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Deep Learning on Monitoring Building Construction

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ABSTRACT - Now a days building constructions have led to low efficiency of construction schedule management and caused many construction projects to have cost overruns and legal disputes with site managers due to schedule delays on time. The manual extraction of construction procedural constraints is costly and also time-consuming. Construction industry suffers from the highest number of problems among all industries, i.e., one in five worker deaths in private industry were in construction. Tremendous loss has occurred to the workers families, the industry. Considering the increasing in number of these accidents there is a growing necessity of developing innovative methods to automatically monitor the safety for the workers at construction sites. Since the head is the most critical area of a human body and is the most vulnerable to an impact that could cause serious injury or death, the use of a protective helmet in construction work is needed.

In this paper, we aim to automatically detect the uses of construction helmets e.g., whether the construction worker wears the helmet or not by analysing the construction surveillance images. Based on the collected images, we first detect the object of interest i.e., construction worker and further analyze whether the worker wears the helmet or not, by using computer vision and machine learning techniques like using of convolutional neural network process of resnet34 model which is pretrained on image-net dataset. In the first step, we incorporate frequency domain information of the image with a popular human detection algorithm Histogram of py-troch for construction worker detection; in the second step, the combination of colour-based and open cv feature extraction techniques is applied to detect helmet uses for the construction worker. With regard to actual video surveillance of power station, the content change of frames is not so intense, thus, we can combine the detecting results of several adjacent frames to improve the recognition accuracy of whole system. For example, if a safety helmet with similar position coordinates has been detected in four of five real time video frames, then the confidence of safety helmet detecting results will be largely increased.

***Key Words*:** *Construction industry; Convolutional neural networks; Deep learning; Helmet detection; Machine learning; Open-cv; Py-torch; Torch vision.*

INTRODUCTION

Monitoring the construction process according to specific procedures mentioned in the supervisory documents is important to assure construction quality [1]. This interaction is called guideline-based quality consistency checking, which is area information concentrated. Earlier research has been conducted on regulation-based construction quality management systems to ease the checking process, and then help to reduce quality inspection errors and control violations such researches include a proposal for a system for construction quality management, functions.

Construction work is complicated, risky, and strongly reliant on the cooperation of numerous trades. In general, each trade has its own set of standards and safety regulations, which outline the safety practises and expertise needed to operate effectively. Many countries use training programmes to teach personnel safety skills and use qualification and

certification tests to assess their safety knowledge [2]. As a result, people who perform construction work without the necessary qualification represent a major risk to the safety of building sites. Despite the enormous safety risk provided by non-certified construction activity, few researchers have examined direct ways to increase the dependability of this verification procedure, indicating a significant knowledge gap in the body of knowledge.

In construction, researchers focus on combinations of algorithms and application scenarios to solve their existing problems like cost overruns, risk mitigation, construction safety, shortage of labour. There have been several reviews on machine learning in building construction management. Machine learning technologies play a vital role, especially when processing large amounts of data brings a significant added value to saving time and maximizing computing resources. For example, they can be used for text mining in project-related documents or automatic monitoring to help reduce the demand on human resources like hiring workers, while at the same time increasing safety.

construction monitoring commonly includes construction procedures, construction objects, and the temporal relationships between activities [3]. In particular, there are a few normal attributes of the information articulation of development procedural imperatives in Chinese guidelines, for example, the different syntactic developments of development guidelines and the muddled and questionable area elements engaged with a sentence immediately images. According to the research objective and the characteristics of research objects, semantic representations of entities involved in monitoring construction should be considered insufficient context. Particularly, to actually distinguish the area explicit substances connected with development procedural limitations and arrange relations among elements as expressed in the development guidelines, significant distance conditions between various elements in a regulation clause are critical.

Artificial intelligence technologies such as deep learning have continuously shown solid usefulness in the field of construction engineering in recent years, while a minimal expense, mechanized, and intelligent construction schedule management strategy that can be applied to the construction site environment in combination with artificial intelligence technologies has yet to be studied. In the field of computer vision and computer graphics, 3D reconstruction is a technique for recuperating the shape, structure, and appearance of real objects. Because of its rich and natural expressiveness. In this research, a deep learning approach is proposed for extracting construction procedural constraint knowledge automatically from construction regulations, which is divided into two steps: named entity recognition and pattern recognition. In named entity recognition, the Bi-LSTM-CRF bidirectional long short-term memory and conditional random field model is applied to identify and label entities like construction procedures, construction objects, and time intervals in clauses. In pattern recognition, the LSTM-MLP long short-term memory and multilayer perceptron model is used to identify patterns of construction procedural constraints [4].

