

# Artificial Intelligence Methods in Construction Industry - A Survey

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**Abstract**— Building construction projects usually are once in a lifetime designs with little imitation in the structure, pattern and configuration. The ability to re-design and configure the project and network optimization performance helps smart manufacturing system. This problem can be addressed by Artificial Intelligence (AI). This paper reviews AI methodologies and the application of technology in automated construction manufacturing systems. Beginning with introduction to AI followed by review of AI applications in Construction Industry and a case study and finally, the future scope of AI in construction manufacturing is discussed.

**Keywords**—Artificial Intelligence, Machine Learning

## I. INTRODUCTION

Construction is a large industry of strategic importance which lays impact at regional, national and global levels. Construction industry has been experiencing many difficulties viz., low productivity, low-profit margins, waste management and safety issues [1]

Technology and Engineering have become inseparable part of our day to day life. Advancements in technical applications encourages us to explore the utility of various concepts in general and construction domain in particular. During recent years, the usage of artificial intelligence (AI) in the field of construction engineering and management has increased. The reason behind this is the potential of the technology to help to improve construction performance and efficiency. The combination of IoT and AI technologies when implemented in construction domain will bring advancements in construction domain with new business opportunities, models and revenue streams. AI enables to update business models in the construction industry in areas viz., logistics, customer relationship management, support, workflow, automation and finance. AI helps in training, safeguarding from injuries and carrying out operations more efficiently by enabling better usage of existing labour resources [1]. Inclusion of AI and IoT technologies in construction industry provides opportunities to complete large construction projects within the stipulated time frame and budget.

## II. LITERATURE SURVEY

Construction Industry, Construction Management and Construction Technology is taking help of digital technologies

viz., Big data, Data Analytics, IoT, Artificial Intelligence, Machine Learning and Deep Learning. The utility of advanced technology in Construction Industry has considerably increased [1], [2]. In India, the construction industry is the second largest trade business after agriculture is developing rapidly and adopting new technologies mentioned earlier. Construction projects incorporating IoT devices like digital sensors, smart machines, and mobile operated devices are widely being seen. Amongst all the technologies, Artificial Intelligence is providing novel solutions to the problems faced in construction industry [1],[2],[3].

## III. ARTIFICIAL INTELLIGENCE (AI)

Artificial Intelligence is a rapidly evolving technology that is becoming a part of our day to day life. Artificial Intelligence aims at creation of human –like intelligence that can learn, reason, plan, perceive or process natural language. Artificial Intelligence is giving amicable solutions to the problems in almost all the domains. Artificial Intelligence technology has capability to provide solutions to the problems in construction industry as well. In future, Artificial Intelligence will play an important role in improving productivity, quality, and safely on the job site [4]. Artificial Intelligence uses the power of machines to model natural intelligence of human. It uses the machine learning (ML) to store problems and execute tasks with greater speed & recovery. [1].

## IV. ADOPTION OF AI IN CONSTRUCTION

Advanced technology is slowly being adopted on the construction site. The usage of cloud-based applications and mobile devices to access data like jobsite photos, materials used, labor hours, equipment utilization etc.) has exponentially grown which enables to do deeper analysis. The further digitalization and automation in the construction industry would involve synchronization of Artificial Intelligence & Building Information Modelling (BIM).

Artificial Intelligence when implemented in Construction Industry is expected to alter Business Models in logistics, customer relationship management, and support. It also helps to rectify workflow mistakes by making operations more efficient. The construction industry is currently experiencing an increasing skill shortage due to which, many businesses are pressurized. Artificial Intelligence is bringing transformation

in construction industry through automation and in finance by implementing business models. Also, Artificial Intelligence helps in providing amicable realistic solutions to situations, training, reducing injuries, and costly construction industry. Artificial Intelligence is a technology which without even realizing we are experiencing and benefiting from each and every day. The use of Artificial Intelligence post-construction and the smart home has become highly increased. As a result of which, the construction industry has started to grow in different dimension. The major applications for Artificial Intelligence in construction & building are in (i) Planning & Design (ii) Safety (iii) Autonomous equipment, & (iv) Monitoring & maintenance.

#### A. How AI in construction works?

According to McCarthy (father of Artificial Intelligence), Artificial Intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs. Artificial Intelligence is a way of making a computer controlled robot, or a software think intelligently as human beings. In the table below, some of the applications of AI have been listed.

TABLE I. SUMMARY OF APPLICATIONS OF AI IN CONSTRUCTION METHODOLOGY AND INDUSTRY

	Users	Tool/technique	Activity
1	Designers	Autodesk's Generative Design.	i) To generate option ii) To select iii) To edit
2	Estimators	Combine AI with BIM	Estimates with greater accuracy within a short time.
3	Safety Managers	Smart.....	Visual processing algorithms are risk monitoring & prevention tools
4	Project Manager	Drones sensors cameras Doxel	Jobsite activity To measure quantity of material To keep the project on schedule
5	Foremen	The 3D Model	To detect the defect, if any error or inconsistencies.

