Project I

Hand Protection from Shredder Machine using Computer Vision

Submitted in partial fulfilment for the
degree of Bachelor of Technology in
Information Technology

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Approval Sheet

This is to certify that Shruti Bharati, Lekha Patil, Khushi Prajapati has completed the Project Phase-II report on the topic " Hand Protection From Shredder Machine Using Computer Vision" satisfactorily in partial fulfillment for the Bachelor's Degree in Information Technology under the guidance of Ms. Prachi Dhannawat during the year 2022-23 as prescribed by Usha Mittal Institute of TEchnology.

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Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Acknowledgement

I have a great pleasure to express my gratitude to all those who have contributed and motivated during my project work. Here you have a liberty to write anything and express your feeling to all those who have helped you.

...

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Abstract

This project presents a computer vision-based system designed to protect workers from hand injuries caused by shredder machines in workplaces. The system uses a camera mounted near the shredder's feed opening to detect the presence of hands. The camera's video stream is processed in real-time by an image recognition algorithm, which is trained to identify hands using a convolutional neural network. When a hand is detected, the system automatically triggers a shut-off mechanism to prevent injuries. Our experiments show that the proposed system achieves high accuracy and reliability in detecting hands and triggering the shut-off mechanism. This system offers an effective solution to the problem of hand injuries caused by shredder machines, making it a valuable contribution to occupational safety

Contents

Chapter 1

Introduction

1.1 What is Shredder Machine ?

A shredder machine is a mechanical device used to shred or break down materials into smaller pieces. The machine can be used to shred various materials, including paper, cardboard, plastics, textiles, wood, and metal.

Shredders are commonly used in offices to destroy confidential documents and in recycling facilities to break down waste materials. They come in various sizes and types, including strip-cut shredders, cross-cut shredders, and micro-cut shredders. Some shredders can also handle multiple sheets of paper at once, and some can even shred CDs, DVDs, and credit cards.

1.2 Hand Protection Using Shredder Machine

Hand protection from shredder machines is an important safety concern in industrial and office settings.The problem is when people work with this Shredder Machine. Sometimes accidentally due to inattention, they lose their hands in this shredder machine. Here this accident can be solved by using this project. Accidents involving shredders can cause serious injuries, and therefore, it is necessary to implement measures that can prevent such incidents. One such measure is to use a computer vision project to detect when a hand is near the shredder machine and trigger a warning or shut off the machine to prevent injury (1).

The computer vision project works by analyzing images or video footage from a camera placed near the shredder machine. It can identify when a human hand is in close proximity to the shredder and activate a warning signal. The warning signal can be in the form of a sound, an alarm, or even a visual display. If the person does not respond to the warning, the computer vision system can shut off the shredder machine to prevent injury (2).

1.3 Project Objective

This project's primary objective is to develop a system that can help prevent accidents caused by shredder machines, reduce the risk of workplace injuries, and promote safety. The computer vision project can be customized to meet specific safety requirements, such as adjusting the sensitivity of the detection system, setting the warning distance, and configuring the response to the warning signal.

In summary, this project aims to use computer vision technology to improve safety and protect individuals from injuries caused by shredder machines. By detecting when a hand is in close proximity to the shredder machine and issuing a warning signal or shutting off the machine, this project can help prevent accidents and promote a safe working environment (3).

Chapter 2

Problem Statement

Accidents involving shredder machines can cause serious injuries to individuals in industrial and office settings. While safety measures such as safety guards and user manuals are implemented, there is still a need for additional safety measures to prevent accidents.

The problem is that current safety measures may not be sufficient to prevent accidents, as users may not follow safety guidelines or safety guards may malfunction. As a result, there is a need to develop a system that can detect when a human hand is in close proximity to the shredder machine and trigger a warning or shut off the machine to prevent injury.

