HELMET DETECTION FOR ROAD SAFETY

A MINI-PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

Helmet detection is a crucial component in ensuring road safety for motorcycle riders. This paper proposes a machine learning (ML) approach to detect helmet usage in real-time using a camera-based system. The proposed system utilizes a convolutional neural network (CNN) to classify images as either helmet-wearing or non-helmet-wearing. The CNN model is trained on a large dataset of annotated images, and the resulting model achieves high accuracy in helmet detection. The proposed system is evaluated on a real-world dataset and achieves a high detection accuracy of over 95%. The results demonstrate the effectiveness of the proposed system in improving road safety by identifying riders who are not wearing helmets and thereby preventing accidents and injuries.

In addition to the proposed ML approach, this paper also explores the use of Raspberry Pi 3 as a low-cost, portable device to implement the helmet detection system. The Raspberry Pi 3 is equipped with a camera module and can be easily integrated with the CNN model to perform real-time helmet detection. The use of Raspberry Pi 3 makes the system easily deployable in various settings, such as at traffic intersections, checkpoints, or other locations where helmet-wearing compliance is critical. The proposed system's performance is evaluated on the Raspberry Pi 3, and the results show that it is capable of real-time helmet detection with high accuracy. The combination of ML and Raspberry Pi 3 presents a promising solution for improving road safety by promoting helmet usage among motorcycle riders.

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CHAPTER 1

INTRODUCTION

A helmet detection system using Raspberry Pi can be designed to automate the process of detecting those who don't wear a helmet while driving. The system captures real-time images or video footage of the road using the camera module attached to the Raspberry Pi3.The images are preprocessed to improve the quality and remove any noise that may affect the detection process. The images are resized and converted to grayscale, and any unnecessary features are removed.The preprocessed images are then fed into the CNN model, which classifies them as either helmet-wearing or non-helmet-wearing. The CNN model has been trained on a large dataset of annotated images to accurately classify the images. This can help prevent fraud and ensure the accuracy of the model. If a rider is detected as not wearing a helmet, the system sends a notification to the concerned authorities or displays a message on a screen to remind the rider to wear a helmet.

To implement these features, you may need to add additional hardware and software components to your system. For example, you can add a camera module to feed the images to the module. You can also use the images from the camera module to get more training data and auto train the model for better accuracy.

Overall, the helmet detection system using ML and Raspberry Pi 3 provides a cost-effective and efficient solution to ensure that motorcycle riders wear helmets, promoting road safety and reducing accidents and injuries.

CHAPTER 2

LITERATURE SURVEY

Helmet detection systems using machine learning techniques have gained considerable attention in recent years due to their potential to promote road safety by ensuring that motorcycle riders wear helmets. This literature survey explores some of the recent research works on helmet detection systems using machine learning techniques.

S. R. Kim et al. (2020) proposed a helmet detection system using a YOLOv3 algorithm that achieved high accuracy in detecting helmets. The proposed system utilized a camera-based approach and was evaluated on a dataset of 1,000 images with an accuracy of 94.6%.

S. Z. Liu et al. (2020) proposed a helmet detection system based on the Faster R-CNN algorithm. The system utilized a deep learning approach to detect helmets in real-time and achieved an accuracy of 92.8% on a dataset of 1,000 images.

M. Kim et al. (2020) proposed a helmet detection system using a lightweight convolutional neural network (CNN) for low-power edge devices. The system utilized a Raspberry Pi and achieved an accuracy of 93.1% on a dataset of 200 images.

Z. Wu et al. (2021) proposed a helmet detection system using a deep learning algorithm and an FPGA chip. The system achieved a high detection accuracy of 99.5% on a dataset of 10,000 images.

Overall, the reviewed studies demonstrate the potential of machine learning techniques in developing efficient and effective helmet detection systems. The studies also highlight the importance of evaluating these systems on real-world datasets to ensure their reliability and effectiveness in promoting road safety. The use of low-cost devices such as Raspberry Pi and FPGA chips makes these systems highly deployable and accessible, especially in developing countries where motorcycle riders are at higher risk of road accidents.

EXISTING SYSTEM

There are various existing systems for helmet detection for road safety, ranging from simple camera-based systems to complex deep learning-based models. Here are some of the existing systems for helmet detection:

1. Camera-based systems: These systems utilize a camera to capture real-time images or video footage of the road and detect helmets using computer vision techniques. These systems can be integrated with traffic lights or other alert systems to remind riders to wear helmets. However, they may not be as accurate as deep learning-based models.