Restricted examination endeavours have been coordinated to the data extraction (IE) of development administrative provisos, which principally centre around rule-based techniques. It includes a lot of manual effort-intensive and time taking to develop extraction rules, and they are difficult to be reused for heavily domain-dependent and defined for specific regulatory documents. Moreover, these efforts involve heavy feature engineering, including exploring lexical, semantic, syntactic, general domain and specific domain features. This manual feature extraction process is conducted using human-specified shallow features, limited by human domain knowledge. Recent developments in deep neural networks, specifically recurrent neural networks (RNN), have presented new opportunities to model sequential time-series data with recurrent lateral connections [5].

EXISTING WORKS

Existing research efforts in regulation information extraction mainly focus on quantitative knowledge, and a small amount of attention has been given to qualitative knowledge [6]. This research expands regulation information on monitoring building construction. The proposed approach expands the current regulation of information extraction by incorporating it in construction. Unlike most of the existing IE efforts in the construction domain which apply rule-based methods, a hybrid deep learning approach is proposed to extract the procedural constraint knowledge from construction regulations, without complex handcrafted feature engineering.

Artificial intelligence technologies such as deep learning They have gradually demonstrated strong productivity in the field. While a lot has changed in the field of construction engineering in recent years, low-cost, automated, and intelligent construction schedule. A construction management method that can be applied to the site environment in combination with artificial intelligence. Technologies have yet to be studied. In the field of3D reconstruction, computer vision and graphics It is a technique for recovering the shape, structure, and appearance of real objects. Due to its rich and intuitive expressiveness in this paper [7].

Machine learning is widely used to solve a huge range of tasks and problems with structured and unstructured data. In fact, many research fields using feature extraction have been trying some machine learning techniques. Analysis of spatial data has been involved in these models. Adjusting them can be very difficult and without knowing clear methodology and some information about data, leads to bad results. Most learning algorithms is partly based on theoretical machine learning arguments. Deep learning is one of the most prominent machine learning Method used in the construction process.

Deep learning took the lead in image processing in the second decade of the twenty-first century As per the information types noted in the gathered writing, the four principle classes of profound learning techniques in development can be ordered as: object identification, picture division, activity acknowledgment, and natural language processing to operate such a human-like ability to understand and learn and also to function accordingly, there must have to be some strong forces which we popularly algorithms [8]. Deep learning algorithms are interactively made to work through several layers of neural networks which are nothing but a set of deciding networks that are pre-trained to set out a task. Later each of these goes through simple layered representation and moves on to the next layer and most importantly machine learning is trained to work correctly well on databases that have to face

hundreds of features. Machine learning serve to fail mostly because the failure to accept a simple image having for a traditional machine learning algorithm to handle such depths where deep learning. Object detection in safety during construction Safety research in construction with deep learning focuses on the field of PPE, using object detection methods and algorithms some common practices for using object detection methods in PPE inspection can be identified [9]. These practices usually follow a three-step process: 1) using transfer learning techniques and pretrained models for basic feature extraction, 2) detecting workers and PPEs with object detection models like Single Shot Detection, 3) developing classification or recognition schemes based on the detection results, such as traditional machine learning algorithms, specific mathematical skills, or direct usage of deep learning networks. In the final step, the object detection results are further processed to provide the final outcomes. It very well may be seen that customary AI strategies or explicit numerical methods are appropriate for little informational collections while the profound learning model is a superior arrangement for large data sets. on the other hand, the deep learning techniques that have emerged in recent years to provide us with a powerful tool to achieve better modelling and prediction performance. The deep

learning algorithm uses deep architectures or multiple-layer architectures adopting the layer wise pre-training are used by the algorithm. Hence, the deep architectures have greatly improved performance for the modelling, classification and visualization problems, and they have found lots of applications [10].

PROBLEM STATEMENT

While new technologies have changed almost every aspect of our lives, the construction field seems to be in struggle in providing safety to the workers at the site environment. As the site manager needs to monitor the site environment it is very difficult to go and watch each and every place at the site as it also time taking and consuming a lot of man power. So instead of that process which is vicious, we propose a method for the monitoring purpose which helps to monitor the workers by detecting whether they are wearing a helmet or not by using deep learning techniques.

