International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

IJIEMR Transactions, online available on 07th Jan 2023. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=ISSUE-1

DOI: 10.48047/IJIEMR/V12/ISSUE 01/48

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Volume 12, Issue 1, Pages: 533-539

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DEEP LEARNING-BASED WORKERS SAFETY HELMET WEARING DETECTION ON CONSTRUCTION SITES USING MULTI-SCALE FEATURES

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ABSTRACT: On construction sites, workers still wear safety hats to keep them safe. On the other hand, workers frequently remove their helmets due to discomfort and a lack of security knowledge, making them vulnerable to hidden dangers. Workers who don't wear safety helmets are more likely to get hurt in accidents where people or objects fall vertically. Therefore, identifying security protective cap use is a significant piece of building site wellbeing the board, and a high velocity, high-exactness wellbeing cap identifier is desperately required. Conventional manual screens, then again, find opportunity to work, and choices like putting sensors on security head protectors are difficult to standard. Consequently, this study proposes a deep learning-based method for detecting safety helmet use with high speed and accuracy. Our method begins with YOLO v5, adds a fourth detection scale to anticipate additional bounding boxes when small items are present, and uses the attention mechanism of the network's backbone to generate more informative features during subsequent concatenation operations. When insufficient data is the problem, targeted data augmentation and transfer learning preservation are used to fix it. The advantages of each modification are examined in this report. Finally, our model can recognize a 640x640 image in less than 3.0 milliseconds and has a mean average accuracy of 92.2 percent, up 6.3% from the previous method. The robustness and adaptability of our method are demonstrated by these outcomes. In the meantime, our trained model is portable

due to its 16.3-meter length. Finally, a graphical user interface (GUI) is developed to make our method easier to use after a sufficient model has been obtained.

Keywords: *Detection of safety helmet wear, YOLO v5, four detection scales, attention mechanism, and GUI design.*

1. INTRODUCTION

Building site safety is getting more attention from the public than ever before as a result of the necessity to construct various infrastructures as a result of urbanization. Many disasters can be avoided with the help of personal protective equipment (PPE) [1]. One of the most important pieces of personal protective equipment (PPE) that employees should use to protect themselves from falling objects is a safety helmet [2, 3]. Everywhere in the world, wearing one is required by law. However, the use of a safety helmet is frequently not reported due to pain and a lack of safety knowledge. Consequently, it is essential for workers' safety to wear appropriate safety helmets and may raise the bar for safety management. Human patrol and image surveillance are traditional methods for ensuring that workers on construction sites wear helmets [4]. The latter takes a lot of work and time, and manual monitors force inspectors to look at displays for a long time, which can lead to judgment errors caused by fatigue. As a result, new technologies that use sensors and image processing to determine whether construction workers are wearing safety helmets are developed more quickly.

Fig.1: Example figure

Chinstrap sensors, three-axis accelerometer sensors, pressure sensors, and radio frequency identification (RFID) readers were utilized in order to track safety helmet usage [6-7]. These methodologies, then again, are more expensive to recognize and might be viewed as a break of laborers' security. Concerns about health and privacy often prevent workers from wearing safety helmets with above-the-head sensors [8]. Computer vision holds significant promise for detecting the use of safety helmets, and non-intrusive methods are becoming increasingly popular [9]. The support vector machine, histogram about oriented gradient (HOG), and the Gaussian mixture model (GMM) [10] are just a few of the computer vision-based methods for object recognition. These algorithms were also used to identify safety helmets due to the high death rates in the construction industry. Liu and co. utilized skin tone and hu moments to identify helmets. Rubaiyat et al., after identifying people with HOG, used a color-based approach and a circle-hough transform to completely identify safety helmets. Wu and co. utilized a hierarchical support vector machine to extract color information from safety helmets to classify personnel. However, there are drawbacks to more advanced detecting techniques. GMM battles to segregate between front classes, while hand-planned credits like as variety and Hoard battle to catch high and mid-level portrayals properly.

2. LITERATURE REVIEW

Learning accurate personal protective equipment detection commencing virtual worlds

Deep learning has achieved outstanding results in a wide range of AI applications, including image identification and computer vision. The availability of significant prepared material, which includes a large number of persons described models, aids its applicability to regulated problems (for example millions). To solve this issue, the AI world has been gradually using forged photos or video groups using practical photograph providing motors comparable to those utilised in entertainment applications. As a consequence, massive photo-creation setups are still easily developed to do deep learning computations. In this study, we used image reasonably built picture sets to train deep learning models to recognise correct use of individual security gear (e.g., expert security head coverings, high visibility jackets, ear assurance gadgets) throughout hazardous work activities. Then, using a tiny number of legitimate photographs, we experimented with transforming space images to real images. We proved that preparation among manufactured preparation sets generated and used in the area variation stage is a feasible alternative when no preparation set is available.

