

Application of Artificial Intelligence (AI) in the Construction Industry

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Abstract

The application of AI has switched the dimension of the construction industry. In upgrading the several aspects of the construction, AI has made it easier and possible by automatic data collection and analysis. In this paper, two sensors are used (i.e motion sensor and RFID). The motion sensor will automatically detect the human and animal within its range of danger zone. It contains a pyroelectric sensor that will notice the movements human and animals within its range. This sensor works by noticing the heat energy in the form of an infra-red signal. Further, this paper deals with the application of AI in construction sites. Similarly, the paper gives some focus on RFID use in the safety of construction. RFID deals with personal warning systems, real-time tracking, and location. Finally, the outcome of the developed platform figure-out that it is feasible to be applied in construction sites for better safety management.

Keywords

Artificial intelligence (AI), Construction, Motion sensor, Radio frequency identification device (RFID), Safety.

1. Introduction

Artificial intelligence (AI) can be explained as the capability of any machine to impersonate the human behavior of learning, growing and gaining knowledge/experience. AI can also be represented as an expert system that can know and construct intelligent entities and make a methodology that is quick, simple and efficient in decision making. The automation of cognitive computing is something that AI is concerned with which acts and thinks like humans. It is widespread and deeply rooted into our daily lives. It supports interactions of multiple disciplines like cybernetics, computing, neurophysiology, scientific theory and psychology. AI is engaged with designing, research and application of our time-efficient projects. It cooperates with machines designed to perform functions specialized to work intelligently when performed by humans. The AI concept may be already entangled in our day to day lives but its main aim is to explore different ways to mimic and execute various intelligent functions of a human brain in such a way that people emerge with technical products and create relevant theories. Almost every industry is influenced by technology today and hence the design and construction fields have also begun to cope up with advancements. Today, it won't be any surprise for anyone to fly a drone, to have an eye on a project before completion over a construction site with a computer game or to decide simplest of settings from supported predictions given by AI. Belief networks or Bayesian networks are a type of AI that deals with uncertainty using applied mathematics and conditional dependencies. For the creation of development operations, an automated approach that involves a blend of assumption networks and simulation is explained by AI and for the development operations to perform analysis, these assumption networks provide diagnostic functionality in this application. To create these development operations and validate them, computer simulations and assumption network recommendations are employed.

2. Literature Review

By various authors, many references have been made which is dependent on the construction industry its management and project with digitization including big data, automation, IoT, CC, The platform and BIM (Gerber & Kensek, 2010),(Cearley, 2017),(Egbu, 2004) and (Buyer, 2017) explained about the usefulness of Digitalization technology in changing the Construction industry. Similarly, Prefabrication with applications and significance, drawbacks and benefits are mentioned in their literature explained by(J.Adwan & Al-Soufi, 2016). AI adoption is important for the construction management is important explained by (A. G. Patil, 2019). Smart materials role for structural health monitoring, self-repairing materials, structural engineering, waste management, concrete mix design, and estimations explained by (Patil et al., 2017). They have also talked about the role of Artificial neural networks in their review paper.

Construction business is trying to apply more of IoT and sensors to improve its operation and productivity says the construction blog of Autodesk (Ragan, 2022). They explain the optimized use of sensors in construction which will creates enormous chances and opportunities in the future for the industry.

Bharadwaj, (2017) explains about vital applications for artificial intelligence in construction industry. He also explains the AI use in Planning and design, safety, Autonomous equipment, and Monitoring & maintenance (Zhang et al., 2017) suggested that due to the ever-increasing amount of information, traditional construction safety management has operated under difficult circumstances. For upgrading safety management in construction field Sensor-based technology is offering new generation of methods. Further it was mentioned that high efficiency and accuracy of safety management in construction can be made with the application of sensor based technology with modernization.

Cheung et al. (2018) proposed that many sensors are placed below the ground of construction sites to detect gas levels and environmental conditions. They mentioned the BIM model which will alert and alarm the risky site automatically for warning. Zhou et al., (2013) talked about preconstruction attention to be given in the construction industry as comparison to construction phases. Also They explain about reactive to proactive transformation of construction management. Various technology like sensor, GPS and RFID are mentioned by them which are responsible for gaining real-time safety information.

Sarkar et al. (2020) explain the development of an internet of things (IoT) platform for safety and asset managements in the sites. Their developed prototype gives clear information about the real-time location of the assets on the sites and their better management. Their prototype helps to reduce the number of errors in information management. The experience gain through the implementation of digital tools of advanced technology like AI and Human behavior are discussed by (Schia et al., 2019). Similarly, The productivity problem of construction industry and its reinvention using different technology has been discussed by Barbosa et al., (2017).

3. Conceptual Framework

At First, a conceptual framework for the sensor-based platform is developed. As shown in Figure 1, the first Hazardous area in the construction site will be identified and sensing techniques like PIR sensor will be placed there. If any object within the range of the sensor is identified, then it will read by the sensor reader. Such information is passed through the sensor gateway. Once information is passed through the gateway an indicator (light or alarm) will indicate that someone is in the hazard zone. This information will easily assist in maintaining safety in the construction sites so that no project gets delay. Workers in the sites will have a positive and safe feeling of working in the sites.

