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Detection of Mobile Phone Usage among Motorcycle Riders: A Computer Vision Approach

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Abstract. This study examines the prevalence of mobile phone use among motorcycle riders at signalized intersections in Marrakech, utilizing advanced computer vision techniques. Employing the YOLOv8 object detection model and the DeepSORT tracking algorithm, our approach effectively detects and tracks mobile phone usage in real-time traffic scenarios. By analyzing data from strategically placed cameras at high-traffic intersections, the research identifies patterns in mobile phone usage among motorcyclists and evaluates the impact on traffic safety. The findings highlight significant times of day for phone usage and offer insights into behavioral trends, providing a foundation for developing targeted interventions to enhance road safety.

Keywords: Signalized Intersection, YoloV8, Motorcycles, Mobile phone detection, computer vision.

1 Introduction

The landscape of research surrounding motorcycle safety and mobile phone usage while driving continues to evolve, providing critical insights into the factors influencing risky behaviors and potential interventions. Studies across various countries have emphasized the significant impact of mobile phone use while driving, along with other risky behaviors, contributing to heightened accident risks and proposing different prevention strategies [1].

Our paper is organized into distinct sections. Initially, we delve into the "Methodology" (Section 2), where we discuss the process of selecting sites, methods of data collection using cameras and advanced algorithms, and subsequent data analysis. Following this, Section 3, titled "Results and Discussion," offers an in-depth exploration of motorcycle behavior related to mobile phone use while on routes, and its impact on traffic flow in Marrakech. Lastly, Section 4, "Conclusion," summarizes our key findings and outlines potential applications, emphasizing the importance of our contributions and suggesting directions for future research.

2 Related work

In Vietnam, a survey of both motorcyclists and car drivers found that attitudes towards mobile phone use and compulsive behaviors played significant roles in driving safety, suggesting that educational and awareness campaigns could effectively change these attitudes and increase risk perception [2, 3]. Another study within the same region used the extended Theory of Planned Behavior to explore how negative attitudes and habitual behaviors related to mobile phone use impacted motorcycle riders' intentions and actions, advocating for targeted safety interventions [4]. Similar concerns were addressed in Indonesia, where a significant prevalence of mobile phone use among motorcyclists prompted calls for interventions that modify riders' attitudes and improve their behavioral control [5].

Research in sub-Saharan Africa, focusing on rural areas, noted that while mobile technology has potential to improve transportation access, the adoption of mobile-based ride-hailing solutions is still limited to urban settings, highlighting a gap that might be bridged with innovative solutions tailored to rural needs [6, 7]. The study on online motorcycle taxis in Semarang, Indonesia further exemplified the urgency of addressing mobile phone use in traffic settings, as it significantly correlated with increased accident rates, underscoring the need for stricter regulations and awareness initiatives [8].

Technological advancements have also been explored to enhance safety without compromising utility, such as the development of a mechanical control unit that allows riders to use smartphones without having to remove their hands from the handlebars, aiming to reduce the risks associated with digital interfaces [9]. This aligns with broader efforts to address the root causes of motorcycle accidents, as evidenced by studies in Iran that identified key behavioral risk factors, such as smoking and SMS usage while driving, calling for comprehensive educational campaigns [10] and [11].

Furthermore, the influence of social norms and peer behavior was highlighted in a study from Yogyakarta, Indonesia, where peer influence significantly affected junior high students' intentions to ride motorcycles, leading to recommendations for policies that restrict motorcycle use among young people to mitigate future risks [12, 13].

However, it is essential to critically assess the methodology used in this study. The dependence on sensors to detect motorcycle activity raises questions about the accuracy and representativeness of the data collected. Sensor-based systems may face challenges such as misclassifications and sensitivity to environmental conditions, which could affect the reliability of the results. Furthermore, the use of simulated data adds another layer of complexity. While simulated or synthetic data provides a controlled environment for analysis, it may not entirely reflect the complexity and variability of real-world situations. It is crucial to consider how well these simulated conditions mimic the actual behaviors seen in traffic related to mobile phone use by motorcyclists.

Additionally, focusing exclusively on motorcycles when analyzing the impact of mobile phone use, while yielding valuable insights, may neglect the broader interactions and dynamics involving other vehicles. A more comprehensive analysis, including

various vehicle types and driver behaviors, could provide a more complete understanding of the factors influencing mobile phone use among motorcyclists on the roads. These methodological concerns necessitate a thoughtful evaluation of the study's results and their relevance to real-world traffic scenarios.

