CURRENT TRENDS IN DIGITAL TECHNOLOGIES AND STRATEGIES THAT CONTRIBUTE TO ENSURING DURABILITY IN CONSTRUCTION AND INFRASTRUCTURE

Andrei BALTAGA

Civil Engineering and Geodesy, CIC-2101, Faculty of Construction Geodesy and Cadastre,
Technical University of Moldova, Chișinău, Republic of Moldova

Correspondent author: Andrei Baltaga, andrei.baltaga@icg.utm.md

Scientific coordinator: **Viorica ȚIBICHI**, associate professor, Technical University of Moldova

Abstract. *This paper analyzes current developments in the field of digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Big Data, along with associated strategies, to promote durability in construction and infrastructure. The research focuses on the integration of these technologies into current practices, emphasizing their impact on problem identification and prevention, optimization of construction processes, and efficient resource management. By examining digital strategies and their contribution to durability, the article provides a comprehensive perspective on the development directions in construction industry.*

Keywords: *Internet of Things, Artificial Intelligence, Big Data, Durability, Collapse Prevention*

Introduction

The rise of Artificial Intelligence (AI) as an efficient tool fit to be implemented in every domain of human activity has put it at the forefront of research and development in every field of science and technology. The construction industry has not been indifferent to these new innovations and began developing various tools based on Artificial Intelligence models for crack detection and damage assessment, building energy consumption, building cost prediction and workers' physical condition evaluation. These are the main aspects to be improved on in the future as they reflect our need for cheap, strong and efficient buildings. By gathering data and processing it researchers have developed powerful AI models to automatically detect and predict cracks, building occupancy etc. This also opens some ambitious prospects for the future of construction industry with the implementation of AI technology.

Internet of Things

Internet of Things (IoT) is comprised of various sensors collecting data and channeling it to a Supervisory Control and Data Acquisition (SCADA) system for analysis and storage. IoT is a technology that aims at optimization and keeping track of the state of the construction site to help manage and take decision using real time data. For practical uses IoT can be implemented for early preparations to logistic tasks to the maintenance of the structure in the last phases of the project life cycle. An example of this has been demonstrated with the platform Smart Construction. The said platform was involved during a highway construction project. A comprehensive scheme of the platform can be seen in Fig. 1.

The smart node (Fig. 2) is a small device secured to the excavators and trucks that acquire data (truck speeds; bulldozers, trucks, and rollers status) from sensors and send it to the SCADA system.

Thus the smart node communicate interactively with other smart nodes as well with the server in this case the supposed SCADA system.

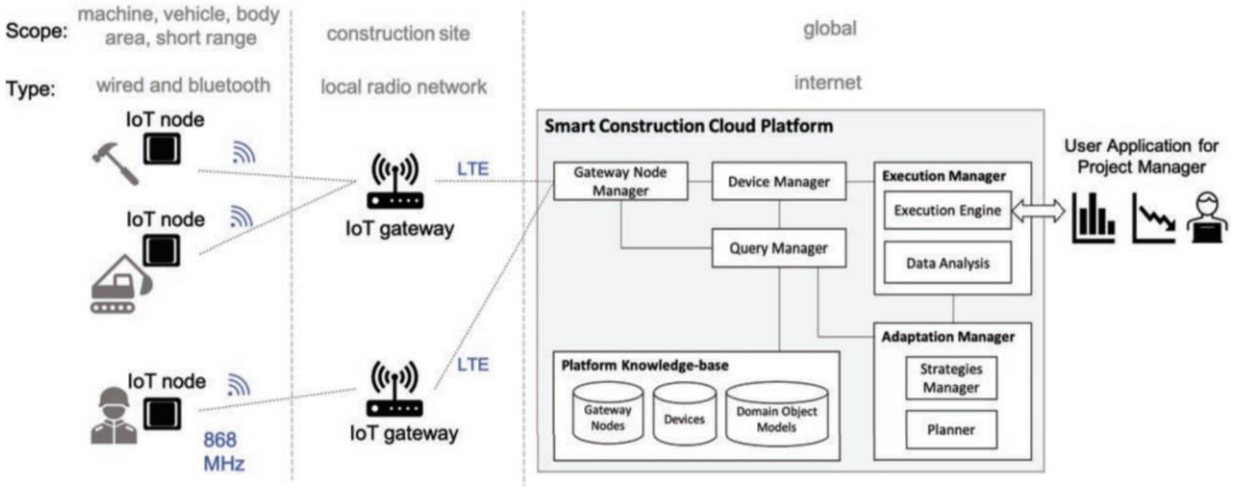

Figure 1. High-level technical overview of the Smart Construction platform [1]

Figure 2. Smart nodes and their location on the machines [2]

Big Data

Big Data plays a big part in Construction nowadays with the implementation of Building Information Modeling (BIM) and Internet of Things (IoT). BIM modeling of construction projects is convenient for engineers and contractors as it lets us contain various types of data (architectural, engineering, cost, survey data) in a single file. Such files can take up to 50GB and even 100GB in size. BIM is used both in office and on site to guarantee that the design corresponds to the reality. BIM is usually place on a server platform to ensure that both in office and on site engineers work with the same file. Managing a good connection between office and site becomes crucial in making sure that work is being done efficiently .For this reason managing big amounts of data is a necessity in construction industry.