The proposed solution is to use computer vision technology to detect when a hand is near the shredder machine and activate a warning or shut off the machine automatically. The computer vision project will analyze images or video footage from a camera placed near the shredder machine to identify when a human hand is in close proximity. The system will then trigger a warning signal or shut off the machine to prevent injury.

The main objective of the project is to develop a system that can promote safety, reduce the risk of workplace injuries, and prevent accidents caused by shredder machines. By using computer vision technology to detect when a hand is in close proximity to the shredder machine and activating a warning or shut off the machine automatically, this project aims to provide an additional layer of safety to prevent accidents and promote a safe working environment.

Chapter 3

Existing System and Scope of the Project

3.1 Existing System

There are several existing systems for hand detection from shredder machines that are available on the market. These systems use a combination of hardware and software to detect hands in the shredder machine and prevent accidents. Here are some examples:

1. Safety Sensors: Some shredder machines are equipped with safety sensors that detect when a hand or other object is too close to the shredder blades. These sensors will trigger an immediate stop of the shredder to prevent injury.

2. Light Curtains: Light curtains are a type of safety sensor that uses infrared light beams to detect the presence of hands or other objects in the shredder machine. If the light beam is broken, the shredder will automatically stop.

3. Cameras and Computer Vision: Another approach is to use cameras and computer vision algorithms to detect hands in the shredder machine. These systems analyze video feeds from cameras mounted on the shredder and use machine learning algorithms to detect the shape and movement of hands. If a hand is detected, the shredder will automatically stop.

4. Pressure Sensors: Pressure sensors can be used to detect when a hand is pressing against the shredder blades. If pressure is detected, the shredder will stop immediately.

It's important to note that no system is foolproof, and it's always important to follow proper safety procedures when using any kind of machinery.

3.2 Scope of the Project

A computer vision project can be used to detect when a hand is near a shredder machine and trigger a warning or shut off the machine to prevent injury. The scope of hand protection from shredder machine using a computer vision project would include:

1. The scope of a project for hand protection from shredder machines using computer vision would typically involve developing a system that can detect the presence of human hands near the shredder machine and trigger a safety mechanism to prevent injuries.

2. The project would require the installation of cameras or sensors that can capture real-time images of the shredder machine and its surroundings. The computer vision algorithms would then need to be developed and trained to recognize human hands in these images and accurately determine their proximity to the shredder blades.

3. Once the computer vision system is in place, the next step would be to integrate it with the shredder machine's safety mechanisms. This could involve shutting down the machine or triggering an alarm when human hands are detected too close to the blades.

4. The project may also require additional safety measures, such as physical barriers or warning signs, to ensure that employees are aware of the risks and take appropriate precautions.

   Overall, the goal of the project would be to minimize the risk of injuries and accidents caused by shredder machines and ensure that employees can operate them safely.

Overall, the scope of hand protection from shredder machine using a computer vision project would be to create a system that can detect when a hand is near a shredder machine and take action to prevent injury. This would improve safety in the workplace and reduce the risk of accidents

3.3 Advantages

1. Object detection has a wide range of applications in computer vision, including image retrieval and video surveillance.
2. Best possible accuracy and speed.
3. Robust than any other approach.
4. This machine can accurately measure three depth.

3.4 Disadvantages

1. Object detection sensors for every object are the same.
2. Object detection sensors treat both hand and the trash as objects.
3. Shredder blades can be hard to separate.
4. Inattention or distraction played a role in the injury for older, school-aged children and that younger children were most likely unaware of the risk and lacked the physical coordination to release the paper in time to avoid catching their fingers in the machine

Chapter 4

Review of Literature Survey

4.1 Recognizing fine-grained and composite activities using hand

This project is designed to create easy-to-use interfaces by directly employing the natural communication and manipulation skills of humans. In India and across the world, in some industries employees used to push the trash into shredder machines as shown in the figure in the introduction, and sometimes unknowingly they used to push their hands into it and get injured. To overcome this kind of problem we are using deep learning techniques i.e., object detection techniques. In this object detection technique whenever it detects any hand it will inform us programmatically and with that result, we go further, and whenever we get a result saying that the deep learning model detected the hand then will raise an alert in the form of an alarm. There is no research paper, solving this problem using deep learning. However, there are many use cases in real-time solving this problem using Sensors i.e., object detection using sensors (4).