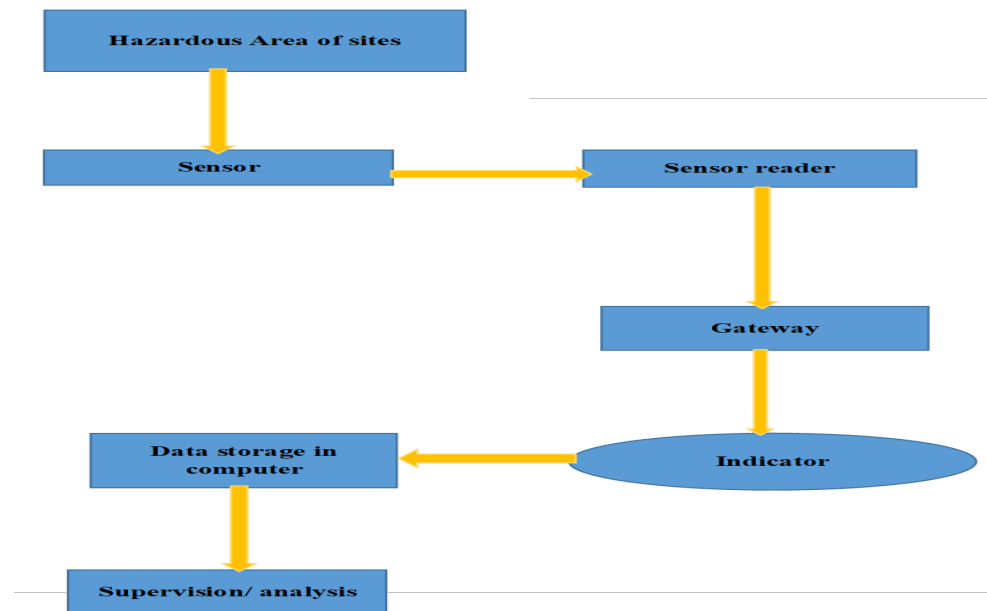


Figure 1. Conceptual Framework of platform

4. Multi-Application of AI

AI helps to predict the cost overrun of the project taking into consideration to the size of projects, types of contract, and level competence of managers in the concerned project. AI helps to enhance the skills and knowledge of the staff quickly by accessing real-life training materials.

Similarly, BIM helps to architecture, engineers, and construction professionals for better design and planning. The clash detection between different engineering work applied are easily found out by BIM-based 3D models. Also, the risk in completing the project with good quality and safety is more in a large project of construction. To monitor and risk prioritize on the construction sites by general contractors, AI solutions are used such that workers feel risk free to work in the sites and focus on completing the task on time. Risks are easily mitigated with the application of AI in the construction industry.

5. Platform Development: Methodology and Analysis

5.1 Sensing Technique

The model consists pyroelectric sensor when exposing to heat i.e. when the body of human or animal comes within the range of the sensor it will notice the movements because the form of infrared radiation heat is generated from humans. Since it uses heat energy in infrared radiation, it is also called PIR sensor and the passive means no energy used for detection purposes. It gets started by detecting the energy from the object. It also consists of Fresnel lens which helps in focusing infrared signal onto the pyroelectric sensor. The module consists of jumper along with three another pin between them. For selecting trigger mode these pins are useful. These pins are:

Non-repeatable mode:

In this mode there is automatic change of output from up to down whenever output of the sensor goes up and time of delay is over (Figure 2, Figure 3, Figure 4).

Repeatable mode:

In this mode output remains high all the time until sensor detection of objects.