The data from construction site recorded with the IoT comes as an unsorted stream of raw data which are then processed. As such data has to meet certain criteria as follows:

1. accessibility needs to be implemented for different types of data;
2. massive data needs to be stored efficiently;
3. the engineering system needs to be capable of scalability;
4. the data needs to be controlled globally.

The various data that comes from site such as sensor readings (velocity, temperature, frequency data) is brought together and processed by a Supervisory Control and Data Acquisition (SCADA) system. SCADA is a centralized system designed to manage the data gathering process in an organized and unified manner. The use of this kind of system allows real time monitoring of the site, fine tuning of processes, elaboration of empirical historical data and data visualization (Fig. 3).The visualization of data is of utmost importance as it enables the managers to have a clear image of the situation on site.

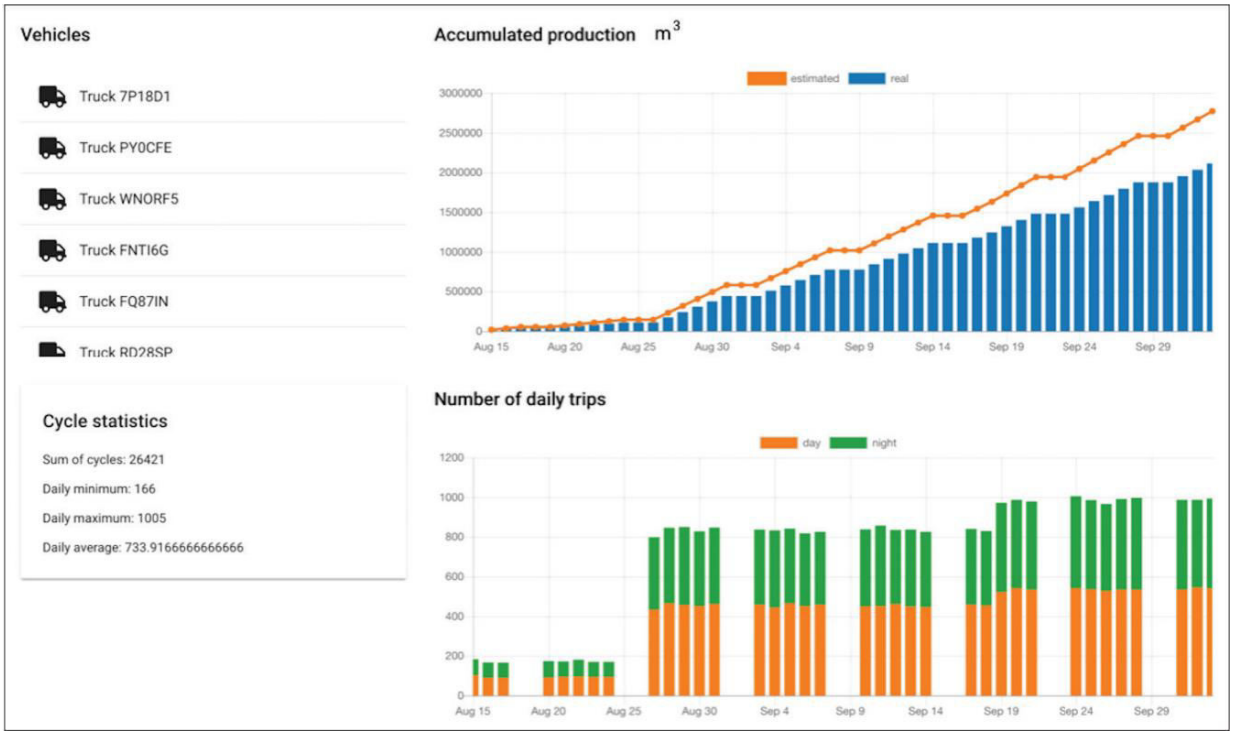

Figure 3. Historical production data over weeks [3]

Insights on Artificial Intelligence

Artificial Intelligence systems are algorithms designed to detect and sometimes solve certain problems without the involvement of humans. There are a couple of levels to the complexity of AI systems.

Machine Learning is the most fundamental component of AI and it is an algorithm that takes as an input an accurate representation of data and outputs some prediction based on the data it was trained on and has access to. The machine learning will output something regardless of whether the input data is representative or not and so it is up to the user to evaluate the quality of the data as Machine Learning does not have any level of abstraction to it.

Representative Learning enhances the Machine Learning by finding meaningful patterns in the mass of data. The algorithm helps represent relationships within the data sets between two or more variables.