In addition to the above mentioned applications, following are specific instances where AI has played an important role in construction industry.

#### B. Attention-guided analysis of infrastructure damage with semi-supervised deep learning

In the field of civil infrastructures physical inspection of infrastructures is needed for ensuring safety. It is difficult to inspect some structures by human beings. In such cases computer vision and machine learning based software techniques are used to detect damage in place of manual observations. In recent years, deep learning approaches are found more robust techniques in identifying damages. But for using these approaches precisely labelled data is needed as a training data. In image segmentation operations, damages have to be subtracted from the background image for further analysis. There are many segmentation methods available. By using these present methods there is a possibility of mis-localization of damaged regions. This leads to drop in accuracy. In this paper, a novel method to improve the

accuracy of the damage quantification (detection + segmentation) using attention guided technique has been described. In the proposed method a fast object detection model is used. It is a Single Shot Detector (SSD) method, trained on VGG-16 base classifier architecture. This model performs a real-time crack and spall detection along with inspector's verification. The detected region is used for further analysis. This initial region of interest selection reduces the computational cost, required amount of training data. The proposed attention-guided infrastructure damage analysis technique provides 30% more precision with a very minor amount of decrease in computational speed.

#### C. Implementation of artificial intelligence in the construction industry and analysis of existing technologies

Here, the research is done on the applications which are done on Artificial intelligence. The study used fuzzy logic methods and machine learning to mark visual data and analyze it for potential threats and to reduce all possible risks. Here the study is done to check the possibility to reduce the risk of a project in advance so that it does not affect the final profit. The work aims to understand the potential benefits of implementing artificial intelligence in the construction industry and how the construction industry is currently getting benefitted from the introduction of artificial intelligence.

This study is limited to case studies of a construction project located in Oslo, Norway. The case study is limited to three digital tools- Touchplan, Synchro and ALICE.

Touchplan is a construction planning tool which aims to create exceptional teams that deliver impressive projects – ones that run smoothly, complete on time or ahead of schedule, and use the collective intelligence of the entire team to learn and solve problems every day.

Synchro is a 4 - Dimensional digital construction platform that gives workers the ability to visualize, discuss and collaborate to find all constraints before completing projects. ALICE is an artificial intelligence-based construction platform that uses AI to analyze the flow of labor and equipment across the entire jobsite. This technology allows users to explore different construction plans in real time and understand the impact of key building decisions on the cost and duration of a project.

The study highlights the potential of artificial intelligence and machine learning technology in the construction industry. The implementation of the proposed approaches will improve the efficiency of construction, its safety and quality. The potential of big data in construction can be realized through machine learning and artificial intelligence algorithms, it is necessary to accumulate a critical mass of data on various construction projects and integrate various information systems of construction companies. The results of the study will be useful in the standardization of construction processes and the processing of data on construction projects.

#### D. Concrete Compressive Strength Prediction using Machine Learning – A Case Study

Concrete is one of the most vital materials in Civil Engineering and knowing the compressive strength of concrete is equally important. The Compressive Strength of

Concrete is a highly nonlinear function of ingredients used in its production and their characteristics. Engineers prepare small concrete cylinders with different combinations of raw materials and test these cylinders for strength variations with a change in each raw material. The general wait time for testing the cylinder is 28 days. This method is time consuming and requires a lot of labour to prepare different prototypes and test them. This method is highly prone to human error. Thus, to predict the strength, Machine Learning Algorithms could be useful in generating a combination of ingredients which result in high Strength.

A methodology to analyze Concrete Compressive Strength dataset and build Machine Learning models to predict the compressive strength has been developed [3]. In this method, Linear Regression and its variations has been calculated and Decision Trees and Random Forest algorithms have been used to make predictions and later their performance has been compared. It is found that, Random Forest Regressor has the lowest Root Mean Square Error (RMSE) and thus is a good choice for this problem. Also, performance of the algorithm can be further improved by tuning the hyperparameters by performing a grid search or random search.

#### V. THE FUTURE OF AI IN CONSTRUCTION

Robotics, AI, and the Internet of Things can reduce building costs by up to 20 percent. To plan the routing of electrical and plumbing systems in modern buildings, AI technology can be used. Many companies are utilising AI to develop safety systems for worksites. To track the real-time

interactions of workers, machinery, and objects on the site and alert supervisors of potential safety issues, construction errors, and productivity issues, AI and IoT can be used.

#### VI. CONCLUSION

To address the ongoing issues with construction projects and promote the construction industry automated construction manufacturing has been considered a potential alternative. Unlike other industries, the construction industry can benefit from AI methodologies in project planning, monitoring, coordination and control, as well as safety diagnosis, and quality control. Automated construction manufacturing may follow other industrial approaches such as, robotic coordination for modular or prefabrication construction, applying predictive AI solutions for reducing R&D expenses, supervised learning for modularization and prefabrication in engineering and construction, machine-learning methods for image recognition for risk and safety management, online optimization for better monitoring and management.

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