Deep learning-based safety helmet detection in engineering management based on convolutional neural networks

On-the-spot guidance on the necessity of construction workers wearing security head protection to prevent beginning wounds and a visual assessment of the working environment A PC vision-based programmed reaction with continuous recognition is required because video inspection frameworks generate a lot of unstructured picture data on the spot. A good answer considering business application is less researched due to the complex scene on the building site, despite the fact that a developing writing group has developed various deep learning-based models to identify head coverings from a traffic observation standpoint. As a consequence of this, we call for a comprehensive, learning-based strategy that incorporates the consistent application of a security head cover on a construction site. The suggested strategy makes use of the SSD-MobileNet computation, which is based on convolutional brain structures. A dataset of 3261 pictures of security head protectors was published and made available to the public. These pictures were taken manually starting with a video observing framework at work and were open images taken with the help of web crawler technology. With a roughly 8 percent inspection rate: 1: First, there is a test set, an approval set, and a preparation set in the picture set. According to the findings of the study, the provided deep learning-based model that makes use of SSD-MobileNet computing is suitable for recognizing hazardous behavior regarding dissatisfaction with wearing a protective cap on the construction site while maintaining acceptable accuracy and productivity.

Improved YOLOv3 algorithm & its application in helmet detection

Because of its high speed and exactness, YOLOv3 target finding algorithm is frequently utilised in industry; nonetheless, it has numerous drawbacks, such as accuracy corruption in uneven datasets. YOLOv3 target location computation is built on a Gaussian fluffy information expansion approach to deal with preprocess informational gathering and further improve YOLOv3 target locating calculation. Professional pre-handling increased certainty level about YOLOv3 by 0.01-0.02 without affecting acknowledgment speed about YOLOv3, and handled pictures also perform better in picture limitation because of compelling element combination, which is more in line with requirement about acknowledgment speed and exactness underway.

Safety helmet wearing management system considering construction workers using three-axis accelerometer sensor

Legitimate and institutional wellness board enhancements are still sought in Korea's growth industry. However, compared to the previous year, the number of construction workers murdered in 2017 increased by 4.5 percent. It is widely believed that one of the primary factors contributing to the rise in catastrophes is the inability to wear safety caps. Therefore, in order to determine whether safety head coverings are still in use, it is essential to encourage innovation. However, contemporary professional investigations on this issue have largely focused on chinstrap sensors and have been confined to the topic of whether security hats are still used. Meanwhile, improper wearing has not been proven, such as when the chinstrap and tackle fastening about security protecting cap maintain are not as intended fixed. To address this shortcoming, our study developed a detecting wellness hat with a three-hub accelerometer sensor connected. During development worker exercises, tests were performed in which detecting information was produced to determine if a safety head protection was worn properly, not worn, or worn incorrectly. The findings showed that with a high accuracy of roughly 97.0%, it is able to discern between wearing status and advised security head protection.

3. IMPLEMENTATION

The traditional assessment of head protection used on construction sites consists mostly on an analysis of an observing image and supervised watch. The manual screen necessitates monitors staring at the screen for an extended period of time, which may give the impression of sluggishness, and the final option requires a significant amount of time and effort. As a consequence, new developments in determining labourers' wellness head protection wearing condition on building sites continue to spread swiftly, with assistance from sensors and picture investigation approaches.

Disadvantages:

1. It takes a significant amount of time and work, and a manual screen requires assessors.

A deep learning-based method for quickly and accurately identifying security head protectors is presented in this study. Our method employs YOLO v5 as a pattern, followed by the addition of a fourth recognition scale to anticipate additional bouncing boxes when considering small items, and the incorporation of a consideration system in the foundation about organisation to develop more useful highlights when considering following connection activities. Targeted information augmentation and motion learning preservation were utilised to counteract defects caused by a lack of knowledge.

Advantages:

1. quick detection speed

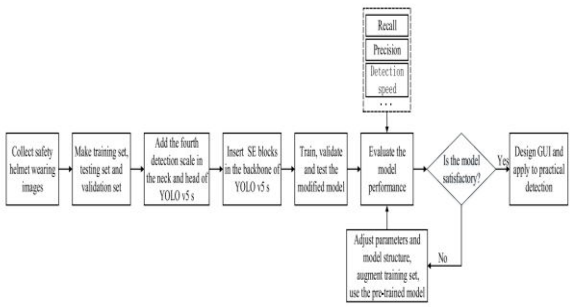

Fig.2: System architecture

The GPU can now be used in large-scale parallel computing to train massive deep neural networks thanks to advancements in computer technology. Due to their superiority in high-level feature extraction, convolution neural networks (CNNs) are the deep learning-based algorithms that are used the most frequently for object recognition. Consequently, they are gradually replacing traditional image analysis detection algorithms. There are two distinct categories of CNN-based object detection systems. One type of detector has two stages of operation: The list of possible object-containing zones is first created, and then CNN detectors are utilized to classify and locate objects.