PROPOSED METHOD

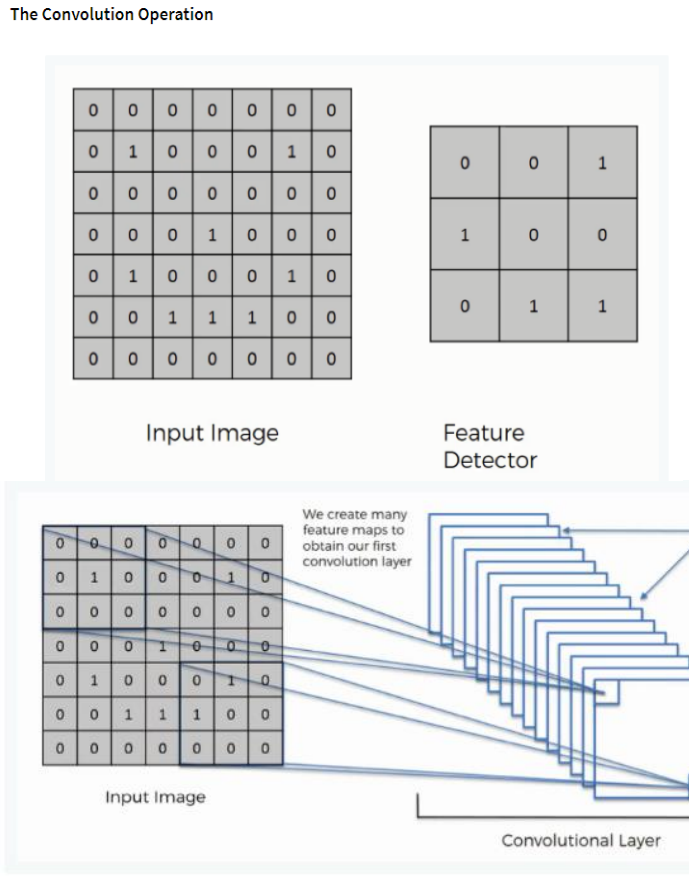
To create and develop a deep model that can automatically detect items, a design science research approach is used. Design science research is concerned with the development and performance of (designed) objects in order to improve their function and performance. Algorithms, human/computer interfaces, process models, languages, and the design and development of technology are some of the types of artefacts to which it is commonly used. Furthermore, design science can be used to build the necessary knowledge and applications in order to design and implement a product that adds value to a company. In this paper, the research approach for designing and developing a better CNN for automatically recognising objects on a building site is described.

Deep learning is a selection of the analytical (or) grading that actually depends on artificial neural networks. So deep learning is to perform and also implement with the help of deep networks with multiple hidden layers [11]. Deep learning is the method of machine learning and artificial intelligence planned to encourage humans and their actions based on certain human brain functions to make the strongest decisions. It is very necessary to the data science element that channels its modelling based on data-driven techniques anticipating modelling and statics. CNN's and RNN's are two common deep learning network topologies.

CNNs have two distinct advantages. To begin with, a CNN kernel's knowledge can be applied to any section of a dataset. If a kernel or collection of kernels is responsible for recognising humans, for example, the humans can be recognised throughout an image, regardless of their position. With fully connected neural networks, where each input feature is fixedly connected to each neuron, this is impossible to do. Second, CNNs contain substantially less parameters than fully linked layers, which speeds up the learning process and allows for the usage of far more complicated networks. CNNs are currently the most widely used structures in machine learning, particularly in computer vision (such as picture identification, object detection, and image segmentation) [12]. RNNs are mostly employed in time series processing applications such as speech recognition and natural language processing.

1. Convolutional Neural Network

Step1: convolutional operation the first building block in our plan of attack is convolution operation. In this step, we will touch on feature detectors, which basically serve as the neural network& filters. We will also discuss feature maps, learning the parameters of such maps, how patterns are detected, the layers of detection, and how the findings are mapped out [13].

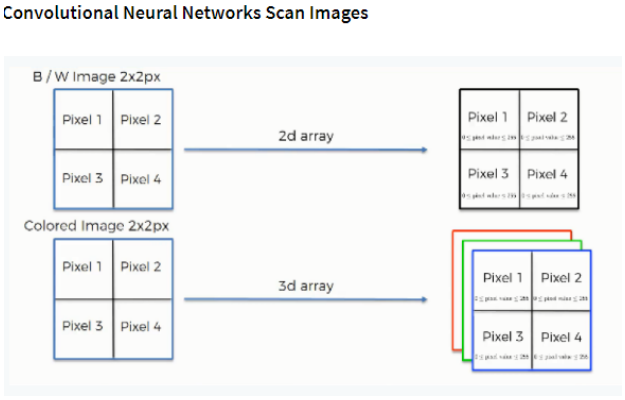


Step (1b): Re-lu Layer

The second part of this step will involve the Rectified Linear Unit or Relook. We will cover

Relook layers and explore how linearity functions in the context of Convolutional Neural

Networks.