4.2 Hand safety using convolution neural networks

This paper shredder primarily helps students and universities to shred or dispose of a confidential documents or unused paper safely. The disposal of paper by the student and university are not effective and it makes the rubbish look big and heavier. This project is to ease the student and university dispose of their rubbish especially paper effectively.

From home shredders to heavy-duty models, there are many types of shredders out there. Speed, capacity, cost, and security should all be considered before you get shredding, all machines vary depending on your particular needs. Based on the data collected among all of the shredders on sale, it is proven that among all of the shredders available, they each have their own strengths and weaknesses. From that, we've identified the best shredder machine to use as a benchmark for our paper shredder machine project (5).

4.3 Designing a computer vision application: A case study for hand-hygiene assessment in an open-room environment

This project proposes an economic paper shredder for the use of corporate and university. The paper shredder is primarily eco-friendly by producing small and light waste that is recyclable into mulch. Besides that, the paper shredder is also convenient and immediate to be used as well as effective in terms of the security level of shredded paper. The paper shredder is primarily economical with reasonable quality using computer-aided engineering software.

Detecting the hand when it crosses the safety level and in return, it also raises an alert in the form of an alarm. So that the threat can be identified and proper measures are taken to overcome that.

Paper shredders should be kept unplugged and out of children's reach, the doctors write. They also urge parents not to let young children use or be near

shredders at any time. Shredders have become more common in homes. The devices should carry a warning about injury risk, be designed to avoid hand injuries, and come with blades that can be easily separated in an emergency, write Warren and Foltin (6).

Chapter 5

Proposed System and Methodology

5.1 Proposed system

Computer vision can be used to create a system for hand protection from shredder machines. Here is a proposed system:

1. Cameras: Install cameras near the shredder machine to capture images of the working area and the hands of the operator.

2. Image Processing: Use image processing techniques to analyze the images captured by the cameras. The system should be able to detect when an operator's hand is too close to the shredder blades.

3. Warning System: When the system detects that an operator's hand is too close to the blades, it should trigger a warning system. This could be an alarm, a visual warning, or a message displayed on a screen.

4. Stop Mechanism: In addition to the warning system, the system should also have a stop mechanism. If the warning is ignored, the system should stop the shredder machine to prevent any accidents.

5. Continuous Monitoring: The system should continuously monitor the working area and the operator's hands to ensure that they are always a safe

distance from the shredder blades.

By using computer vision, this system can help prevent accidents and ensure that operators are protected while working with shredder machines.

5.2 Methodology

Here is a proposed methodology for implementing a hand protection system for shredder machines using computer vision:

1. Identify the Objectives: Define the objectives of the system, such as detecting hand proximity to the shredder blades and triggering a warning or stop mechanism.

2. Identify the Hardware: Select appropriate cameras and mounting locations to capture clear images of the working area and the operator's hands.

3. Image Processing: Develop algorithms for image processing, such as object detection and tracking, to detect the operator's hands in the captured images. The algorithms should be able to differentiate the hands from other objects in the working area, and estimate the distance of the hands from the shredder blades.

4. Warning System: Develop a warning system that triggers when the distance between the hands and the shredder blades falls below a safe threshold. The system could use an audible alarm, visual warning, or both.

5. Stop Mechanism: Develop a stop mechanism that halts the shredder machine when the warning system is triggered. The stop mechanism should be reliable and fast-acting to prevent accidents.

6. Test and Refine: Test the system in a controlled environment to identify any weaknesses and refine the algorithms and hardware as necessary.