Deep Learning helps by finding complex relationships within the data set which is given to it based on the simple relationships found between variables in the data set at the stage of Representative Learning. These findings then are processed to create various levels of abstraction. Abstraction enables tackling serious tasks as crack detection and prediction , energy needs prediction, cost analysis, site layout optimization.

Applied Artificial Intelligence

In a study on construction equipment activity recognition Inertial Measurement Units(IMU). Figure 4(c) have been placed on articulated pieces of equipment to register data points. After data from the field has been collected the team assigned a number of different actions to distinguish from(Engine off, idle, scoop, dump, swing loaded, swing empty, etc.). The data was then split into a test data set and a raw training data set Fig. 5. The deep learning algorithm used was a Long-short term memory which is a type of Recurrent Neural Network. As AI takes huge amounts of data the team generated synthetically data based on the data from the field. Upon training of the AI model the team evaluated the performance of the recognition algorithm at up to 96,2%.

The prospect of such technology provides a framework for the assessment of the activity, productivity and safety on site in real time.

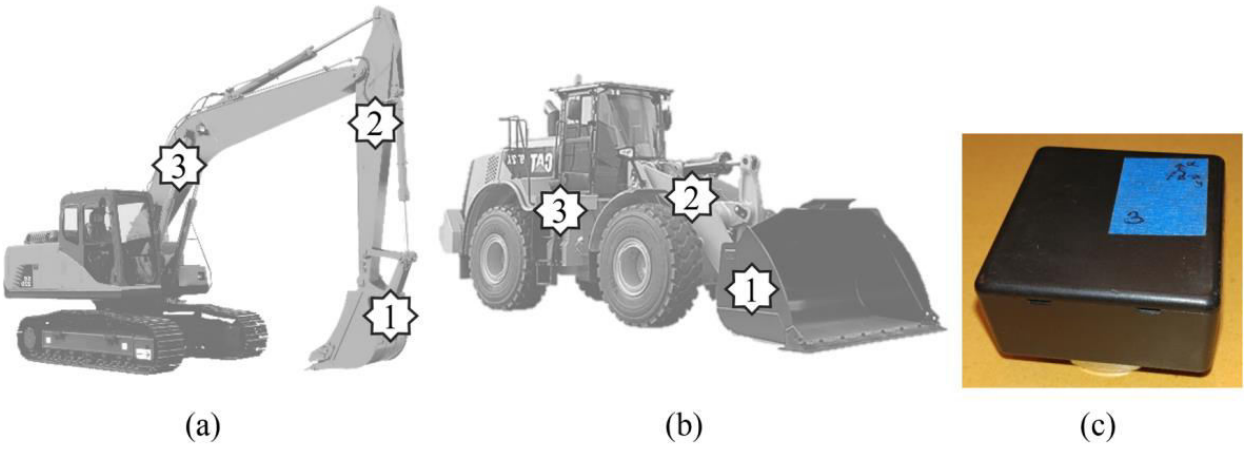

Figure 4. (a) excavator;(b) front-loader;(c) IMU [4]

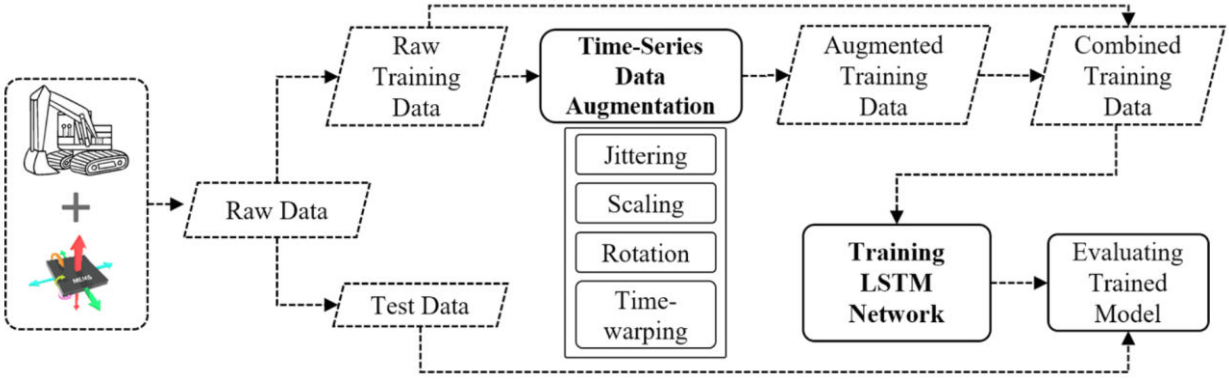

Figure 5. Overall methodological architecture of this study [4]

Conclusions

We are at a stage where we can massively increase our productivity on the management side of things. The combination of IoT , Big Data and AI will change the construction business by enabling the creation of detection and optimization systems for management which require minimal human input that wouldn't be prone to human error. I see the development of AI in particular as a natural evolution of the IoT and Big Data. These two components enable unburdened development of AI. Of course there are still challenges to overcome such as biased data and inconsistent data which AI models are trained on. But even now AI technology shows great prospects for the future.

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