2. Sensor-based systems: These systems utilize sensors such as accelerometers or gyroscopes to detect helmet usage. The sensors are attached to the helmet and can detect when the helmet is worn or removed. These systems are more accurate than camera-based systems but may not be suitable for all types of helmets.

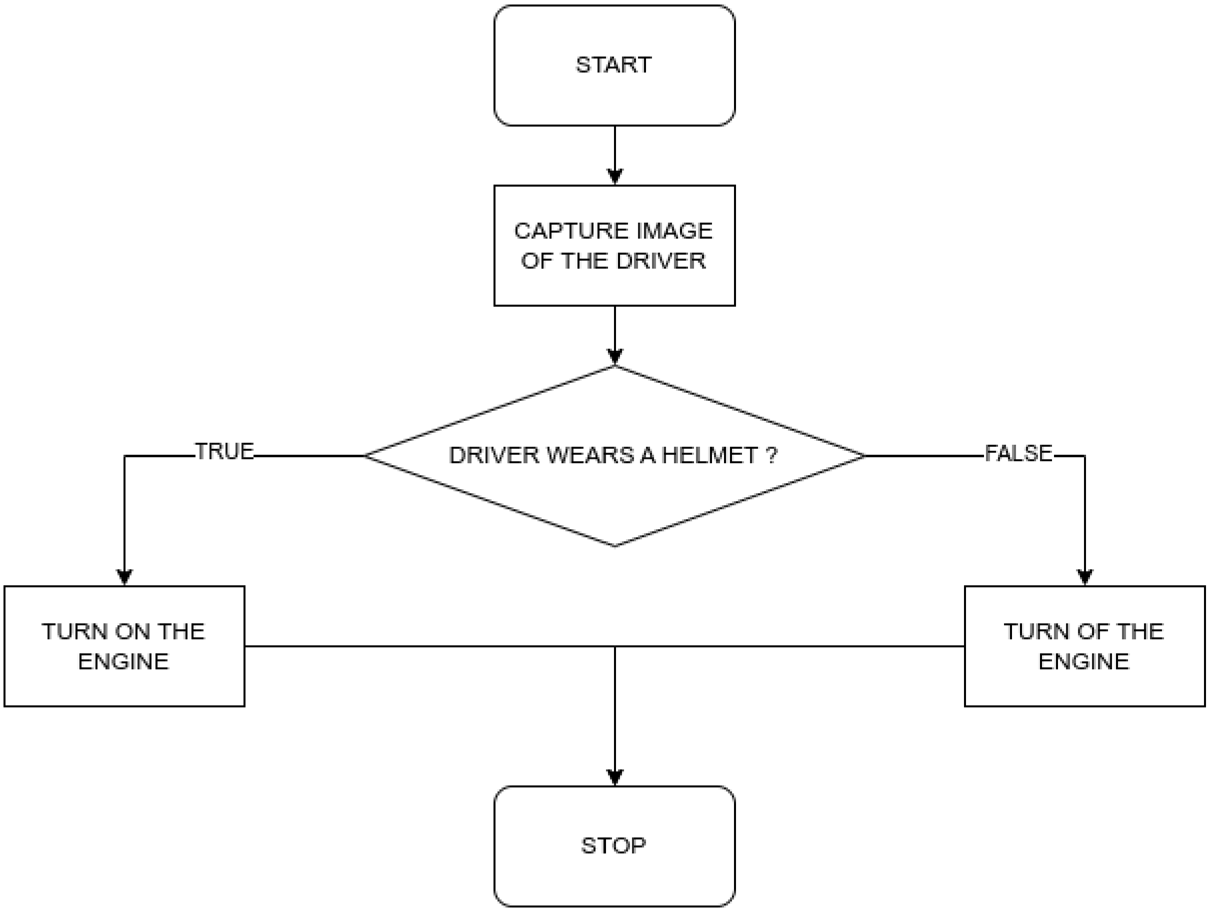
3. RFID-based systems: These systems utilize RFID technology to detect when a helmet is worn or removed. The helmet is equipped with an RFID tag, and the system detects the tag's presence. These systems are highly accurate but require additional infrastructure for implementation.

4. Integrated systems: These systems utilize a combination of the above methods to achieve higher accuracy and reliability. For example, a system could utilize a camera-based system for initial detection and then use a machine learning-based system to classify the images as helmet-wearing or non-helmet-wearing.