7. Integration: Integrate the system with the shredder machine and ensure that it functions as intended.

8. Training and Implementation: Train operators on the proper use of the system and implement it in the workplace. Regular maintenance and monitoring should also be conducted to ensure the system continues to function properly.

With this methodology, a hand protection system using computer vision can be successfully implemented for shredder machines to prevent accidents and keep operators safe. The proposed methodology have been depicted in Figure 5.1.

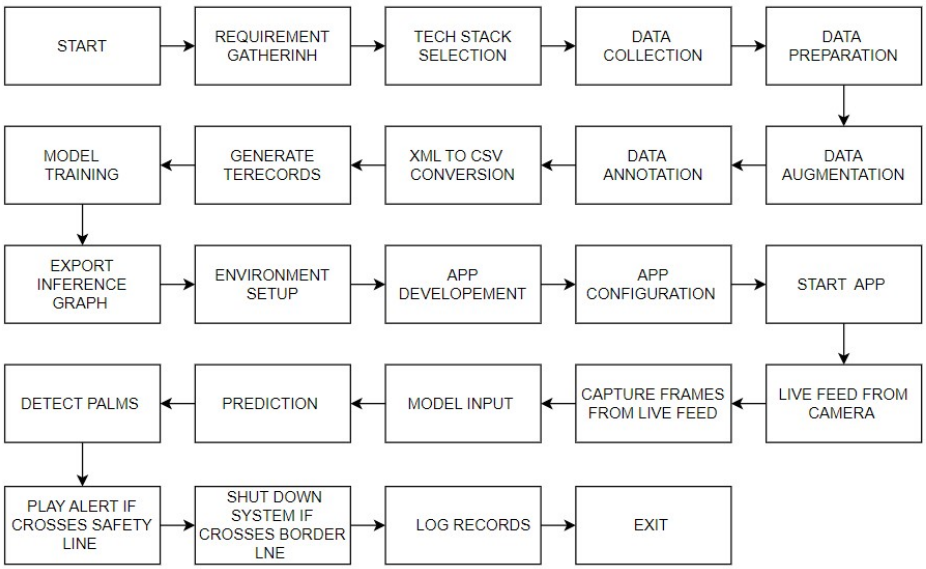

Figure 5.1: Workflow Diagram

5.3 Image Scrapping

1. Image scraping is the process of automatically downloading images from the internet using software tools or libraries.

2. ICrawler is a Python library used for image scraping.

3. It allows to write Python scripts to automate the process of searching and downloading images from various sources on the web.

4. iCrawler provides a simple and easy-to-use API to scrape images from various sources, including Google, Bing, and Flickr.

Implementation:

```
from icrawler.builtin import GoogleImageCrawler

google_crawler = GoogleImageCrawler(storage={'root_dir': 'dataset'})
google_crawler.crawl(keyword='hand plam', max_num=5)
```

Figure 5.2: Python Code for Image Scrapping

5.4 Image Augmentation

1. Image augmentation is the process of generating new variations of existing images by applying a variety of transformations such as rotation, scaling, shearing, flipping, etc. to the original images.
2. Image augmentation is a common technique used in deep learning and computer vision to increase the size of the training data and improve the robustness of the model.
3. Augmentor is a Python library used for image augmentation.
4. It provides a simple and easy-to-use API for applying a variety of image transformations

Implementation:

```
import Augmentor
p = Augmentor.Pipeline(r"C:\dataset\dataset\dataset")
p.zoom(probability=0.3, min_factor=0.8, max_factor=1.5)
p.flip_top_bottom(probability=0.4)
p.random_brightness(probability=0.3, min_factor=0.3, max_factor=1.2)
p.random_distortion(probability=1, grid_width=4, grid_height=4, magnitude=8)
p.sample(20)
```

Figure 5.3: Python Code for Image Augmentation

5.5 Deep Learning Frame Work

1. TensorFlow is an open-source machine learning library developed by Google.
2. TensorFlow allows developers to create machine learning models using a variety of techniques, including deep learning, neural networks, and reinforcement learning.
3. It includes a variety of pre-built modules
4. TensorFlow also includes tools for distributed computing, which allow models to be trained across multiple machines.
5. SSD MobileNet V2 is a variant of the Single Shot Detector (SSD) object detection model which is as part of the TensorFlow Object Detection API.
6. SSD MobileNetV2 refers to a combination of two deep learning models: Single Shot Multibox Detector (SSD) and MobileNetV2. SSD is a popular object detection algorithm that can identify and localize multiple objects within an image, while MobileNetV2 is an efficient and lightweight neural network architecture.