Step 2: Pooling Layer

In this part, cover pooling and will get to understand exactly how it generally works. Our nexus here, however, will be a specific type of pooling; max pooling. We, cover various approaches, though, including mean (or sum) pooling [14]. This part will end with a demonstration made using a visual interactive tool that will definitely sort the whole concept out for you.

Step 3: Flattening

This will be a brief breakdown of the flattening process and how we move from pooled to flattened layers when working with Convolutional Neural Networks.

Step 4: Full Connection

In this part, everything that we covered throughout the section will be merged together. By learning this, you get to envision a fuller picture of how Convolutional Neural Networks operate and how the neurons that are finally produced learn the classification of images.

Design approach for detection CNNs

The Faster R-CNN design and parameters are identical to the Ren et al default option. It is made up of two modules. The RPN is a fully convolutional network that generates object proposals and feeds them into the second module [15]. The Fast R-CNN (FRCN) detector is the second module, and it seeks to refine the region recommendations. The RPN and Fast R-CNN detectors both use the Zeiler and Fergus (ZF) network, and the important characteristics of the Faster R-CNN are briefly discussed. The procedure to implement the IFaster R-CNN model is described in the following three steps:

Step 1: At first of original image of any size is fitted into the CNN, and it will be reshaped into fixed size. Based on the convolution layers, max pooling layers and fully connected layers of the CNN, then the image convolutional feature maps are extracted and generalized.

Step 2: The RPN module extract the module from the convolutional feature map, which can acquire the target score and regressed bounds of each proposal.

Step 3: The region proposal and corresponding extracted feature maps are combined. Then the proposal feature maps are combined to a fixed size by through a process of ROI pooling

and then sent to the fully connected layers, which are used to detect workers and heavy equipment.

Computer Vision

Computer vision is a process by which we can understand the images and videos how they are stored and how we can manipulate and retrieve data from them. Computer Vision is the base or mostly used for Artificial Intelligence. Computer-Vision is playing a major role in self-driving cars, robotics as well as in photo correction apps.

OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis. To Identify image pattern and its various features we use vector space and perform mathematical operations on these features.

The first OpenCV version was 1.0. OpenCV is released under a BSD license and hence it's free for both academic and commercial use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. When OpenCV was designed the main focus was real-time applications for computational efficiency. All things are written in optimized C/C++ to take advantage of multi-core processing.

Image-Processing

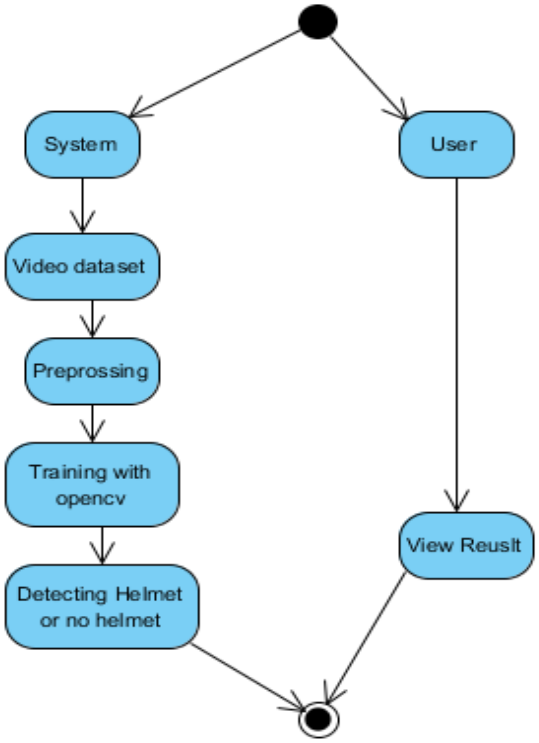
Image processing is a method to perform some operations on an image, in order to get an enhanced image and or to extract some useful information from it. If we talk about the basic definition of image processing then "Image processing is the analysis and manipulation of a digitized image, especially in order to improve its quality".

