e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:05/May-2023 Impact Factor- 7.868 www.irjmets.com

IMPLEMENTATION OF ROBOTICS TECHNOLOGIES IN TRANSPORTATION ENGINEERING

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ABSTRACT

By replacing humans in risky jobs, robot systems employed in building construction sites can effectively shorten construction times and improve safety. Field robots that operate in dynamic environments are what are referred to as construction robots. Due to their increased reliability, safety, efficiency, accuracy, and productivity, robotic systems are now widely used in various industrial and production processes. Robots have several unique applications that could help the business world. A comparison of how well relevant building jobs are performed manually versus by robots helps establish whether using robots in construction is feasible. In the study that follows, two dimensions of robotic feasibility—the reduction of human labour and its effect on costs—are quantitatively evaluated. This study contrasts conventional, human-operated systems with autonomous systems and offers a series of recommendations for designing new technology more affordably.

Keywords: Construction Robots, Safety, Building Works, Reduce Labours.

I. INTRODUCTION

In recent years, robotics technology has revolutionised the transportation sector, making it more dependable, safe, and efficient. Robotics is the use of intelligent devices that can complete tasks on their own, without assistance from humans. Robotics technology is used in a variety of ways in the field of transportation engineering to increase vehicle performance, safety, and efficiency. The creation of autonomous cars is one of the most important uses of robotics technology in transportation engineering. These are automobiles that don't need a human driver to operate them. Radar, lidar, and cameras are just a few of the sensors that autonomous cars employ to identify their surroundings and decide how to move through them. The creation of drones, or unmanned aerial vehicles, is another use of robotics technology in the field of transportation engineering. Drones are being utilised more often in the transportation industry to do duties including package delivery, traffic monitoring, and infrastructure inspections of bridges and railroads. The development of robotic exoskeletons, which may aid employees in lifting large things and completing duties more effectively, as well as the use of robotic technology in transportation for activities like loading and unloading freight are also being done using this technology. Overall, the use of robots technology in transportation engineering is revolutionising the way we carry people and products, improving safety, effectiveness, and dependability.

II. METHODOLOGY

NEED FOR ROBOTS

Construction and other rapidly evolving, project-based sectors suffer from a serious lack of reliable, timely, and systematic technical, cost, and production data from ongoing operations. In the meanwhile, technology has advanced to the point where it is now possible to not only keep an eye on the operation of production plants and gather operational and passenger volume data from transit systems, but also to monitor the characteristics of vehicle operation and transit high quality video pictures. For the traditional method of carrying out the building job to be effective and reliable, highly competent workers are needed. Costs associated with this labor-intensive building procedure are rather expensive. Various approaches have been attempted in an effort to increase rationalisation and humanization. The sand-lime brick and cellular concrete industries, for instance, adopt this strategy by increasing the size of the construction components. However, these blocks' expanded dimensions also match up with an increase in their actual weight of up to 300 kg. These construction pieces are not ergonomically ideal due to their greater sizes and higher weights, hence different mechanical aids like hydraulic balancers or tiny cranes with counterweights are utilised for the assembly. For the traditional method of carrying out the building job to be effective and reliable, highly competent workers are needed. This labor-intensive building Cost of the process is rather considerable. Various approaches have been attempted in an effort to increase rationalisation and humanization. The sand-lime brick and cellular concrete industries, for instance, adopt this strategy by increasing the size of the construction components. However, these blocks' expanded dimensions also match up with an increase in their actual weight of up to 300 kg.