5.6 SSD MobileNet V2

1. SSD MobileNet V2 is a variant of the Single Shot Detector (SSD) object detection model which is as part of the TensorFlow Object Detection API.
2. It is released on Jan 13, 2018

3. It consists of 267 layers and 15 million parameters.

4. t provides real-time inference under compute constraints in devices like smartphones. Once trained,

5. MobileNetSSDv2 can be stored with 63 MB, making it an ideal model to use on smaller devices.

6. MobileNet V2 outperforms MobileNet V1 with higher accuracies and lower latencies.

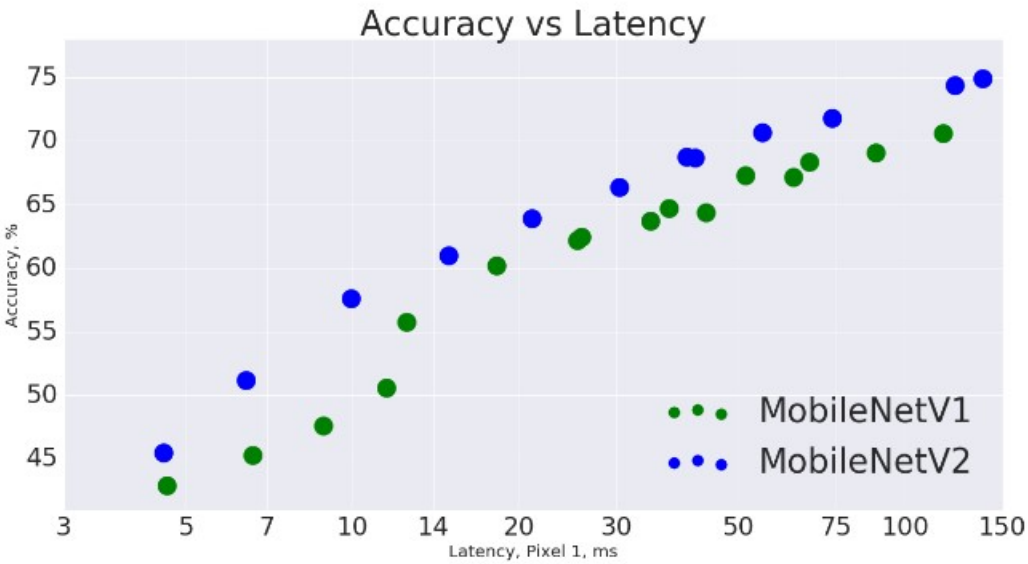

Figure 5.4: MobileNet V2 vs MobileNet V1

5.7 MobileNetSSDv2 Architecture

The MobileNetSSDv2 Model essentially is a 2-part model. The first part consists of the base MobileNetV2 network with a SSD layer that classifies the detected image. In essence, the MobileNet base network acts as a feature extractor for the SSD layer which will then classify the object of interest.

