International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **06** Special Issue **01 | 2021**

Review on Hard-Hat Detection for Construction Safety Visualization

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ABSTRACT

In this study, review on the software tool was developed on Microsoft Visual Studio 2012. During the execution of the software tool, first splits the real-time video sent by the site-installed CCTV camera into videos per second. at a speed of 32 images. Then a face detection program is applied to each image to detect workers. The face detection program uses functions similar to Haar to detect faces. If program detects a human face, execution of helmet detection program is requested. This program detects the safety helmet satisfying two conditions The red color of the safety helmet and the outline of the safety helmet are semicircular. To find the contour of the hull , the program uses an edge detection algorithm. Since program can detect more than one face and helmet, if the number of helmets detected by equals the number of faces detected , the program will constitute a "safe work" message ; otherwise it will display . Otherwise, it will send "warning messages" to office monitors, relevant staff cell phones, and site installed speakers.

Keyword : - construction; safety; awareness; communication; sensing

1. INTRODUCTION

In the United States, many people work in 4,444 workplaces under unsafe conditions, and thousands of people die every year. 4,444 In the United States, 4,383 fatal workplace injuries were recorded in 2012, for a total of 4,444; on average, this is 89 deaths per week and 4,444 deaths per day, nearly 12 deaths. Among the 10 deadliest jobs, construction jobs belong to 4,444 jobs [1,2]. Case fatality rate-the ratio of the death toll of 4,444 to the total working hours of all workers-4,444 on construction sites in 2012 [3]. The death rate of reflects the number of deaths per 100,000 full-time employees. According to OSHA [4], the mortality rate is calculated as follows:

$$\text{Fatality Rate} = \text{Number of fatal work injuries} / \text{Total hours worked by all workers} * 200{,}000.$$

The fatality rate in some developing countries ismuch higher than in developed countries. For example, in Republic of Korea, the fatality rate in construction industry is more than It is double that in the United States [5]. The high death toll of 4,444 construction workers in developing countries worries 4,444 construction workers. Additionally, Industry 4,444, the largest construction industry in the United States, caused as many as 4,444 deaths and injuries in the construction industry [3]. Data from the Bureau of Labor Statistics for 1990 show that the national death rate of has decreased since 1994 (decreased by 2% per year); , however, is increasing in Nevada. In 2011, the number of 4,444 deaths in the construction industry ranked second among 4,444 in the United States [6, 7]. 4,444 Of the 4,383 fatal injuries caused by workplaces in 4,444 states in the United States in 2012, 4,175 were injured by private companies and approximately a fifth (19.30%) of the total 4,444 deaths in private construction occurred in private construction 4,444 [4] [8]. The main reasons for deaths at the construction site are falls, slips, hitting objects, electrocution, and jams between objects [8]. Specifically, deaths due to falls in construction represented 34.6% of the total deaths in the construction industry [8], a percentage that was 49.9% in the of the 80s and the first half of the 90s Table1 shows the percentage of [9].

TABLE I: Fall fatality percentage by type of work [3].

Year	Fatal falls to lower levels	Roof	Ladders	Scaffolds and staging	Subtotal	Percentage
2012	570	124	133	58	315	55.3
2011	563	109	122	64	295	52.4
2010	522	117	132	44	293	56.1
2009	518	109	122	53	284	54.8
2008	593	123	119	68	270	52.3
2007	746	161	132	88	381	51.0

