Automation and Artificial Intelligence in Construction and Management of Civil Infrastructure

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***Abstract*—** *The main aim of this paper is to review the the use of artificial intelligence and automation in the construction and management of civil infrastructure. The construction business is being transformed by digital technologies. Building is critical from a regional, national, and global perspective. It is now a time of great technological and industrial developments and problems in the geotechnical engineering and construction business, as well as IT proliferation and the right use of sustainable practices. [1] Big data, automation, and artificial intelligence are just a few of the latest developments, techniques, and technologies that may improve the construction industry. In order to foster a more collaboration and coordination approach to managing projects, advances in AI and automation hold enormous promise. This study provides a comprehensive literature analysis on the use of artificial intelligence and automation in the design and management of civil infrastructures. The use of these new technologies in the construction industry may have a great impact on productivity. Additionally, this paper is a development of our former communication based on existing developments in the digitization of building projects, sector in particular, and project management [1]. Even though this technology is still developing, this study will help us better understand how it transforms and open the door to further research in this field. Infrastructural automation, civil infrastructure, and artificial intelligence.*

Keywords: Automation, vibration, Structural health monitoring, structural damage detection; deep learning algorithm; Machine Learning, sensor; signal processing.

I. INTRODUCTION

Growth and rising need for varied technological applications necessitates us to stay up to date on several related areas, including building, in general, and their power. In recent years, there has been a rise in the application of artificial intelligence (AI) in the domain of geotechnical engineering. This is primarily attributable to the fact that the technique has the potential to enhance the effectiveness and performance of construction industry. As a means of providing a full understanding, this study includes a survey of the current literature on automated AI that has been published over the last decade [1]. Long-term changes in construction will be brought about by the convergence of IoT and AI, which will open up new future prospects and income streams, as well as innovative business models and organizational structures. Supply chain, customer services, support, productivity, robotics, and finance are just a few of the areas where artificial intelligence is projected to have a significant impact on the construction sector. Even more AI can aid in realistic circumstances for training, decreasing injuries and expensive blunders and increasing the efficacy of operations. A lack of skilled workers may be alleviated by allowing operators to better use their current workforce [1–2]. As a result, the construction sector can now complete large-scale projects on budget and on schedule thanks to digitization. It is the primary goal of this study to apply artificial intelligence (AI) into the construction industry and management. The use of artificial intelligence (AI) in widespread fashion is hastening the pace of digital change being experienced in the field of construction engineering and management. Because AI-based approaches in the construction and management of infrastructure projects have recently emerged as a primary focus of study, it is essential that this topic be comprehended in its entirety.

II. RESEARCH PROBLEM

The main problem that will be solved by this paper is to explore how automation and artificial intelligence may be used in civil infrastructure construction and management. When compared to other businesses, the construction industry has exceptionally poor production because of the many difficulties it faces. Because of its age-old aversion to change, it's no surprise that construction is one of the least digital sectors on Earth. [2] Project management is made more difficult and time-consuming because of the industry's reliance on paper and other antiquated technologies [3,4]. The lack of sufficient adequate knowledge and skills and adoption of information technology within the construction field has been attributed to a number of issues, including uninformed decision-making, cost waste and inefficiency, missed deadlines, low quality outcomes, and poor output, health, and safety. Most construction work requires some level of risk, which may manifest itself in a variety of different ways, including quality, safety, schedule, and financial risk. Because several subcontractors are working on various crafts simultaneously on construction sites, the risk level increases proportionately with the size of the project [3]. Nowadays, construction companies may utilize AI and machine learning technology to track and assess risk on the construction site. This allows the project team to devote their fewer options on the risk variables that pose the greatest threat. The determination of an issue's priority may now be done automatically thanks to AI. Subcontractors are given a risk score, and construction managers use this number to grade them. This allows the managers to engage more closely with high-risk teams to reduce risk.

III. LITERATURE REVIEW

A. Construction site analytics

The rising prevalence of Internet of Things sensing devices and other modern devices is fast transforming construction projects into smart work settings [3]. This transformation is occurring at a rapid pace. Analytical work on the building site is focused with gathering, storing, and analyzing data in order to derive new insights for visualisation. For construction projects, a vast number of unprocessed photographs, recordings, and other types of data are created, such as surveys, real-time gear, and site monitoring [4]. IIn order to improve site performance in all crucial aspects, including such planning, designing, safety, quality, scheduling, and expense, the data gathered may be pooled in BIM and processed using modern AI algorithms. Data collected on building sites must be analyzed in real time utilizing an AI-powered site analytics solution in the cloud [5] . Improved productivity, quality control, and the achievement of stated goals will result from this change Project managers and other stakeholders might greatly benefit from a building site AI chatbot that provides real-time information on site operations.

