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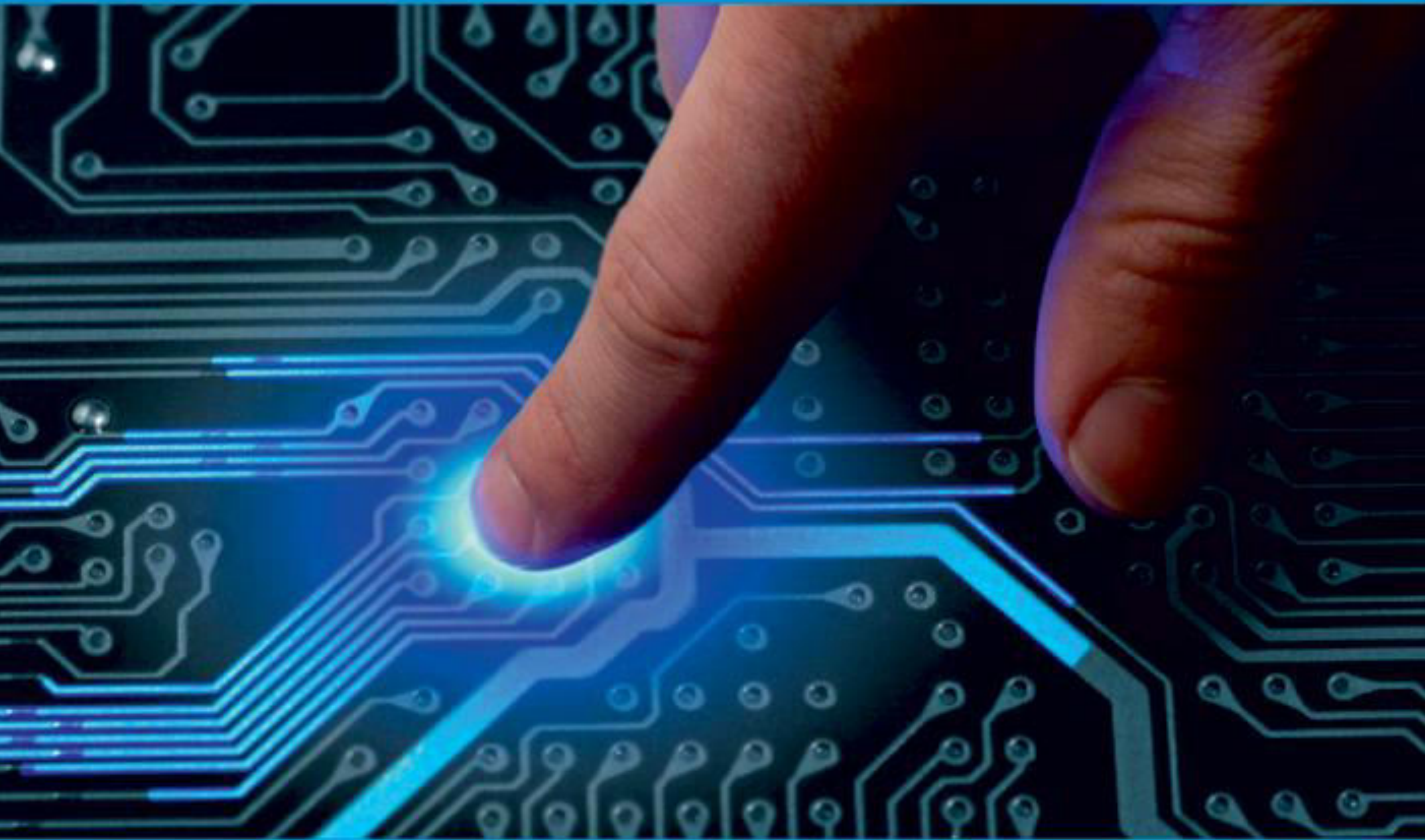

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Helmet Detection and Safety Measures using Ml and IoT

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ABSTRACT: "Helmet detection and safety measures using ML and IoT" presents a comprehensive study on the integration of Machine Learning (ML) techniques and Internet of Things (IoT) technology to enhance helmet detection and safety measures. The primary objective of this project is to develop a robust system capable of detecting helmet usage in real time scenarios, particularly focusingon enhancing safety in environments such as traffic and bike riding. This systememploys a Machine Learning algorithm for helmet detection utilizing image processing techniques, trained on a dataset of images containing individuals with and without helmets. Furthermore, IoT sensors are utilized to gather real time data regarding helmet usage, including instances of non-compliance. This data is processed and analyzed in real-time to trigger alerts and notifications in cases of non compliance, thereby promoting safety protocols.