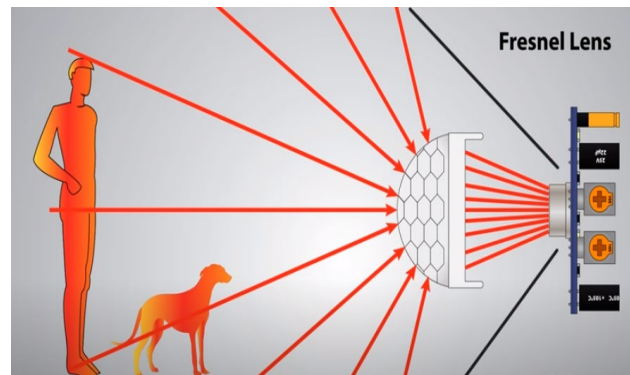


Figure 2. Sensor Detecting Objects

5.1.1 Connecting Module to Arduino Board

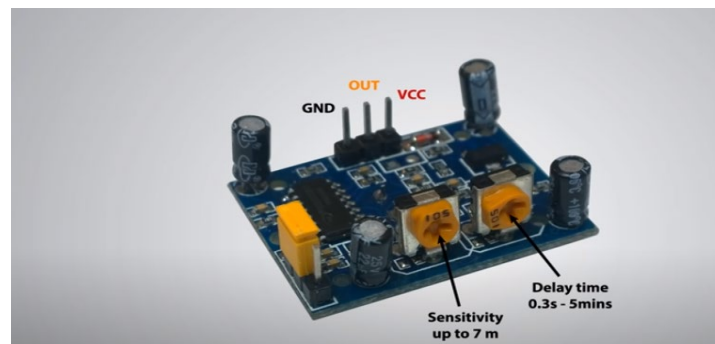


Figure 3. Arduino board

This is three-pin module: Ground (GRN), VCC & Output. Ground and VCC are used in order to powering the model (5to12 V) whereas high logic level is given by output whenever an object gets detected. The module has two potentiometers: One type potentiometer is used for sensitivity of sensor adjusting and other type potentiometers used for adjusting the time. Whenever the object is detected within the range of the sensor output signal goes high. The adjustment of time detected can be made from 0.3 seconds to 5 minutes.

5.1.2 Circuit Schematic

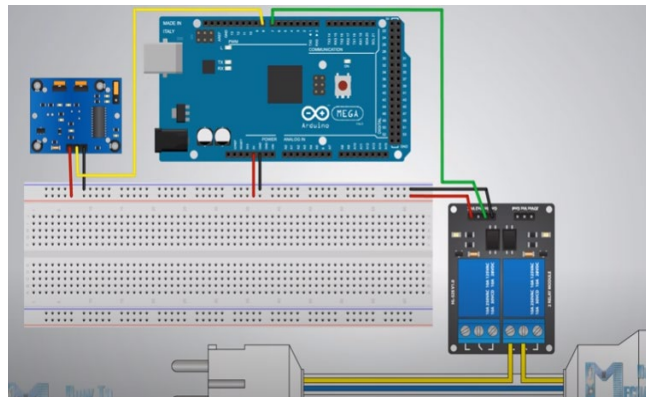


Figure 4. Schematic Circuit
Source:(Mechatronic, n.d.)

This circuit will turn a lamp with voltage when it detects any objects within its range. Here, On the Arduino board PIN 8 and output pin will be connected together and PIN 7 will automatically start the relay model whenever the object is within the range of sensor for detection as a result of it a high voltage lamp gets turn on.

5.1.3 Arduino Code

```
Int pirSensor = 8;
Int relayInput = 7;
Void setup () {
  pinmode (pirSensor, INPUT);
  pinmode (relayInput, OUTPUT);
}
Void loop () {
  Int sensorValue = digitalreadRead(pirSensor);
  If (sensor value == 1) {
    digitalWrite (relayInput, LOW); // The Rel
  }
}
```

Figure 5. Code used

Here, the input is sensor pin and output is taken as relay pin (Figure 5). With digital read function sensor used to read that if an object is detected or it's high relay gets activated automatically. The relay will be activated as soon as the object is detected. Since relay pin works inversely, a low logic is sent for operation and activation of relay module.



Figure 6. Indicator after detection of object

After power switch is on, about 20-60 seconds is required for sensor in order to function properly (Figure 6). The relay will activate the lamp/alarm when object is detected within sensor range. After the adjusted delay time is over, the lamp/alarm will turn-off.

6. Result and Discussion

The prototype developed above is ready to serve in the construction sites. Each year fatality in construction sites is growing. Many workers lose their lives in the sites due to improper safety systems. In such a scenario, when the concept of this developed prototype is used, it will be beneficial to the construction project as well as people working on the sites. A good manage system of safety encourages the worker to work freely in the sites that will ultimately benefit the project completion. Furthermore, an RFID tag with each worker will make them safe from hazardous locations and help the site supervisor to locate the reallocation of the worker. The buzz or alarming system will restrict the worker from going from those hazardous locations. Thus, we can say the site will be safer to work on once the developed prototype and application of artificial intelligence are taken into account before carrying out the project.

7. Conclusion

The growth of the construction industry now depends upon the use of new technologies. With the use of new technologies, the construction sector will achieve proper and continuous growth along with other sectors in this modern-changing world. AI has shown its potency to perform better than conventional methods. The use of smart sensors will easily overcome the safety risk and issues. Construction sites have challenging environments to manage with many critical issues in asset management, tools tracking, production safety, as well as worker safety AI-based sensors, which have proved to be a boon for this industry.

Physical assets and workers are easily monitored on the sites and can be managed well with consideration of RFID active tags. Keeping in mind with those risk and hazardous area in the construction sites, Motion sensors and RFID active tags will keep all the safety of the workers to prevent them from going to those restricted areas producing alarm or turning on the red lights.

With keeping in mind to provide better safety on the sites, this project or dissertation work aims at developing a sensor-based platform. This platform will help the construction workers and other staff members to be safe on the site so that construction projects go on smoothly. This will provide workers' information and location in real-time which help to maintain traceability and monitoring of workers on the site. Further, in this research or dissertation work, a prototype of the motion sensor has been developed. We can say without a doubt that AI has the capacity to vary the entire discipline, by providing it with new possibilities and ways to explore.

Abbreviations

Artificial Intelligence (AI)

Radio Frequency Identification device (RFID)

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Biographies

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