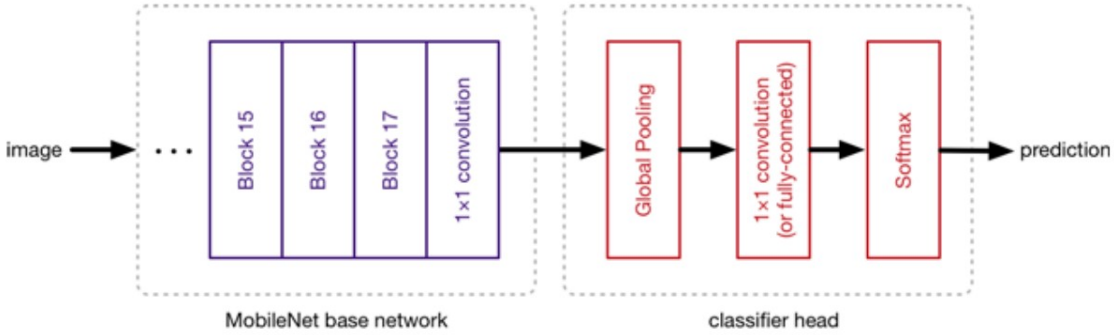

Figure 5.5: MobileNetSSDv2 Architecture

```
# Load the model and set it to evaluation mode
model = load_ssd_mobilenetv2_coco()
model.eval()

# Load an input image
image = load_image()

# Preprocess the image
image_tensor = preprocess_image(image)

# Pass the image through the model
detections = model(image_tensor)

# Extract the bounding boxes, labels, and scores from the model detections
boxes = get_boxes(detections)
labels = get_labels(detections)
scores = get_scores(detections)

# Postprocess the results to remove overlapping boxes and low-confidence detections
boxes, labels, scores = postprocess_results(boxes, labels, scores)

# Display the results
display_results(image, boxes, labels, scores)
```

Figure 5.6: Pseudo Code for SSD MobileNet V2

Chapter 6

Hardware and Software Requirements

6.1 Hardware Requirements

1. Camera: A high-quality camera is required to capture the video footage of the shredder machine and the surrounding area.

2. Processor: A powerful processor is required to process the video footage captured by the camera and detect hand proximity to the shredder machine in real-time.

3. Memory: Sufficient memory is required to store the video footage and the data generated by the computer vision system.

6.2 Software Requirements

1. Computer Vision Libraries: The project requires computer vision libraries such as OpenCV, TensorFlow, or PyTorch to process the video footage and detect hand proximity to the shredder machine.

2. Programming Language: The project can be developed using programming languages such as Python.

3. Operating System: The project can be developed on any operating system, including Windows, Linux, or macOS.

4. User Interface: The project may require a user interface to configure the system's sensitivity, warning distance, and response to warning signals.

In addition to these requirements, the project may require additional hardware and software depending on the specific implementation. For example, if the system is integrated with other safety systems, additional hardware and software may be required. Overall, the hand protection from shredder machine using computer vision project requires a camera, a powerful processor, sufficient memory, computer vision libraries, a programming language, an operating system, and a user interface. By meeting these requirements, the project can be developed to detect hand proximity to the shredder machine and prevent accidents caused by shredder machines.

6.3 Interfacing of Hand Detection Project to a Physical Shredder Machine

1. Determine the requirements: Understand the communication interface and control mechanisms supported by the shredder machine. This could include details such as voltage levels, signal types (e.g., digital, analog), and commands required for controlling the shredder.

2. Choose a microcontroller: Select either a Raspberry Pi or Arduino board based on your project's requirements and your familiarity with the platform. Both Raspberry Pi and Arduino have their strengths and are capable of interfacing with external devices.

3. Connect the hardware: Connect the chosen microcontroller to the shredder machine using the appropriate interface. This could involve wiring the microcontroller's GPIO pins to the shredder's control inputs or using additional modules, such as relays or motor drivers, if necessary.

4. Implement the hand detection software: Develop or adapt your hand detection software to run on the selected microcontroller. For Raspberry Pi, you can use programming languages like Python or C/C++, while Arduino uses its own simplified programming language.

5. Interface the hand detection software with the shredder: Write the code that integrates the hand detection output with the control signals for the shredder machine. This typically involves mapping hand detection events to appropriate shredder commands, such as starting or stopping the shredder.