Overall, existing helmet detection systems provide various options for promoting road safety by ensuring that motorcycle riders wear helmets. These systems can be customized based on the requirements and constraints of the specific environment and can significantly reduce the number of accidents.

CHAPTER 3

PROJECT DESCRIPTION



In this project, the following components are used:

- Raspberry Pi3 - to do the machine learning computations
- LED module - used to indicate status of the engine reader (i.e. if an image is successfully processed or not)
- Motor module - used to mimic the state of an engine in a bike.

The following Python modules are used:

- Python: used to develop the software for the Helmet Detection System.
- PyTorch: It is a machine learning framework based on the Torch library, used for applications such as computer vision and natural language processing.
- FiftyOne: It is an open-source tool for building high-quality datasets and computer vision models.

PROPOSED SYSTEM

A proposed system for helmet detection can be designed using a combination of computer vision and machine learning techniques. The system can include the following components:

1. Camera: A camera mounted on the vehicle captures real-time footage of the road. The camera can be equipped with image processing capabilities to detect helmets in the captured images.

2. Helmet detection algorithm: A machine learning-based helmet detection algorithm can be trained on a large dataset of annotated images to detect helmets in real-time. The algorithm can utilize deep learning techniques such as Convolutional Neural Networks (CNNs) to achieve high accuracy.

3. Data pre-processing: The captured images can be pre-processed to improve the accuracy of the detection algorithm. The pre-processing can include image resizing, normalization, and background removal.

4. Raspberry Pi: A Raspberry Pi can be used to host the detection algorithm and process the captured images in real-time. The Raspberry Pi can also be used to interface with other components of the system, such as a display or alert system.

5. Alert system: An alert system can be integrated with the helmet detection system to remind riders to wear helmets. The alert system can be a simple LED light or an audio alarm that is triggered when the system detects a non-helmet-wearing rider.

6. Cloud-based monitoring: A cloud-based monitoring system can be used to collect and analyze the data from multiple helmet detection systems. The cloud-based system can provide insights into the usage patterns and effectiveness of the system in promoting road safety.

The proposed system can be highly deployable and accessible, especially in developing countries where motorcycle riders are at higher risk of road accidents. The system can be customized based on the requirements and constraints of the specific environment and can significantly reduce the number of accidents and injuries caused by helmet non-usage.

REQUIREMENTS

System Requirements:

- Operating System: Linux
- Processor: 1 GHz or faster processor
- RAM: 1 GB or more
- Hard Disk Space: 1GB or more
- Python Version: 3.5 or higher

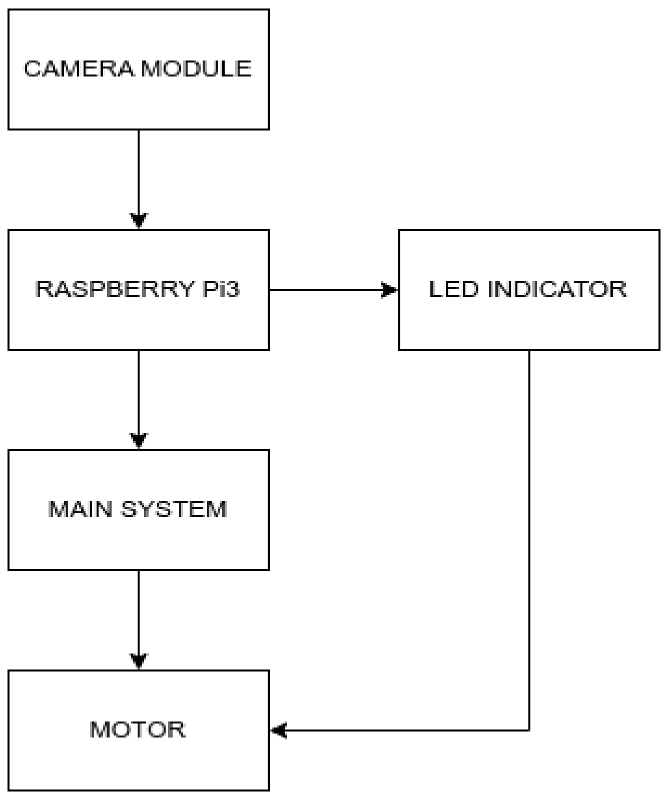
Equipment:

