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Hard Head Detection: Safety for All

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ABSTRACT: A construction worker usually avoids wearing a hard hat because it is too warm while working. An engineer avoids wearing a hard hat because he or she has never been injured before. A utility worker avoids wearing a hard hat because he or she thinks they would look silly. All of these situations are extremely dangerous and can cause tremendous injuries and deaths. Safety has always been a priority when it comes to the workplace in order to ensure a healthy and continuous manpower. The personal risks involved in all types of industrial activities specially at construction sites is a major concern which needs innovation. It is obvious that the more prepared our laborers are, the more effective work is experienced. This is to avoid any type of injuries or health issues and maintain an environment which is precautionary in terms of accidental misfits. Usually, in workplaces like construction sites or mechanical manufacturing factories, there is a risk of accidental head damages among laborers. As we all know, the head is the only organ in a human body that is totally encased in bone and to protect it should be our first priority. It is proven that any forceful act on the head can cause the delicate tissues of the brain to tear. Although it might sound like a self safety concern, many workers show careless behavior in terms of safety which cannot be neglected.

KEYWORDS: Hard Hat Detection, Fatalities, Computer Vision, Machine Learning, Web Application of Hard Hat Detection.

I. INTRODUCTION

The hard hat is a type of signature piece at all the construction sites which is extremely important in terms of the fatality rate for the same. According to a survey, in 2012, the US recorded 4383 fatal work injuries in workplaces like industrial areas and construction sites. This counted as an average of 84 injuries per week for that particular year. Fatality rate is a term used to calculate the total work injuries per number of hours worked by all the workers.

$$\text{Fatality Rate} = \text{Number of fatal work injuries} / \text{Total hours worked by all the workers}$$

Usually, the fatality rate is higher in developing countries than in developed countries and this is the main reason why it has become a major concern for the managers of particular industries. The major cause of fatalities are falls, slips, caught in between objects, struck by the objects etc. The major deaths take place due to falls from height or on a hard surface, because the head being a severely sensitive organ cannot withhold sudden attacks.

To solve the concerned issue, a proposed solution of “Hard Head Detection” can be the best fit. And why not? If we can build such an application through which we can scan and detect whether the individuals on such sites are wearing Hard Hats, then the damage can be minimized exponentially. “Hard Head Detection” as the name suggests, is a detection mechanism which provides employees a way to detect whether each worker is wearing a hard hat or not. With our model, we want to develop such an environment which deals with the same issue, checks the usage of protective gears on each worker and also marks their presence at the same time. Computer Vision will be used for the detection purpose. This can be productive when it comes to work environment particulars.

The web application consists of a Homepage where there will be Guidelines to use the application, a Login page for Employees plus Admins and a Check for Hard Hat necessary login. The Admin will be able to Delete users, Update users, Create new users and most importantly Create Managers. The managers can Delete, Review, Edit and Add Employee details. The technical objectives from this project are to design and develop a full stack website in order to get exposure into web development. Not only this, but to build a computer vision model and get exposure into the field of machine learning. The social objectives include the hassle free environment for the administration reducing the accidents and to create a first line of safety along with the making of a digital photographic attendance system. The rest of the research paper is constructed as follows. Section II provides the literature review in order to vivisection the work previously done. Section III provides the methodology of our proposed project work with relevant figures. Section IV provides an insight about the experimental results of the project and Section V provides the conclusions and future scopes of the project.