These construction pieces are not ergonomically ideal due to their greater sizes and higher weights, hence different mechanical aids like hydraulic balancers or tiny cranes with counterweights are utilised for the assembly. There is a growing corpus of research that examines the possible uses and effects of robotic technology, which are quickly changing the transportation sector. Here are some important conclusions drawn from current research on robotic engineering:

- Automated vehicles Autonomous vehicles (AVs) are among the most important robotic technology applications in the field of transportation engineering. According to studies, AVs might lessen traffic congestion, promote safety, and expand elderly and handicapped people's access to transportation. There are issues with AVs' potential effects on employment and urban planning, as well as with their ethical and legal ramifications.
- Drones: The use of drones for transportation, such as package delivery or performing aerial surveys, is another topic of interest. Drones may lower transportation costs and provide accessibility to isolated locations, according to research, but there are also worries about the safety and privacy consequences of their widespread usage.
- Infrastructure Monitoring: Robotic technology may also be used to monitor infrastructure, such as checking for damage in tunnels and bridges or monitoring traffic in real-time. Robotic technology, according to studies, may increase the effectiveness and precision of infrastructure monitoring, resulting in improved maintenance and safety results.
- Electric cars: Another topic of interest in transportation engineering is electric cars (EVs). Robotic technologies, such as predictive maintenance and demand-response management, may be used to optimise EV charging infrastructure. Additionally, EVs can be integrated with autonomous technology to increase safety and decrease energy usage.Overall, the literature on robotic technology in transportation engineering points to the possibility of considerable advancements in sustainability, safety, and efficiency. The necessity for thorough evaluation of the social and ethical consequences of new technologies is highlighted by worries about the possible effects on employment, privacy, and urban planning.

III. ROBOTS USED IN CONSTRUCTION INDUSTRY

In the next ten years, robotics and automation are anticipated to have a significant impact on the construction sector. It is necessary to do research and development (R & D) in the use of high technology due to the dynamic and unstructured character of the building environment. Recent advancements in robotics in other industrial sectors have shown a significant opportunity to further the automation of challenging building operations. Japan's Shimizu Corporation started doing robotics research and development in 1975 to promote innovation in building manufacturing. The company's justification for R & D in construction is to boost output, enhance quality, lower costs, boost efficiency, find new markets, and enhance workplace safety. The ultimate objective is to provide an environment for the building projects that is adaptable and integrated. The business has concentrated on automating both conventional building sites and innovative construction domains.

The progress made by the business in R&D across several fields is outlined in the section below:

1. The SSR-3 fireproofing spray robot.
2. A manipulator for placing steel beams
3. The CFR-1 ceiling-panel positioning robot.
4. The OSR-1 wall-finishing robot.

robot for spray coating (SB-Multi Coater).

Fire Proofing Spray Robot (SSR-3)

A dangerous construction task is the application of rock wool to steel structural elements to fireproof them. The SSR-3 was created to provide spray workers a safer working environment. The SSR-3 travels parallel to a steel beam while spraying at a fixed distance that is monitored by two ultrasonic sensors.

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Steel-Beam Positioning Manipulator

One of the most hazardous operations on the building site that has to be automated is the installation of steel beams. The manipulator for placing steel beams lifts two or three steel beams and teleports them to the desired location. The manipulator grabs the top of the columns while placing beams, eliminating the requirement for a tower crane lift. As a result, additional tasks may be completed using the tower crane while the manipulator is at work. With a hanging load capacity of 2,100 kg and one degree of freedom, it weights a total of 1,900 kg.

Ceiling-Panel Positioning Robot (CFR-1)

Plaster-board panels, which are formed of plaster and are coated with paper, are used to create the ceilings of office buildings, hostels, and other commercial structures. For instance, a typical midsize office block with eight stories and 5,000 square metres needs 400 panels for every entrance. Temporary scaffolding must be built over the floor and then taken down for the next step in the process of building the ceiling. To set the bulky, heavy panels against the flat bars that dangle from the ceiling, the employees must lift them over their heads. Long-term repetition of this task wears down the employees.

Wall-Finishing Robot (OSR-1)

The high-rise residential buildings use an automated spray painting system called OSR-1 (Ohi Saikaihatsu Robot). Accidents with traditional painting have occurred when things fall from tall scaffolding. The OSR-1 was created to reduce such incidents and achieve robot-assisted consistent spray quality. The OSR-1 extends its multi-axis arm by moving along the wall's handrail. On the arm's terminal piece, a spray nozzle can be seen moving up and down. The arm adjusts its spray nozzle parallel to pipes running down the wall to avoid hitting them and other obstructions.

