weather conditions including variations in humidity and temperature. Additionally, they are constantly exposed to dust and dirt on the site.

Goal of Automation
Reports of the U.N. are demonstrating a deficiency of 600 million dwelling units all through the world. Regrettably, there is no proof that the world has this limit at present, since assessments of lack continue expanding. India produces 2 million homes according to a main Indian financial expert, while United Nations reports that India produces 3.3 million homes every year, which is far not exactly the prerequisite in India’s tenth plan. Initially, we must find or design a framework that can create houses at the ideal speed. Next, we must deliver them at reasonable expenses on the off chance that we are to address the average workers and others.

Objective of Automation
- Identifying the workplaces where the robots can be actualized in the building site, to bring mindfulness among the individuals about computerization and mechanical autonomy and to demonstrate the recipients through a contextual analysis.
- Identify the parameters relying upon the idea of building including the idea of the undertakings to be performed.
- Calculate the expense of robot utilizing parameters, and
- Develop the mechanical framework for full scale experimentation for practical appraisal of efficiency.

Competitive Advantages
As found in different enterprises, robots ordinarily work quicker than people do. Many accept that robots are additionally increasingly trustworthy. With machines, there is less worry about fluctuating efficiency due to the high points and low points of life. Since these robots are viewed as quicker than people at work tasks, temporary workers ought to hope to finish extends sooner. At the point when construction work is done in front of calendar, manufacturers set aside cash because of decreased place of work overhead. Also, they have a chance to offer and work different tasks sooner than anticipated. Also, building proprietors are satisfied to increase early inhabitants to structures and a snappier profit for their speculation. As noted, safety is a significant perspective to any construction ventures. Be that as it may, the expense of security is noteworthy. Putting resources into fall assurance, individual defensive gear, and safety the board can be exorbitant. A portion of these expenses can be diminished if robots are used instead of people.

Inherent Barriers
Construction robots can dispense with laborers from being presented to risky, filthy, and overwhelming work. In any case, they set aside extensive effort for set-up, altering and tidy up. Skilled staff are expected to work and consistently screen the robots. As noted, single errand robots are constrained since they are not equipped for distinguishing and fixing issues continuously. Accordingly, skilled specialists must be available during work activities.
In addition, robot administrators need preparing. Unique preparing in PC use will be compulsory. Laborers will require a more grounded foundation in scholastic territories, for example, perusing and issues tackling to be beneficial. Indeed, even with robots, temporary workers should in any case put vigorously in preparing and instructing the specialist. The principal goal of this postulation is to
acquaint a pathway with automated application in construction industry. A contextual investigation has been considered to show the relevance of robots for a specific exercise and the resultant points of interest are talked about.

**Parameters Deciding the Expense:**
The significant parameters deciding the expense of the robotized work can be in this way isolated into three principal gatherings.

- Parameters reliant on the mechanical framework incorporate its cost, its work envelope (and afterward its secured territory), its speed of development and its method of activity (degree of human control).
- Parameters reliant on the idea of the structure site incorporate the idea of the undertakings to be played out, their quality, the quantity of moves between work areas and the areas/circulation of work in each segment.
- Parameters reliant on the assignment to be performed incorporate the yield every hour, the materials and the assistant works required.

The expense per every hour is recognized utilizing the accompanying equation:

$$ C = \frac{P \times pr (i, n)}{H} + C_m + C_o $$

Where

- $C$ = Cost per hour
- $P$ = Investment on the robot (including cost of carriage, effectors, sensors etc.,)
- $pr (i, n)$ = Capital recovery factor (depreciation and interest factor, assuming annual interest (I) and economic life (n) in years.
- $C_m$ = Cost of repairs and high-level maintenance of the robot per year
- $C_o$ = Operating costs (including some wear effected parts) per hour
- $H$ = Number of robot employment hours / year

2. **Research Methodology**
The strategy for the use of robots comprises of following advances:

- Identify the practicality for utilizing the robots.
- Identify the different innovative and authoritative issue of execution.
- Select the robot setup. (for example, reach, pay load limit, detecting characteristics and control framework for each errand)
- Identify the adjustment legs, beginning work point and the area of work material.
- Develop the pre-modified way to work the robot by remote control.
- Equip sensor gadgets and control instruments to interface with nature.
- Identify the spots where robots can recreate the components.
- Identify the parameters relying upon the idea of building including the idea of the errands to be performed, amount, number of moves between workstations and area of work in each segment.
- Identify the parameters relying upon the assignment to be performed including yield/hour, materials, and the helper work.
- Calculate the expense of the robot utilizing parameters including devaluation, enthusiasm on venture, upkeep and working costs.
- Analyze the expense every hour ‘C’ for robot.
- Develop the mechanical framework for full scale experimentation for sensible appraisal of efficiency.

The above technique is shown utilizing the accompanying contextual investigation
3. Case Study and Results
A Residential Building in Kukatpally, Hyderabad, Telangana, India, has been considered for the application of robotics in building construction. In this case study the robotics is applied only for plastering. The study has been done by comparing the cost and time of the work done (plastering) by conventional method with the robot projected values of cost and time. The building has the following data regarding plastering.