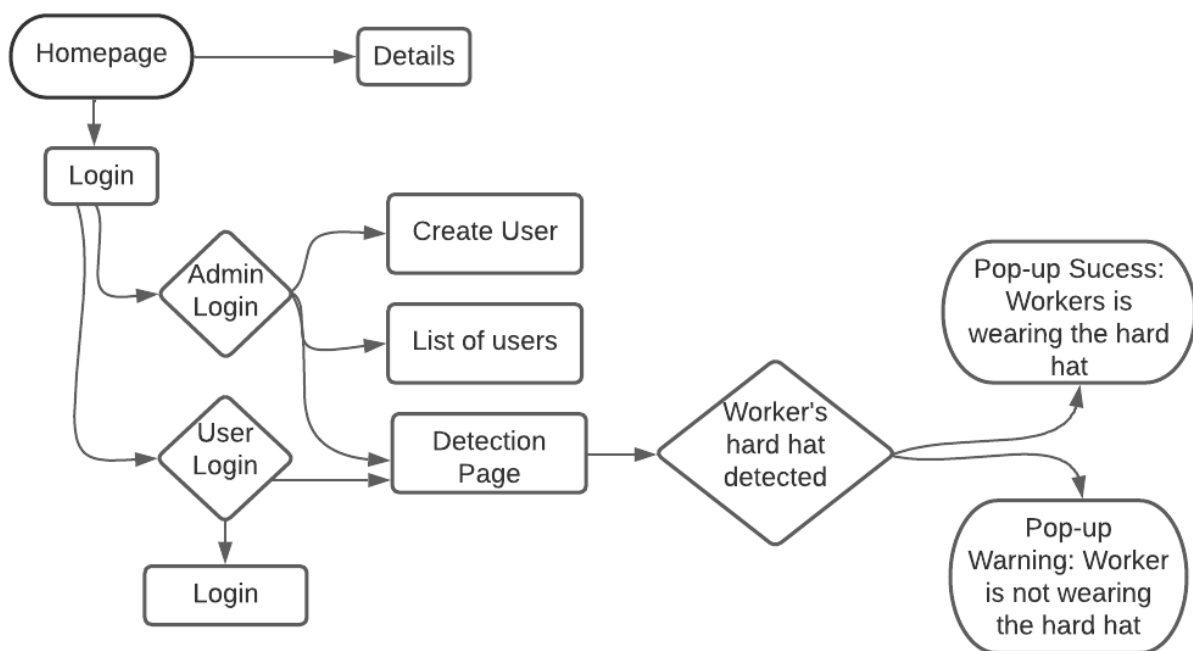


Fig 1. Framework of the Hard Hat Detection Web Application

After we provide the project to a company for using, they can use it in following ways:-

1. Admin can allot managers or supervisors for every department.
2. Supervisor has the power to create and manage user IDs for recognizing the employee and to store their data into the database.
3. He has the power to check the presence of employees and to check whether they are wearing hard hats or not.
4. The system will scan and detect protective gears followed by marking their presence.

The technical aspects of the projects will be taken care of with the relevance of the ideas and technologies involved. Full Stack Web Development involves both Front-End and Back-End Development. Both of them are equally important for a successful and functional website which offers great interactivity between end users and the website. Front-end Development also known as Client-Side focuses on what users see or we can say it's the front and the first face a user gets to see on visiting the website. The structure, positioning, layouting, color theme, font-size and little interactivity comes under Front-End Web Development. Supporting technologies for front-end are HTML, CSS, JS, Bootstrap and React. However, Back-End Development also known as Server-Side focuses on the background processes which are happening without the knowledge of the user. It works like an abstraction property for the end

user. They can see results and perform functions but are unaware of the background functionality. Databases are handled using technologies like MongoDB, MySQL, Express, Node.JS etc. Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs — and take actions or make recommendations based on that information.

II. LITERATURE REVIEW

The literature review for this project revolves around two main areas, i.e., Computer Vision and Image Processing.

Computer Vision: It is a field of Information Technology which deals with the idea of how Computers work and extract high levels of understanding with the help of digital images or videos. It aims to work similar to what human vision can do. It takes place through automatic extraction, analysis and understanding criteria of useful information from a single or series of images. It majorly deals with the theory behind Artificial Intelligence to extract required information. There are a few key aspects of Computer Vision that are used for photograph recognition:

1. Object Detection
2. Object Recognition
3. Object Classification
4. Object Segmentation

Object Detection is used to identify the location of the object which is also considered as the initial stage. Object Recognition falls under the category to locate the objects in the image and their position. Object Classification is used to locate the object in a broad category and Object Segmentation is used for pixels belonging to that object. Computer vision needs lots of data. It runs analyses of data over and over until it discerns distinctions and ultimately recognizes images. For example, to train a computer to recognize automobile tires, it needs to be fed vast quantities of tire images and tire-related items to learn the differences and recognize a tire, especially one with no defects.

Image Processing: Digital Image Processing is a method which uses digital computers to process digital images through an algorithm. It uses practical technology based on Classification, Feature Extraction, Multi-Scale Signal Analysis, Pattern Recognition and Projection.

P. Srujana, J. Priyanka, V. Y. S. S. S. Patnaikuni And N. Vejendla (2021) proposed Edge Detection with a number of Parameters in Digital Image Processing using GUI. In their proposed work four distinctive digital images like Building, Flower, Finger Print, Satellite utilizing edge locator operations like Sobel, Pewitt, LoG, Canny, these were executed on the digital images.

III. METHODOLOGY

This section will provide the step by step procedure implemented to achieve this project. Modules used to implement computer vision and image processing are explained below. The overall architecture of the web application contains three main parts: The web page back end module for the fetching of data sources and authorizing them using Node.JS and MongoDB. The Computer Vision and Image Processing Module using ML for detection of hard hats. The Front end creation using HTML, CSS, JS and Bootstrap.

Below is the step by step procedure for building a successful Hard Hat Detection Web Based Application:

1. Web Page Build

- First we created a server using node and express, then connected it with mongoDB. Then we created users for authentication and authorisation purposes.
- Post this we created a next js frontend for login and sign up which will be used by the admin and the users.
- We created a page for hardhat detection where users will click the picture for verification that they are wearing a hard hat or not.
- We added the python ML model where the clicked image will be stored and we will get results.
- Then we displayed the results on the detection page using the messages and icons.