Spray-Coating Robot (SB Multi-Coater)

An automated sprayer for painting outside walls, the SB Multi-Coater can apply spray coating to the exterior walls of medium and multistory structures. Sealer coating, material spraying, and top coating are their primary uses. It simply requires one operator on the ground and offers a higher output rate that is almost five times that of traditional techniques. It produces a superb finish on par with that of expert employees. The smooth, uniformly sprayed surface is provided by the SB Multi-Coater. During the primary material spraying operation, it moves right and left while using one or two spraying guns revolving at high speed in a regular pattern. There are five different sorts of fundamental wall finishing designs. The designs that work well for the materials being coated are chosen. Compared to the daily production rate of the traditional techniques, which is roughly 80 sq m per day, the SB Multi-Coater can spray the primary elastic coating material at a rate of about 400 sq m per day.

IV. ROBOTS USED IN CIVIL WORKS

Semi Autonomous Robot:

Navigation and tele operation are the special features in this mobile robot prototype. This can be used for indoor and outdoor works. The Semi Autonomous Robot is shown in figure

Fig.1 Semi Autonomous Robot In India

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Concrete Crusher

It is faster and quieter robot to demolish the concrete. Adjoining work can often continue uninterrupted and emollition can even take place at night. The Concrete Crusher is shown in the figure 2.

Fig.2 Concrete Crusher Robot in India

Demolition Robot

It is used in the confined space and selective demolition works. The precise control enables demolition needed sections, while leaving the remaining sections un scattered. The Demolition Robot is shown in the figure 3.

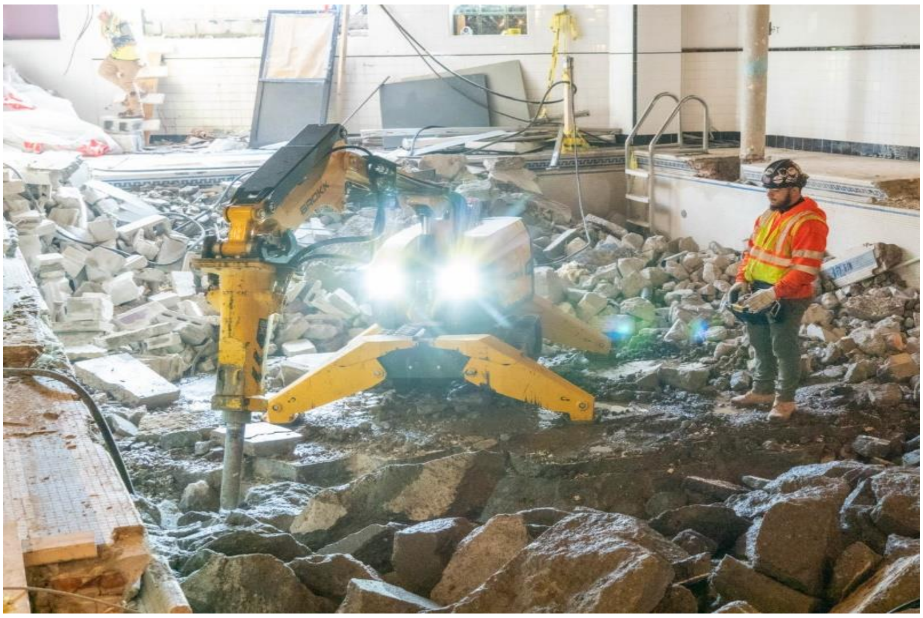

Fig.3 Demolition Robot in India

Robot for All Jobs

It is employed for chiseling up-channels in the floors to allow the replacements of the drains, removing tiles and clinker and it is shown in the figure 4

Fig.4 Robot for All Jobs in India

ROBOTS USED IN HIGHWAY VONSTRCTIONS

To increase safety, efficiency, and precision during highway building, robotic technologies are being used more and more. Several of the most important robotic technologies for building highways are listed below.