For walls:
Plastering 20mm thick in CM (1:6 proportion) and CM (1:4 proportion) for 1st and 2nd coat respectively with dubara sponge finishing including making 12mm grooves on either side of the column and beams at the function of panel walls including cost and conveyance of all materials to side curing, scaffolding charges, and all incidental and operational charges etc., complete.

For ceiling:
Ceiling plastering 12mm thick in CM (1:5 proportions) and CM (1:3 proportions) for 1st and 2nd coat respectively with dubara sponge finishing including cost and conveyance of all materials to site, curing, scaffolding charges, and all incidental and operational charges etc., complete.

Details of plastering manually (conventionally):

For walls:
- The total estimated area of the plastering for the walls 7246.32 Sq. m.
- The above-mentioned plastering for walls was done by 30 Masons and 56 M.M & W.M in 56 days.
- The total cost for the plastering walls manually including all the charges are Rs. 6,28,000

For ceiling:
- The total estimated area of the plastering for the ceiling 2473.09 Sq. m.
- The above-mentioned plastering for ceiling was done by 30 Masons and 43 M.M & W.M in 21 days.
- The total cost for the plastering ceiling manually including all the charges are Rs. 1,85,000

Calculations:
The total cost for the plastering both walls and ceilings
= Cost for plastering of walls + cost for plastering of ceilings
= Rs. 6,28,000 + Rs. 1,85,000
= Rs. 8,13,000

The total time for the plastering both walls and ceilings
= 56 + 21 = 77 days

Cost and Time estimation of robotic systems for plastering works:

Time Estimation:
The total time for plastering the whole building can be calculated as follows:
- Plastering capacity of a robot = 45 Sq. m per hour
- Total area to be plastered = 7246.32 + 2473.09 = 9719.41 Sq. m.

$\text{Time to be taken} = \frac{\text{Total Area}}{\text{Plastering Capacity}} = \frac{9719.41}{45} = 215.986 \text{ hrs}$

= 8.999 days = 9 days (approx.)

Cost estimation:
- Plastering cost of a robot = Rs. 1450 per hour
- Total time for plastering job = 216 hours
The cost of plastering for whole building = 1450 * 216 = Rs 3,13,200

| Type of system | Plastering area (Sq. m.) | Cost (Rs) | Time (Days) |
|----------------|--------------------------|-----------|-------------|
| Conventional System | 9719.41                  | 8,13,000  | 77          |
| Robotic systems   | 9719.41                  | 3,13,200  | 9           |
| **Savings**       |                          | **499800**| **68**      |

- Percentage of Costs saved = \( \frac{\text{savings costs}}{\text{actual costs}} \times 100 = \frac{499800}{813000} \times 100 = 61.476 \approx 62\% \) (Approx.)

- Percentage of Time saved = \( \frac{\text{savings time}}{\text{actual time}} \times 100 = \frac{68}{77} \times 100 = 88.311 \approx 88 \% \) (Approx.)

- From the above case study values displayed in the table, we can infer the following points.
  - Costs can be saved up to 62 percentage
  - Time can be saved up to 88 percentage

4. Conclusions

The accompanying ends are made dependent on the theory work.
- The contextual analysis uncovers that a measure of Rs. 4,99,800 can be made as sparing sum properly utilizing the robot for putting work, in correlation with the ordinary work i.e., 62%
- The timeframe likewise can be chopped down from 77 days to 9 days, therefore contributing or significant sparing in labour costs without any mishaps or wounds to the work power.
- The Construction industry requests an efficiency increment by methods for computerization and advanced mechanics
- Robot, Safety, strength, and subjective components ought to be given need in the visionary thoughts.
- Architects and Engineers need to advocate more normalized plans that consider simpler computerization.
- In request for Construction computerization with robots to be completely operational, Designers must attempt to improve extends however much as could reasonably be expected identifying with repetitiveness and normalization of construction components

Hindrances:
- We have a few issues distinguished prompting the low business utilization of Construction Robots:
- Many improvements are made for explicit employments locales and are not appropriate for other people.
- No further advancement of beginning frameworks is embraced because of absence of input from various building destinations
- Insufficient advancement of development mechanical models
- Insufficient regard for building plan to the imperatives of robotized development.
- Insufficient monetary avocation for mechanical autonomy in building.
- Difficult administrative condition.

The reasons distinguished for the failure of robots are
- Lack of suitable structure locales
- Need for additional improvement/adjustments
- Lack of monetary avocation.
- Lack of enthusiasm for organization's administration.
- Availability of better hardware for same capacity.
Problems with material stock.
The purposes behind the current circumstances are identified as follows:
• Existing robots are not very much evolved to building development
• There are issues related with the ordinarily planned structures.
• It is hard to legitimize robot work financially

Future Scope
Further research should be encouraged to develop the prototypes suiting to the requirements of the construction industry. A certain innovative leap is required by a systems approach that combines the existing construction technologies with new information, automaton, and robot technologies. Research needs to see as an investment not as an expenditure in the industry.

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