B. Automation

A wide range of construction-related activities may be automated, from the very beginning of the project's planning and design through its completion, operation and maintenance, deconstruction and recycling, and all in between. The latest advancements in computer science and robotics have aided the building sector in developing new technologies. Many innovative technologies and machines have been created in Japan, a world leader in robotics and automation, to assist the construction industry in reducing labor requirements, lowering construction costs, and shortening project timelines [6]. As a result, numerous equipment in the construction sector may be employed to minimize worker requirements, lower labor costs, and boost output. Automation in building should be expanded in India's developing infrastructure.

All things considered, automation seems to outweigh its downsides in the building business. Automation-friendly nations have a better level of life than non-automation-friendly ones. The idea that robots are displacing workers who used to construct things by hand is a common one [7]. It is undeniable that the effective implementation of automation technology boosts production, irrespective of the societal ramifications. For today's infrastructure projects and construction enterprises, automation technologies are critical for increasing efficiency while maintaining or improving quality. The use of automation technologies in many areas, including as design, planning, on-site building, and so on, is necessary for small and medium-sized businesses, as well.

Constructing a more automated future is possible in three ways. On-site physical operations, such as pouring bricks and paving roads, may now be automated using robots and other machinery. Module building in factories may be automated, allowing for 3-D printing of parts like facades and other architectural elements. And finally, the third focuses on the digitalization and consequent automation of layout, plan, and managerial operations, and the huge improvements in site efficiency that may be achieved as a result of these changes. An effective planning method is building information modeling (BIM), which integrates architects' and developers' plans to discover problems before they are built on site. It also improves on-site execution, enabling design engineers to minimize errors and better manage their staff. A list of possible automation ideas.

• The Putzmeister Telebelt

In addition to handling materials ranging from sand to rock with a 100mm aggregate size, the telebelt, also known as a telescopic belt machine, is capable of placing materials with a slump of 0 to 300mm. Infrastructure projects that need long-reach and high-volume putting, such as dam foundations, footing and bridge deck tiling as well as mat-pouring are best served by Telebelt[9–10]. Using a telescoping boom, a telebelt consists of a base steel part and four telescopic aluminum sections. Using a telescoping boom eliminates impediments and saves time and money.

• Connected and Automated Vehicles (CAVs)

For CAVs to become a reality, a new methodology is needed to manage current civil infrastructure systems (highways; bridges; sign structures; etc.) [11]. There is a basic introduction to the idea of CAVs, an assessment of the infrastructure requirements for CAVs, and an evaluation of the current infrastructure and its suitability in terms of condition assessment and degradation modeling in this document To help or replace the human driver in the job of driving, connected and autonomous vehicles (also known as CAVs) integrate connection and automated technologies [12]. This may be via a mix of modern sensor technologies; GPS and telecommunications networks; on-board and remote computational resources.

C. Artificial Intelligence in Construction

Machines that simulate human cognitive processes, such as problem-solving, pattern classification, and training, are referred to as artificial intelligence (AI). A subset of AI is machine learning [13]. As a branch of AI technologies, machine learning aims to make computers capable of "learning" from data without having to be directly programmed in any way. Machines become better at interpreting and generating insights when they are exposed to increasing amounts of data. Using Building Information Modeling (BIM), architects, engineers, and construction managers may more effectively plan and design buildings, as well as construct and maintain them. The architectural, structural, MEP) plans and the production process of the separate teams must be considered while creating 3D models for a project. It's a struggle to keep the various systems from the sub-teams from colliding. Artificial Intelligence (AI)-powered dynamic architecture is used to find and minimize conflicts between the dynamic simulation by the various teams to avoid reworking. Computer programs using machine learning techniques look at all the possible solutions and come up with several design options. The generative design program develops 3D models that are optimal for the limitations after the user inputs the requirements into the model [14].

D. Genetic Programming

As one of the most well-known evolution algorithms, genetic algorithms (GAs) are able to model how an organism's ability to adapt to its environment affects its survival. If additional study and improvement can be done, it might have a significant impact on the subject of civil engineering. Civil engineering researchers report that advancement above the genetic algorithm is being made possible by the fast development of genetic algorithms, although there is still room for improvement [15]. Implementing hybrid genetic algorithms, dynamic adaptive innovation, nonstandard evolutionary algorithms, multiple genetic algorithms, and changing the multi - objective genetic components or technological capabilities are a few examples of ways that genetic algorithm techniques might be improved. The development of the genetic algorithm

in recent times has resulted in the introduction of several new computational formulas and the absorption of construction management as the most proper implementation success. [15] As computer technology advances, we may predict that the evolutionary algorithm used in civil engineering applications will become broader and more effective. Scheduling of linear building projects may be improved using genetic algorithms. Managers in the construction industry are able to use the model to produce and analyze construction schedule plans that are either optimum or nearly ideal, hence reducing the amount of time and money needed to complete a project.