The main contribution of our study lies in a detailed examination of mobile phone usage by motorcyclists on routes and the quantification of related traffic behaviors at signalized intersections in Marrakech, with a particular focus on motorcycles. By leveraging advanced technology, we collect real-world data directly from intersections using cameras. The implementation of the YOLO-v8 [14] (You Only Look Once) and deep sort algorithms allows us to efficiently monitor and analyze mobile phone usage by motorcyclists, offering precise and detailed insights. This approach not only provides valuable information about the specific challenges posed by motorcyclists using mobile phones during transit but also enhances our understanding of overall traffic dynamics at these intersections.

3 Methodology

The methodology employed in this study involved the utilization of the YOLOv8 object detection model, pretrained on the COCO dataset [15], to detect instances of mobile phone usage among motorcycle riders. The process began with the collection and annotation of a dataset consisting of images depicting motorcycle riders in various scenarios, including both instances of mobile phone usage and normal riding behavior. This dataset was then preprocessed to ensure uniformity and quality, including resizing images and augmenting data to enhance model performance. The pretrained YOLOv8 model was selected due to its proven effectiveness in object detection tasks and its ability to detect multiple objects in real-time. Fine-tuning of the model was performed on the annotated dataset to adapt it to the specific task of detecting mobile phone usage on motorcycles [16].

3.1 Site Selection

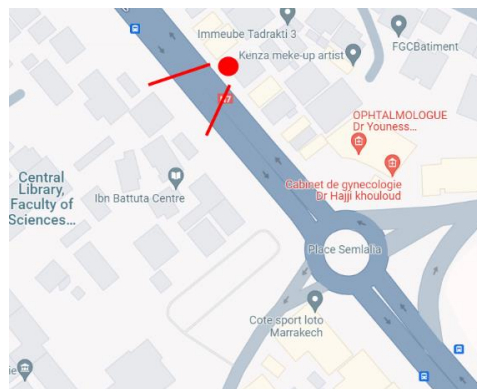


Fig. 1. The chosen route and Camera position.

Figure 1 illustrates the chosen route and camera position for this study. The intersection depicted in the figure was selected for specific reasons, notably due to the high volume of motorcycles passing through this route. Additionally, a significant portion of these riders are students, which adds relevance to the study's focus on detecting mobile phone usage among motorcycle riders. The camera position, indicated by a red point in the figure, was strategically chosen to capture a comprehensive view of the intersection, ensuring effective monitoring of motorcycle riders' behavior, including their use of mobile phones. This location provides an ideal vantage point to observe and analyze traffic patterns, making it suitable for the study's objective

3.2 Data collection

The data collection process involved recording video footage of the selected intersection during specific time intervals to capture varying traffic conditions. Each recording lasted 30 minutes and was scheduled during peak hours to ensure a comprehensive representation of motorcycle riders' behavior. Specifically, recordings were made during the morning peak hours from 10:00 AM to 10:30 AM, midday from 12:00 PM to 12:30 PM, and evening rush hours from 18:30 to 19:00. These time slots were chosen to coincide with periods of high motorcycle traffic, thereby increasing the likelihood of capturing instances of mobile phone usage among riders. The recordings were conducted over multiple days to account for potential variations in traffic patterns due to factors such as weather conditions or special events.

3.3 Data analysis

In our data analysis phase, we employed a robust methodology integrating the YOLOv8 object detection model and the DeepSORT [17] tracking algorithm to detect and track vehicles, particularly motorcycles, within the recorded footage. This approach allowed for precise identification, classification, and continuous tracking of various vehicle types present in the intersection.

Utilizing the YOLOv8 framework [14], we implemented real-time object detection to identify objects such as motorcycles and mobile phones. This approach ensured a high level of accuracy in recognizing and tracking vehicles throughout the recorded sessions.

Complementing YOLOv8, we utilized the DeepSORT algorithm for efficient object tracking [18]. DeepSORT's deep learning capabilities facilitated the association and tracking of objects across consecutive frames, ensuring a seamless and accurate depiction of motorcycle movements.