I. INTRODUCTION

In recent years, the intersection of Machine Learning (ML) and Internet of Things (IoT) technologies has opened up new avenues for enhancing safety measures across various domains. One critical area where this convergence holds significant promise is in the realm of helmet detection and safety enforcement. Helmets serve as a primary protective gear in numerous settings, including construction sites, industrial facilities, and on-road transportation. Ensuring proper helmet usage not only mitigates the risk of head injuries but also promotes a culture of safety compliance.

This project aims to leverage ML algorithms and IoT devices to develop an intelligent system for real time helmet detection and safety measures enforcement. By harnessing the power of computer vision and sensor data, the system can accurately identify instances of helmet non-compliance and trigger appropriate interventions to mitigate risks.

The introduction section of this report provides an overview of the problem statement, highlighting the importance of helmet usage in preventing head injuries and fatalities. It outlines the objectives of the project, which include designing an ML-based helmet detection model, integrating IoT sensors for data acquisition, and developing a user-friendly interface for monitoring and managing safety measures.

Furthermore, the introduction discusses the significance of combining ML and IoT technologies in addressing safety challenges, emphasizing their potential to revolutionize safety protocols and reduce accidents in various environments. It also provides a brief outline of the subsequent sections of the report, including methodology, system design, implementation details, experimental evaluation, and conclusions.

Overall, this project sets out to demonstrate the feasibility and effectiveness of employing ML and IoT in enhancing helmet detection and safety measures, ultimately contributing to the broader goal of promoting safety awareness and preventing accidents in diverse settings.

II. LITERATURE SURVEY

These papers explore various applications of machine learning (ML) and Internet of Things (IoT) technologies to enhance safety, particularly focusing on helmet detection for motorcyclists and smart helmets for industrial and construction settings. The "IoT based Smart Helmet for Ensuring Safety in Industries" integrates multiple sensors, including air quality, temperature, and humidity, using Wi-Fi for data transmission and ThingSpeak for analysis, providing real-time environmental monitoring and emergency alerts. Similarly, "Internet of Things (IoT) based Smart Helmet for Construction" enhances construction site safety with GPS tracking, smoke detection, and IoTconnectivity.

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Several studies focus on helmet detection for road safety. "Helmet Detection using ML & IoT" and "Helmet Detection on Motorcyclists Using Deep Learning" employ YOLO (You Only Look Once) models, a type ofConvolutional Neural Network (CNN), for real-time detection. These systems identify helmetless riders in CCTV footage and evaluate their effectiveness through metrics like accuracy and mean Average Precision (mAP). "Helmet Detection and Number Plate Recognition" extends this concept by integrating Optical Character Recognition (OCR) to capture vehicle license plates, enhancing enforcement capabilities.

"An Empirical Study of Face Recognition under Variations" explores the robustness of face recognition systems under various conditions, such as different lighting and angles, using both traditional methods and deep learning approaches. The findings emphasize the importance of diverse datasets and advanced methods to improve accuracy.

Collectively, these works demonstrate the potential of ML and IoT in improving safety through automated monitoring and data analysis. They highlight the challenges and advancements in real-time detection systems, the importance of robust data transmission and processing, and the practical applications of these technologies in enforcing safety regulations and preventing accidents..

III. METHODOLOGY

Data Collection and Preparation:

Dataset: A comprehensive dataset of images containing motorcyclists with and without helmets is gathered. I utilized publicly available datasets from Kaggle, a popular platform for data science and machine learning projects. These datasets included a variety of images featuring motorcyclists with and without helmets, captured in diverse environments and conditions. Kaggle datasets are known for their quality and comprehensiveness, providing a solid foundation for training robust machine learning models.The below is a picture of dataset from Kaggle.

Fig 3.1 Kaggle Dataset

In addition to Kaggle datasets, I collected my own data to ensure that the model is well tailored to specific use cases and environments. This involved capturing images and video footage from various locations, with my friends,classmates. The custom datasets included both positive samples (riders wearing helmets) and negative samples (riders without helmets), taken under different lighting and weather conditions to enhance model robustness.The below is the picture of my own dataset.