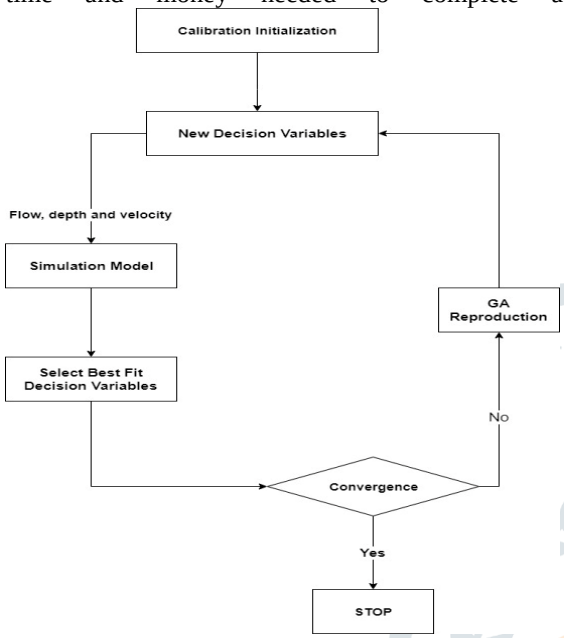

Fig: Genetic Programming process flow

IV. SIGNIFICANCE TO THE U.S

The use of AI in the construction industry has the potential to facilitate U.S. construction industry in realizing value across the lifecycle of a project. This might include the following phases: designing, tendering, and raising capital; contract management; management and investment management; and business strategy transformations. Construction as a whole benefit from AI's ability to assist the sector address some of its most difficult problems, such as skill shortages, safety problems, and schedule and cost overruns [16]. Several construction equipment manufacturers are beginning to provide self-driving machines that can execute repetitive jobs more quickly and effectively than humans, such as pouring concrete and placing bricks. [17] Bulldozers are being used to excavate and prepare job sites autonomously or semi-autonomously, with the support of a human programmer [18]. Human employees can now focus on the actual construction, which saves time and money in the process. In addition, project managers may monitor the progress of work on the job site in real time. Workers' productivity and adherence to policies are monitored via the use of face recognition software, onsite cameras, and other similar tools.

V. FUTURE IN THE U.S.

With automation and artificial intelligence, construction expenses may be reduced by up to 20% in the US. Engineers may now equip themselves with virtual reality goggles and dispatch miniature robots into the interiors of structures that are still in the process of being built. In order to keep an eye on things, these robots employ cameras to monitor their progress. AI would be used in the planning process for the wiring and plumbing systems seen in contemporary structures. Safety measures for workplaces are being developed utilizing AI[18]. It's possible for artificial intelligence (AI) to monitor construction sites in real time and provide alerts to managers if problems with worker safety, construction faults, or productivity arise. Humans are unlikely to be completely replaced by artificial intelligence. As a result, it will change business strategies in the construction projects, decrease costly mistakes, reduce jobsite accidents, and increase building efficiency. Investing in the areas where AI can have the most influence on a construction business's specific demands should be prioritized by company leaders. Ahead-of-the-game players will have a leg up in the short and long run by determining the path of the industry.

Construction companies in the United States are increasingly turning to artificial intelligence (AI) and automation as a way to address labor shortages and improve efficiency. Real-time data analysis, according to a McKinsey research from 2017, has the potential to increase productivity in the construction industry by 50%. In order to better organize the allocation of people and machines across tasks, construction businesses are beginning to apply AI and machine learning [18,19]. Construction managers can better determine which sites get enough personnel to finish the project successfully, and which may be lagging behind where more labor may be assigned, courtesy of a robot that is actively check task project status and the whereabouts of personnel and equipment. It's feasible to get more work done in distant places where experienced labor is in limited supply by using an AI-powered robot like Spot the Dog, which can independently survey a worksite every night to check progress. Off-site factories manned by autonomous robots that put together building components, which are subsequently put together on-site by human employees, are becoming more important to American construction enterprises. Walls, for example, may be built faster and more effectively by automated technology than by humans, freeing up human labor for finishing work such as plumbing, HVAC, and electrical systems once the building has been assembled.

VI. CONCLUSION

This study examined the role that automation and artificial intelligence play in the development and administration of civil infrastructure. In the construction business, productivity is a major issue, but automation and artificial intelligence (AI) have the ability to alleviate these issues. AI has the capacity to harness the rising amounts of data created during the building lifespan and other digital technologies to enhance the construction process, as well as to use the capabilities of other technologies. AI may be used by building management even after the building is finished. A structure's performance may be improved by analyzing data gathered via sensors, unmanned aerial vehicles, and other wireless systems, as well as sophisticated analytics and AI-based algorithms. As a result, artificial intelligence (AI) may be used to keep tabs on potential issues, predict when maintenance should be performed, and even guide human behavior to ensure maximum safety and security. Despite hiring the finest project management teams, most large-scale projects end up over budget. Cost overruns are predicted using Artificial Neural Networks, which consider variables including the scope of the project, the nature of the contract involved, and the skill set of the project manager. Predictive models make use of historical data, such as anticipated start and finish dates, to estimate realistic future project schedules. The use of artificial intelligence (AI) enables

employees to access real-world training materials from any location, allowing them to swiftly improve their skills and knowledge. New resources may be added to projects more quickly as a result of this. Thus, project completion times are shortened..

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