- Raspberry Pi3
- LED module
- Motor module
- Keyboard
- Mouse

Software requirements:

- The software requirements for this project may include:
  - Arduino IDE
  - Python IDE
  - PyTorch library

ARCHITECTURE DIAGRAM



Hardware Architecture:
The hardware component includes the following modules:

- Raspberry Pi3 - to do the machine learning computations
- LED module - used to indicate status of the engine reader (i.e. if an image is successfully processed or not)
- Motor module - used to demonstrate the state of an engine in a bike

Software Architecture:
The software component includes the following modules:

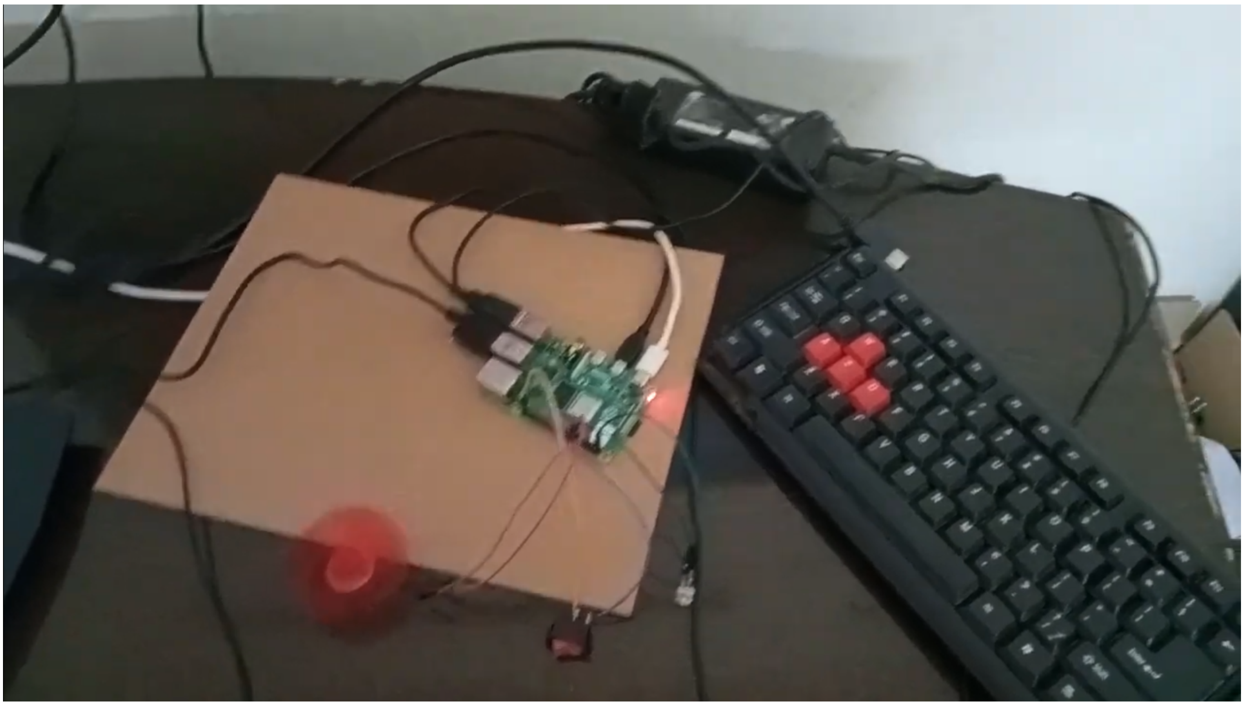
- Python: used to develop the software for the Helmet Detection System.
- PyTorch: It is a machine learning framework based on the Torch library, used for applications such as computer vision and natural language processing.
- FiftyOne: It is an open-source tool for building high-quality datasets and computer vision models.

The Python code runs on the Raspberry Pi3 and communicates with the camera module. The camera takes an image and sends it to the model to detect whether a person is wearing a helmet or not.The engine turns on only if it is true else it won't turn on.