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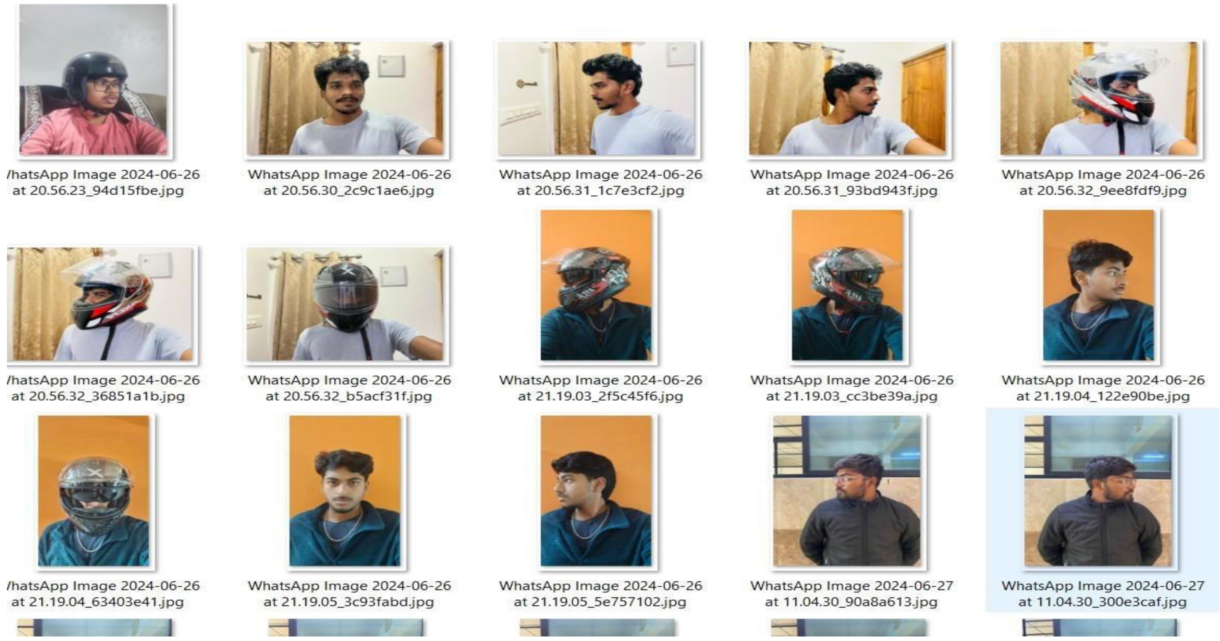

Fig 3.2 Custom Dataset

Labeling: This is a process of labeling the images or dataset, for the model to learn. Basically we have a tool to draw boxes on the images , to label them accordingly like with helmet or without helmet. Labels should be consistent and specific. In the case of helmet detection, the labels might be 'Helmet' for riders wearing helmets and 'No Helmet' for riders without helmets. The process of labeling the images is called as Annotating. Once an image is fully annotated, save the annotations. The tool usually saves the annotations in formats like XML (Pascal VOC), JSON, or plain text (YOLO format).The below image is example of labeling image.

Fig 3.3 Example Labeling

Model Training:

YOLOv5 Model: The YOLOv5 (You Only Look Once) model is selected for its capability to perform real-time object detection. This is how the yolov5 model is trained.The input image is resized to a fixed size, typically 640x640 pixels. This resizing helps in standardizing the input for the model.The image is normalized, usually by scaling the pixel

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values to a range of 0 to 1. This normalization helps in faster and more stable training.
YOLOv5's detection head predicts bounding boxes, objectness scores, and class probabilities. It uses multiple anchor boxes of different sizes to detect objects ofvarious scales.

The head consists of several attributes that process the feature maps and outputa tensor of dimensions which are:

- P(c):This is the probability of a class, which means if there is a object inside the image or not. It take only two values either 0 or 1.
- B(x):This is the x co-ordinate of the center point of the bounding box.
- B(y):This is the y co-ordinate of the center point of the bounding box.
- B(w):This is the width of the bounding box.
- B(h):This is the height of the bounding box.
- C1:This represents the classes, like if C1 represents "with helmet", and if there is a rider wearing helmet in the image then its value is 1 or else it is 0.
- C2:This represents the classes, like if C2 represents without helmet , and if there is a rider without helmet then its value will be 1 or else 0.

And there can be n number classes according to the necessity.
Now for each and every image , all these attributes will contain a unique value, this value is stored in a text file with respect to the image. After all the images get a unique value , it is accessed by the model and the model uses all the unique values and learns what is a helmet and what is not a helmet. This is how the model is trained.

IV. CONCLUSIONS

The "Helmet Detection using ML and IoT" project successfully developed a system to enhance road safety by automating the detection of helmet usage among motorcyclists. Leveraging the YOLOv5 deep learning model for real-time detection and integrating various IoT components like the ESP32-CAM, Arduino Uno, relay, DC motor, piezo buzzer, and a 16x2 LCD display, the project achieved reliable and accurate identification of helmet status. The system demonstrated the ability to take automated actions such as displaying messages, sounding a buzzer, and controlling a relay based on detection results. Despite challenges in model training, hardware integration, and real-time processing, the project met its objectives and showcased the potential of combining machine learning with IoT to address real-world safety issues. Future work will focus on improving detection accuracy, scalability, and adding features like automatic number plate recognition. This project illustrates the importance of interdisciplinary approaches in creating innovative solutions for smart cities and automated safety enforcement systems, contributing significantly to reducing motorcycle-related injuries and fatalities.

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