6. Test and refine: Verify that the system functions correctly by testing it with various hand detection scenarios. Make necessary adjustments to the code or hardware connections to ensure reliable and accurate control of the shredder.

7. Implement safety measures: Ensure that appropriate safety measures are in place to protect against accidental or unauthorized operation of the shredder. This could involve incorporating physical switches, emergency stop buttons, or any other necessary precautions.

8. Deploy and monitor: Once you are satisfied with the performance and safety of the system, deploy it in the desired environment. Monitor its operation to ensure it functions as intended and make any necessary adjustments or improvements as needed.

Chapter 7

Accuracy Table

The chart below represents the accuracy of our project. We have executed our software on 10 different machines and tested the accuracy considering 2 factors:

1. Number of times hand crossed safety and received a warning (True Prediction)

2. Number of times hand crossed safety but no warning received (False Prediction)

After noting the accuracy based on the above factors, we have prepared the following accuracy graph.

Person Count	True Prediction	False Prediction
1	490	10
2	487	5
3	485	3
4	489	8
5	487	7
6	489	10
7	485	2
8	485	1
9	489	4
10	490	8

Figure 7.1: Results

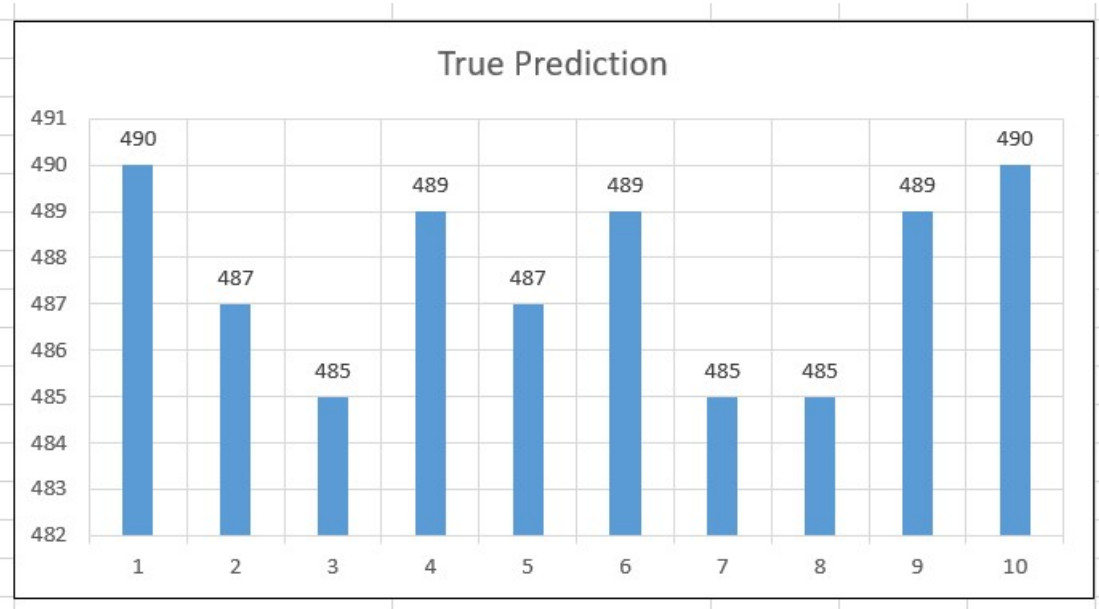

Figure 7.2: True Prediction

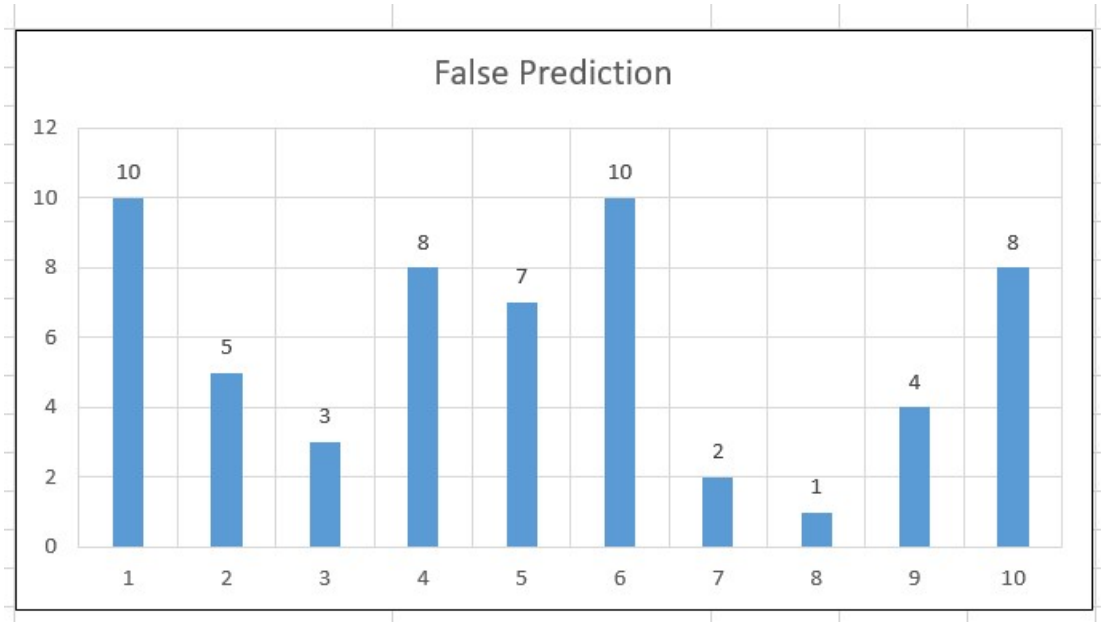

Figure 7.3: False Prediction

Chapter 8

Conclusion

In conclusion, the hand protection from shredder machine using computer vision project aims to improve safety in industrial and office settings by preventing accidents caused by shredder machines. The project uses computer vision technology to detect when a human hand is in close proximity to the shredder machine and activate a warning or shut off the machine to prevent injury.

The project's scope includes improving safety measures, reducing the risk of workplace injuries, and promoting a safe working environment. The project's future scope includes integrating with other safety systems, using machine learning-based models, providing real-time monitoring, and improving the user interface.