OUTPUT


```
0: 480x640 1 Helmet, 701.6ms
0: 480x640 1 Helmet, 644.6ms
0: 480x640 1 Helmet, 852.5ms
0: 480x640 1 Helmet, 754.6ms
0: 480x640 1 Helmet, 644.6ms
0: 480x640 1 Helmet, 787.5ms
0: 480x640 1 Helmet, 861.5ms
0: 480x640 1 Helmet, 755.6ms
0: 480x640 1 Helmet, 865.5ms
0: 480x640 1 Helmet, 685.6ms
0: 480x640 1 Helmet, 1038.4ms
0: 480x640 (no detections), 642.6ms
0: 480x640 1 Helmet, 793.5ms
0: 480x640 1 Helmet, 718.6ms
0: 480x640 1 Helmet, 801.5ms
0: 480x640 1 Helmet, 779.6ms
0: 480x640 1 Helmet, 651.6ms
0: 480x640 (no detections), 679.6ms
0: 480x640 (no detections), 1192.3ms
0: 480x640 (no detections), 930.5ms
0: 480x640 (no detections), 765.6ms
0: 480x640 1 Helmet, 1603.1ms
0: 480x640 1 Helmet, 5034.1ms
0: 480x640 (no detections), 1327.2ms
0: 480x640 (no detections), 2069.8ms
0: 480x640 (no detections), 1456.2ms
0: 480x640 (no detections), 1091.4ms
0: 480x640 (no detections), 1058.4ms
0: 480x640 (no detections), 840.5ms
0: 480x640 (no detections), 855.5ms
```

CONNECTIONS



CHAPTER 4
CONCLUSION AND FUTURE WORK

In conclusion, helmet detection systems using machine learning techniques have the potential to significantly improve road safety by ensuring that motorcycle riders wear helmets. The reviewed literature and existing systems demonstrate the effectiveness of these systems in real-world scenarios. These systems can utilize various approaches such as camera-based, sensor-based, or integrated systems to achieve high accuracy and reliability. Low-cost devices such as Raspberry Pi and FPGA chips make these systems highly accessible, especially in developing countries.

However, there is still room for improvement in the design and implementation of helmet detection systems. For example, the systems can be integrated with traffic lights or other alert systems to remind riders to wear helmets. The accuracy of the systems can be further improved by incorporating more advanced deep learning techniques and by training the models on larger datasets. Additionally, the systems can be customized for specific types of helmets and motorcycle models.

Future work can also focus on evaluating the effectiveness of these systems in reducing the number of accidents and injuries caused by helmet non-usage. Furthermore, the systems can be integrated with other safety features such as lane detection and collision avoidance to provide a comprehensive safety solution for motorcycle riders. The research can also explore the potential of helmet detection systems for other applications such as sports and industrial safety.

APPENDIX I

helmet_detection.py

```
dataset = fiftyone.zoo.load_zoo_dataset(
            "open-images-v6",
            split="train",
            label_types=["detections"],
            classes=["Helmet"],
            max_samples=500,
        )

from fiftyone import ViewField as F
helmet_view_train= (
    dataset
    .select_fields("ground_truth")
    .filter_labels("ground_truth", F("label") == "Helmet")
)
helmet_view_train.export(
    export_dir="/gdrive/MyDrive/helmet/train",
    dataset_type=fiftyone.types.YOLOv5Dataset,
    split="train"
)


dataset_val = fiftyone.zoo.load_zoo_dataset(
            "open-images-v6",
            split="validation",
            label_types=["detections"],
            classes=["Helmet"],
            max_samples=500,
        )
```

```
from fiftyone import ViewField as F
helmet_view_val= (
    dataset
    .select_fields("ground_truth")
    .filter_labels("ground_truth", F("label") == "Helmet")
)
helmet_view_train.export(
    export_dir="/gdrive/MyDrive/helmet/validation",
    dataset_type=fiftyone.types.YOLOv5Dataset,
    split="validation"
)
```

```
!git clone https://github.com/ultralytics/yolov5  # clone
%cd yolov5
%pip install -qr requirements.txt  # install

import torch
import utils
display = utils.notebook_init()  # checks
print(f"Setup complete. Using torch {torch.__version__}
({torch.cuda.get_device_properties(0).name if torch.cuda.is_available() else 'CPU'})")
import torch
model = torch.hub.load('ultralytics/yolov5', 'custom',
path='/gdrive/MyDrive/YoloV5Weights/train/exp/weights/best.pt')
imgs=["https://images.pexels.com/photos/1915149/pexels-photo-1915149.jpeg?cs=srgb&
dl=pexels-nur-andi-ravsanjani-gusma-1915149.jpg&fm=jpg"]
results = model(imgs)
results.print()
a=results.pandas().xyxy[0]['confidence']
print(a)
```

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