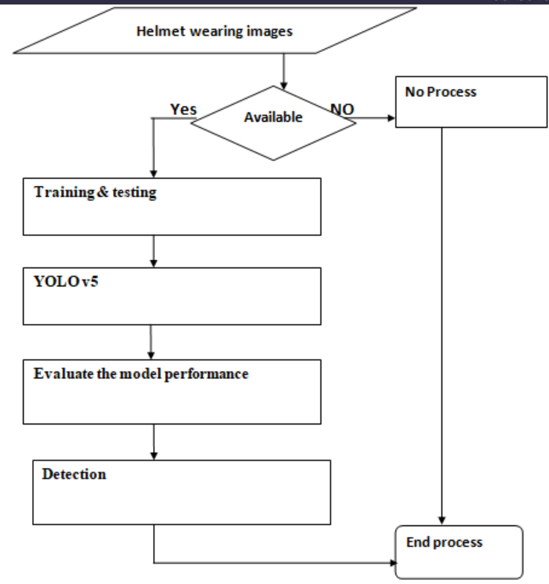

Fig.3: Dataflow diagram

Its delegate organizations include region-based convolution neural networks (R-CNN) and their improved counterparts, Fast R-CNN and Faster R-CNN. Using CNN highlights to directly estimate class probabilities and bounce box organization, another type of identifier views object recognition as a relapse problem. Their agent organizations are their redesigned networks, a single shot multibox indicator (SSD), and you only look once (YOLO). The aforementioned object finders continue to produce increasingly sophisticated results in significant datasets.

4. ALGORITHMS

We used the following algorithms in the aforementioned project.

YOLOV5:

Simply go for it. References to "You Only Look Once" are one of the most adaptable and well-known methods of article discovery. YOLO is recommended

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by Data Scientists and Machine Learning developers for any ongoing item identification activities. Calculations simply divide all pictures supplied into a SxS lattice structure. Any lattice can be used to find objects. Limit boxes for identified objects are now anticipated by these Grid cells. For each crate, we have five primary credits: x and y for facilitates, w and h for width and level of item, and a surety score for the probability that container contains object.

It is a one-of-a-kind convolutional neural network (CNN) that detects demos with unrivalled accuracy. This technique deals with the whole picture using a single mental connection, then breaks it into portions and predicts bobbing boxes and probabilities depending on each component. It is a groundbreaking convolutional neural network (CNN) that identifies objects with incredible accuracy all the time. This technique processes the whole visual with a single brain organisation, then separates it into portions and predicts jumping boxes and probabilities for each component.

In terms of exactness, it was determined that YOLOv5 surpasses YOLOv4 and YOLOv3. YOLOv3 discovered quicker than YOLOv4 and YOLOv5, however YOLOv4 and YOLOv5 discovered at the same rate. In this work, we looked for correlations between YOLOv3, YOLOv4, and YOLOv5l. There are several educational projects available on the internet to help you deepen your understanding of YOLOv5, which is very accurate and speedy. If you want to learn more about YOLOv5, here are some instructional exercises to try:

5. EXPERIMENTAL RESULTS

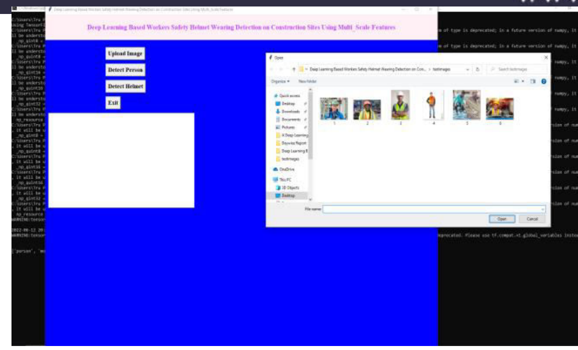

Fig.4: Home screen

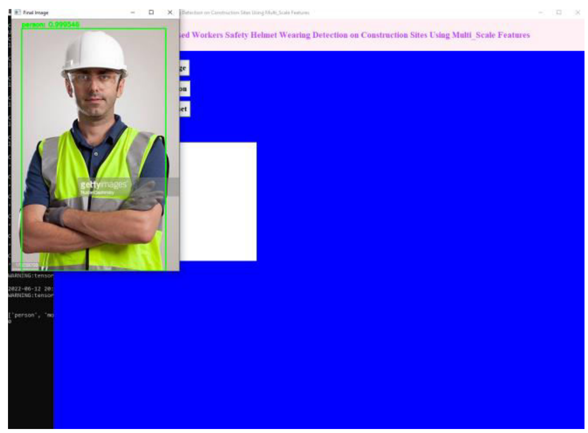

Fig.5: Output

Fig.6: Output

6. CONCLUSION

Not at all like regular cycles, for example, manual perception, the methodology utilized in this study needn't bother with faculty to keep their eyes locked on the screen consistently. They only need to concentrate on indicating the presence of experts without wearing safety caps, which significantly reduces the amount of time spent screening personnel and the number of required faculty. Simultaneously, since this strategy has a superior plan among obstructions for small and multi-scale things, it keeps on recognizing things far away from the underlying camera. As a result, our method makes use of a wider range of camera observation and requires fewer watch employees and cameras.

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