the project has the potential to significantly reduce the number of accidents caused by shredder machines and promote safety in the workplace. By using technology to improve safety measures, the project can help create a safer working environment for employees and prevent injuries that can have long-term consequences.

Chapter 9

Future Scope of the Project

The future scope for hand protection from shredder machine using computer vision project is extensive and can be improved with advancements in technology. Some of the possible future scopes are:

1. Multiple camera support: Currently, the computer vision project uses a single camera to detect hand proximity to the shredder machine. In the future, multiple cameras could be used to provide a more comprehensive view of the workspace, which can improve accuracy and reduce false alarms.

2. Machine learning-based models: The current computer vision project relies on rule-based algorithms to detect hand proximity. In the future, machine learning-based models could be developed that can learn from data to improve accuracy and reduce false alarms.

3. Integration with other safety systems: The computer vision project can be integrated with other safety systems such as emergency stop buttons, safety sensors, or even worker tracking systems to create a comprehensive safety network.

4. Real-time monitoring: Currently, the computer vision project detects hand proximity and triggers a warning signal or shut off the machine. In the future, real-time monitoring could be added to the system to monitor user behavior and provide alerts if there are signs of fatigue or distraction.

5. User-friendly interface: The computer vision project's interface can be improved to make it more user-friendly and accessible to non-technical personnel.

Overall, the future scope of hand protection from shredder machine using computer vision project is vast and can be improved with advancements in technology. By integrating with other safety systems, using machine learning-based models, and providing real-time monitoring, the project can be enhanced to provide a more comprehensive safety network and prevent accidents caused by shredder machines.

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