2. Computer Vision Model

We are using the visual methodology wherein we would be detecting firstly the construction workers and then checking for their PPE's

- Installation of CCTV camera at the site
- Connecting it to the main server computer acting as the analyzer computer
- Then the CCTV sends the video to the server by the means of wired communication
- The video is then converted into firstly into series of images and then into grayscale for the purpose
- Then the computer looks for faces through the images as the first stage of the program
- Whenever the system finds a face or no of faces it implements the hard hat detection software in that frame reference as by default we have programmed our program such that firstly a face needs to be detected for hard hat detection.
- Figure with face detection marking an rectangle around the face with the help of OpenCV
- Then a figure with hard hat detection will be shown

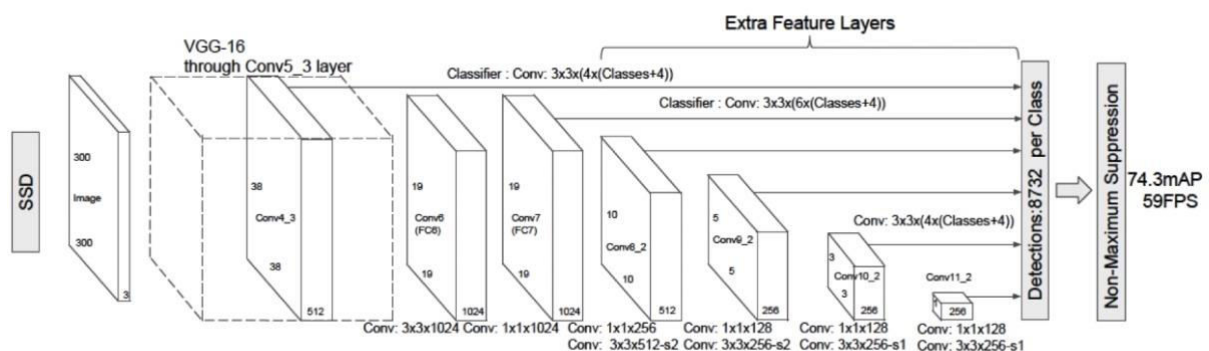


Fig 2. Computer Vision Model

IV. EXPERIMENTAL RESULTS

After successfully establishing all the modules and technologies, we have developed a web based application on Hard Head Detection, which fulfils all the functionality of the proposed project. It allows managers or admins to control the fatalities by scanning its employees and keeping a check whether they are wearing hats or not. Initially we have implemented the check through a normal CCTV camera whether the face of the employee is involved in that particular scan or not. The hard head cascade is successfully implemented in the program on the frame reference of the face of the employee to reduce the computation time and secure the implementation.



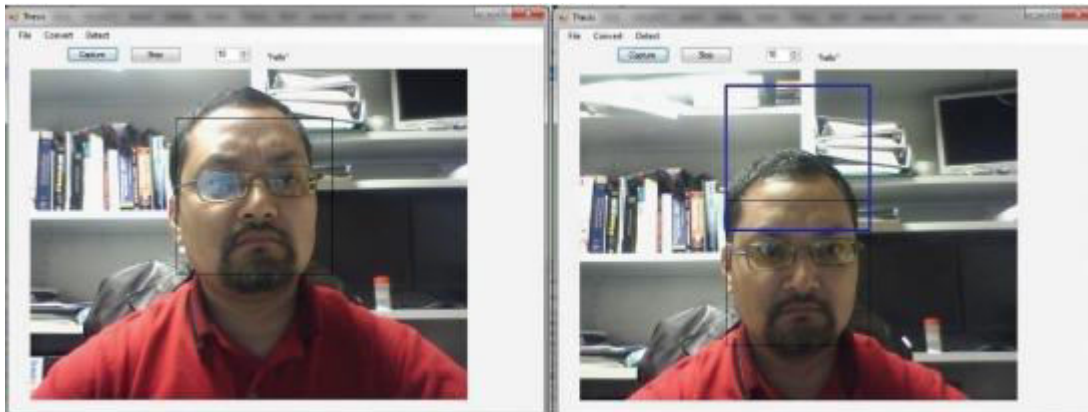


Fig 3. Experimental result on Detection

The two rectangles seen in the picture above are for the face and hard hat.

We successfully stored the image in the server, the program converts the image into grayscale and locates the object or hat. Convert the image into colored elements and display the result.

V. CONCLUSION

We developed a digital control for the surveillance of construction / mechanical sites by using web development along with Computer Vision, where CCTV cameras are installed such that they deliver a live feed to the server computer and server runs it by the computer vision program where firstly it distinguishes the people working and then check for the hard hats which means that it checks if every worker is wearing a hard hat or not. It then raises a warning if the employee is not wearing a hard hat controlling any disaster from happening at that particular stage. However, any type of careless behavior is welcoming a big disaster in our lives. These measures can prevent certain damages and maintain safety for all at such locations.

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