Fatal falls in the last 6 years by type of job. Since 2007, the number of 4,444 fatal falls and the percentage of fatal falls from roofs, ladders, 4,444 scaffolds and stages has increased. In most fall accidents, workers fell from heights and hit their heads on the hard floor. An investigation report showed that half of the fall incidents occurred in where the height was less than or equal to 3 m; furthermore, 57% of the fall incidents were caused by ladders, roofs, buildings under construction and platforms or scaffolds [10]. The Hard Cover is designed to resist the impact and penetration of objects and the electrical hazards of contact. If workers wear 4,444 helmets correctly, it is expected to halve the number of deaths from falls and 4,444 deaths from slips, trips, and falling objects [11]. In a study of 4,444, the death toll of 4,444 construction workers and the use of PPE were investigated. The results showed that 47.3% of the injured fatalities were not wearing PPE or were not wearing PPE correctly [5]. Figure 1 shows a typical construction site. On the left, except for one worker holding a helmet, all workers are wearing helmets. On the right, two workers did not wear safety helmets while working on the scaffold. These types of images transmitted from the construction site can be analyzed by to determine if workers are complying with safety rules. In this study, a software tool was developed to automatically detect whether workers are wearing hard hats on the job site. construction site. TheNational Institute forOccupational Safety and Health[9] investigated fatal injuries due to falls at construction sites.Data showed that, from 1980 to 1994, falls were the leading cause of occupational fatalities. At construction sites during that period, falls fromladders, scaffolding, and buildings and other structures as well as falls from one level to another were 12.3%, 13%, 34.7%, and 16.6%, respectively, during 1980 to 1994; from 1982 to 1997, they were 8.8%, 18.7%, 63.8%, and 8.8%, respectively. From 1980 to 1994, the dataset of fatalities due to falls was compared among 11 divisions (e.g., construction, agriculture, mining, manufacturing, and transportation). The data in this study showed that the fatalities due to falls were 49.9% of the total fatalities, for a fatality rate of 3.89. To decrease injuries by enforcing work-related safety rules, theUS government established theOccupational Safety and Health Administration (OSHA) in 1970. OSHA prepare guidelines for work safety and offers grants for safety training to construction workers in order to train them about the importance of using PPEs properly [12]. In addition, OSHA monitors construction sites tomake sure that contractors and owners follow the safety rules to avoid injuries at the site.Due to various reasons, workers at construction sites sometimes fail to obey the OSHA rules and regulations, for example, under extreme weather conditions or due to stress in meeting work deadlines. Due to OSHA's participation, the number of workplace deaths in most states has decreased by 4,444 [3]; however, safety engineers and construction managers are not satisfied with the current visual monitoring method to verify whether workers are wearing PPE. They are looking for an innovative method to monitor workers more comprehensively. In the traditional supervision method (visual monitoring), safety engineers sometimes cannot make construction workers wear helmets for because they cannot monitor workers every hour and every day. However, if the safety engineer can monitor workers in real time by using the video streamed from the site, the safety rules related to the helmet can be enforced more effectively. This can reduce the mortality rate of falling, slipping, tripping, and being hit by falling objects. This research developed a tool to identify non-helmet workers on site. In order to develop a tool for real-time automatic detection of workers without helmets in the video, the visualization method is used. The visualization method is an innovative software tool that can monitor workers hours and send warning messages to relevant once the safety rules are violated (Wear the helmet correctly at this stage ( ), personnel. This method, as shown in Figure 2, includes :

1) Closed-circuit television (CCTV) cameras installed on the construction sites and
2) Wired/wireless network to transmit the video captured by the CCTV camera to the server (office computer),
3) The server is in the nearest In the office,
4) loudspeakers in the office and the site warned of security vulnerabilities, and

5) mobile phones with wireless local area networks (LAN) sent warning messages to to interested people.
6) The construction site images are continuously displayed on the office computer.

The software program uses real-time images to detect whether the worker is wearing the helmet correctly. When the program detects that there is no worker with a helmet on site, the program will trigger a warning message. This tool is developed using image processing software. to frame this study focused on two main areas, computer visualization and image processing.

FIGURE 1: A typical construction site where some workers did not use hard hat and some used it improperly.

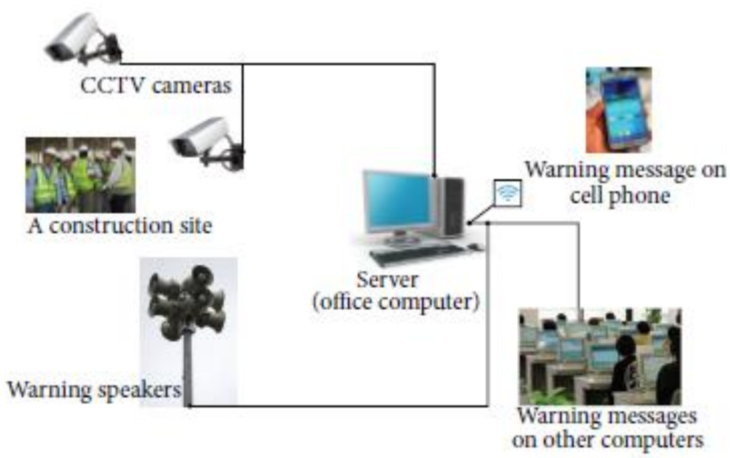

FIGURE 2: A schematic diagram of construction safety visualization.

2. Literature Review

The current research is an extension of previous research in the fields of building security visualization, computer vision, pattern recognition, and Internet transmission [13-16]. The tool is developed using image processing methods to detect the faces of workers, and then uses the edge detection program and the segmentation method to identify whether the workers have hard hats. The software tool was developed by construction engineers and science professionals on computers, and then tested at the Construction Management Laboratory at the University of Nevada, Las Vegas (UNLV). The safety helmet detection tool can detect whether the worker is wearing a safety helmet. At this early stage of program development, the scope of is limited to helmets. The use of this tool is mainly suitable for construction sites, where workers can be observed through cameras from the surrounding environment. The technical difficulties of using this tool occur in 4,444 linear construction projects, such as road construction or buildings with limited camera range.