Autonomous construction vehicles

For operations like grading, digging, and paving in highway building, autonomous vehicles are being deployed. To manoeuvre and run safely and effectively, these vehicles employ a mix of sensors, cameras, and machine learning algorithms.

Robotic surveying

Construction sites are being precisely measured and mapped using robotic surveying tools. These systems gather information and build 3D models of the building site using lasers, cameras, and other sensors. These models may be used to better effectively plan and carry out construction projects.

Automated road marking

On highways, paint and road markings are applied by robots. These robots correctly and quickly apply marks using sophisticated computer vision systems, increasing safety and shortening the time needed for this activity.

3D printing

In order to produce concrete structures like bridges and barriers more quickly and precisely, 3D printing is being employed in highway building. The time and money needed for conventional building techniques may be decreased using this technology.

Drones

Drones are being used for various tasks in highway construction, such as site inspection, surveying, and monitoring progress. Drones can provide real-time data and imagery, improving safety and reducing the time required for these tasks.

CHALLENGES FACING AUTOMATION AND ROBOTICS IN CONSTRUCTION

The primary contribution of automation in construction is the development of a comprehensive, multidimensional analysis of costs and benefits associated with a specific robotic application. It is quite important to analyse success through the technical and economic feasibility. The technical feasibility is determined by an ergonomic evaluation of individual steps taken to accomplish the given work task, and by analysis of the requirements for robot control and process monitoring. The economic feasibility, which is perceived to be the decisive factor in the market success of the proposed robotic systems, is determined by the analysis of the costs and benefits associated with their development and field implementation. Specific technologically challenging process and characteristic of robot construction applications include:

Performance in a harsh work site environment, or undefined and sometimes hostile conditions such as:

- Exposure to dust
- Calibration in relation to environment
- Adjustment to changing surface conditions
- Complexity of the working environment
- Some changes in the nature of the robotized work process versus the traditional, human- performed work process.
- Real-time "Sense-and-Act" operation for mobile construction robots to perform accurate and/or delicate tasks
- Identification of various types of objects in natural environment conditions
- Interactivity between sensors and end-tools.

V. CONCLUSION

Moreover, automation in the construction business depends on how quickly materials are delivered. Robotics use will either directly or indirectly protect the builder, contractor, or owner from legal issues while also allowing the activities to be accomplished more quickly. Although robotic technology has numerous potential applications in the construction sector, it is not inexpensive, particularly when used in harsh outdoor settings.

❖ For robots to be used economically, there must be enough suitable work to support their ongoing employment.

❖ The major arguments in favour of such employment will likely centre on the lack of available local employees and the obvious and covert costs associated with importing foreign labour.

❖ Currently, the robots may be economically used in the construction of repetitive structures that are built with adequate consideration for robotics limits, in complex activities requiring high levels of accuracy, as well as in hazardous and filthy building work.

❖ Transportation engineering has seen several changes thanks to robotics technology. Robotics has improved transportation efficiency, safety, and environmental friendliness via the use of drones and driverless vehicles.

❖ Self-driving cars, trucks, and buses, also known as autonomous vehicles, are gaining popularity because they are expected to minimise accidents brought on by human error and improve traffic flow. To find and avoid roadblocks, they use a range of sensors, including cameras, radar, and lidar.

❖ Drones are also growing in popularity in the field of transportation engineering. They may be used for many different things, such package delivery, traffic monitoring, and aerial surveying. Drones are a useful tool for transportation engineering because they can visit places that are inaccessible to or unsafe for people to enter.

❖ Robotics technology has aided in the creation of smart cities, which use sensors and other modern conveniences to enhance living conditions for citizens. Smart traffic systems, for instance, utilise sensors and algorithms to optimise traffic flow, lessen congestion, and cut emissions.Finally, through enhancing sustainability, efficiency, and safety, robots technology has revolutionised the field of transportation engineering. Future transport problems are likely to be solved even more creatively as long as technology keeps developing.

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