Digital-Image:

PyTorch:

PyTorch is an open-source machine learning library based on the Torch library, used for applications such as computer vision and natural language processing, primarily developed by Facebook's AI Research lab. It is free and open-source software released under the Modified BSD license PyTorch is an optimized tensor library for deep learning using GPUs and CPUs.

Fig 1. Activity diagram how the detection is done



Architecture

The dataset is given to the system later on it is processed for the training after that testing is done for the detection.

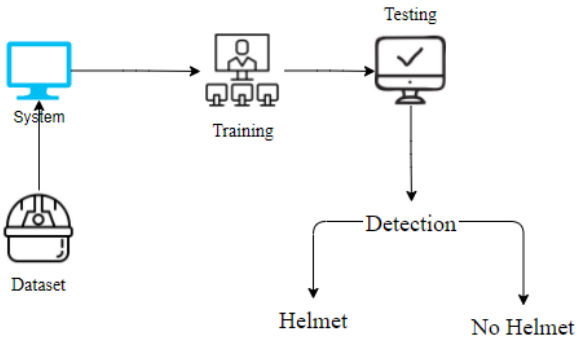


Fig 2: Architecture

Steps

Step-1: Import the required libraries like torch vision, matplotlib, cv2, detecto.

Step-2: Firstly, we have collected industrial video dataset

Step-3: In video converted into frames and labeling the image with using labelimg

Step-4: Create label for each image as xml file

Step-5: Applying the trouchvision, detecto method to create model

Step-6: Train the model to use opencv by applying the video.

Step-7: And it will be detecting the person wearing helmet or not in industrial video.

Experimental Setup:

To illustrate the method proposed in this research, a dataset of images of objects must be created in order to detect helmet on-site. To avoid any potential bias, the photos in the collection were taken from several perspectives, at various scales, positions, occlusions, and lighting conditions. This section describes the experiment that was carried out to create a deep learning model by using following methods like CNN algorithm to train and test the data taken from the dataset and then for GPU purpose we use tensor flow which is preferred version for deep learning algorithms. The minimum pc requirements for conducting our experiment are 8-16 GB RAM and for graphical processing purpose tensor flow is used, and then libraries like Anaconda in which it has most of the packages like Num-py (for numeric computation), pillow (for image processing), matplotlib (for visualizing and analyzing the given data). The implementation work was written in Python and operated on a server with a Processor of 11th Gen Intel(R) Core (TM) i5-1135G7 @ 2.40GHz Logical Processor, 2419 Mhz, 4 Core(s), 8GB RAM and x64 bit processor.

SYSTEM SPECIFICATIONS:

H/W Specifications:

Processor : I5/Intel Processor
RAM : 8GB (min)
Hard Disk : 128 GB

S/W Specifications:

Operating System : Windows 11

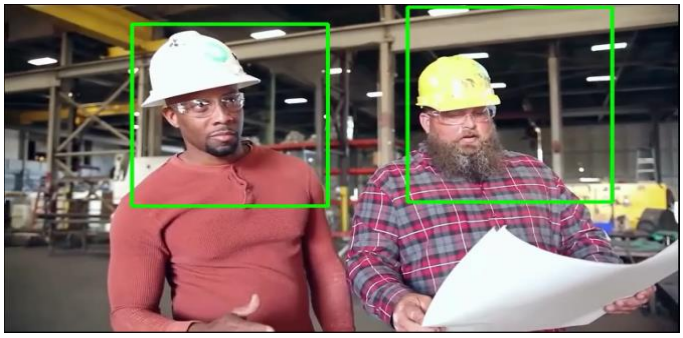
Programming Languauge : Python

IDE : Pycharm

Libraries Used : Numpy, pandas, Opencv, Pytorch, detecto.

RESULT

After giving input video or image it will detect the workers wearing helmet by showing a rectangular box around the head & for without wearing the helmet the detection is like red colour box around the head.



CONCLUSION

The research presented in this paper Deep Learning on Monitoring Building Construction used Hardhat pre trained model to detect hardhat wearing workers on construction sites in real time, which can offer managers with information to help them make better safety and planning decisions. This was made possible by compiling a database of construction-related worker images with and without helmet are converted into xml files after labelling, which was then used to train a cnn model properly to detect their occurrence. During monitoring get the video from the user and preprocess them into images for the classification and then after use the pretrained model to detect the workers wearing helmet and who are not wearing helmet and show them as with various colour rectangular boxes around the head with different colours using open cv tools. The suggested method could be used for monitoring safety purpose of construction site workers by the site manager.

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