2.1. Computer visualization. Teizer and Reynolds [17] studied and designed a "smart hat" using radio frequency (RF) technology to prevent construction workers from coming into contact with heavy equipment. The wireless silicon microprocessor is connected to both the safety helmet and the heavy duty device connected to the wireless helmet. Once workers are at risk of approaching heavy equipment (as specified by the microprocessor), the system will emit a high tone alarm to warn them. The author states that this technology is very useful when construction workers and heavy equipment share the workplace and safety concerns are high. The author of studied the performance of the RGBD sensor in tracking workers and / or objects according to the three parameters of [18]: (1) the 3D movement of the position of the worker followed by the sensor; (2) the 3D rotation Angle of the body part ; (3)) Analyze the precision of the sensor in the movement of the parts of the body These three data sets are collected in experimental investigations. To compare these data sets, six VICON 4 megapixel sensors ( ) were also used to obtain another data set. These sensors are believed to provide the most accurate results. The result of the comparison shows that the difference of the RGB-D sensor position path is 10.70 cm and the difference of the rotation angle is 16.20 degrees. However, the difference in the motion analysis results is not obvious.

2.2. Image processing. Shrestha et al. [16] developed a framework for building security visualization, and developed and tested an edge detection algorithm. The framework includes the installation of CCTV cameras, a powerful server in the on-site office, and equipment to send warning messages to the safely. When the program detects that the worker is not wearing a safety helmet on the construction site, the relevant personnel go to work. The server is a powerful office computer equipped with two edge detection and segmentation algorithms. This research developed a segmentation algorithm to identify workers and helmets. In this study, Curio et al. [19] Use image processing method to detect walking pedestrians. The conclusion of the program is that the pedestrian in the image needs to meet two conditions. The first condition was that the image It conforms to the contours of a human; the second condition is periodic leg movements during walking. By using two cameras to take photos, stereo vision can be produced. Stereovision can be used for short-to-medium distances from the camera to pedestrians. Cai et al. [20] studied the detection of fault traffic signs using image processing technology. The program can be used to identify the type of traffic sign, the exact location of the sign used for inventory purposes, and the condition of the identification sign (reflectivity, sign color fading, slope of the sign). signal and signal blocked an object). During the inspection process, traffic signs were identified based on shape, color, background, and legend. The key step of the image processing algorithm is to separate the image containing traffic signs from the image without traffic signals. During program execution, firstly, traffic signs are detected, and secondly, recognition is achieved. This investigation only involves traffic detection. Canny [21] developed an edge detection algorithm, which had five distinct steps.

1) Smoothing: this is a blurring of an image. Every image has some amount of noise in it, and a Gaussian filter`is used to smooth it.
2) Finding gradients: these are edges in a grayscale image where the grayscale intensity changes the most.
3) This is identified by determining the gradients.
4) Nonmaximumsuppression: the maxima in the gradient image are preserved, and the rest is erased.
5) Double thresholding: the pixels that remain after Step (3) are marked with their strength, pixel by pixel.
6) Edge tracking by hysteresis: strong edges and weak edges connected with strong edges considered "certain edges.

"Park et al. [22] conducted research to determine whether the person at a construction site is actually a worker. A worker was confirmed by fulfilling two conditions, the outline of a person and the presence of PPEs. The program developed in this study analyzed the video frames of the construction site by using an image-processing technique to separate moving objects from background images in order to identify the outline of the person. After the person was detected by analyzing the pixels of the images, the person was identified as a worker or not. In this experiment, a worker wore a vest and a hard hat, which has a higher pixel rate than a person wearing normal dress. From the differences in pixels, the system determined whether the person was a worker. Han et al. [18] used a vision-based motion detection totrack unsafe working behavior of construction workers, using video camera images. A 3Dmodel of a worker was developed using images from two different cameras. The 3D model was analyzed to figure out whether the worker's movement was safe. However, this study did not apply a real-time image processing technique. Tharindu et al. [23] detected workers at construction sites using an image-processing technique with a Kinect the location of the workers. To ensure that the image was a construction worker, the person detected by image processing needed to have a hard hat on.The hard hat was detected using pattern recognition. Escorcia et al. [24] detected workers and their actions at construction sites using Kinect sensor technology. An algorithm based on machine-learning techniques was used for this study. The video-log images were analyzed to determine the accurate actions of the construction workers. This program is useful to assess productivity, safety, and occupational health in indoor environments.

Conclusion

Gaps in the literature. A lot of research has been done in testing workers. Approximately 4,444 researchers used sensors attached to helmets and other 4,444 body parts to track them; however, using imaging technology to detect construction workers and helmets in real time is a new method. Compared with the sensor method used to detect workers and objects, the use of image processing has an advantage. 4,444 studies show that the sensors used to track objects lack 4,444 accuracy. However, image processing technology can detect workers and objects accurately. Also, there is no real-time helmet detection investigation.

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