Furthermore, we conducted an analysis of mobile phone usage by motorcycles. This involved leveraging computer vision techniques to identify and detect instances of mobile phone usage by motorcycle riders. By combining these methods, we were able to accurately track motorcycles and analyze their behavior, including mobile phone usage, within the intersection.

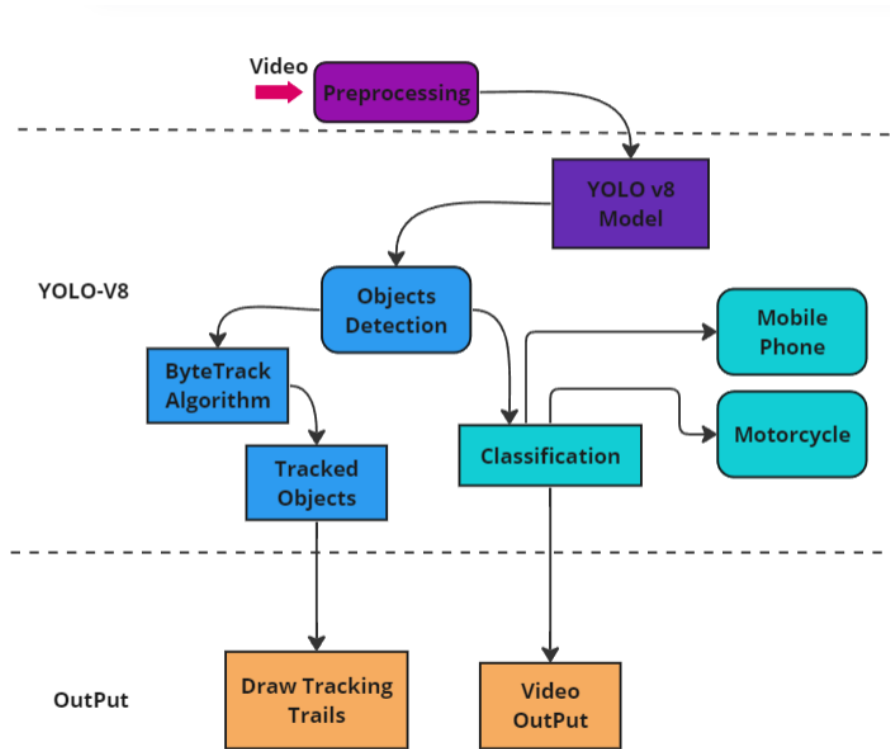


Fig. 2. Data Analysis Workflow with YOLO-v8 and DeepSORT for Motorcycle Tracking and Mobile phone Detection.

Figure 2 illustrates the data analysis workflow employed in this study, integrating the YOLOv8 object detection model and the DeepSORT tracking algorithm for motorcycle tracking and mobile phone detection. The architecture of our approach begins with preprocessing the recorded footage to enhance the quality and uniformity of the data.

The preprocessed data is then fed into the YOLOv8 model for object detection, which identifies and classifies various objects, including motorcycles and mobile phones, within the intersection. The detected objects are then passed through the ByteTrack algorithm, a component of DeepSORT, for efficient object tracking.

The ByteTrack algorithm tracks the objects across consecutive frames, ensuring accurate and continuous tracking of motorcycles and mobile phones. The tracked objects are further processed for classification, distinguishing between motorcycles and other vehicles, as well as detecting instances of mobile phone usage by motorcycle riders.

This integrated approach enables precise tracking of motorcycles and accurate detection of mobile phone usage, providing valuable insights into rider behavior at the intersection.

Table 1. The result of tallying the number of motorcycles using mobile phone.

Time		Cars	Motorcycles	Mobile Phone Using
	10:10	93	62	6
10:00 -	10:20	84	56	1
10:30	10:30	107	71	2
	12:10	139	92	9
12:00 -	12:20	134	89	11
12:30	12:30	154	102	15
	18:40	167	111	5
18:30 -	18:50	149	99	3
19:00	19:00	172	114	4

Table 1 presents the results of tallying the number of motorcycles observed using mobile phones at different time intervals. The table is divided into three sections, each corresponding to a specific time slot: 10:00 - 10:30, 12:00 - 12:30, and 18:30 - 19:00.

For each time slot, the table lists the specific time within that slot, the total number of cars passing through the route, the total number of motorcycles observed, and the number of motorcycles seen using mobile phones.

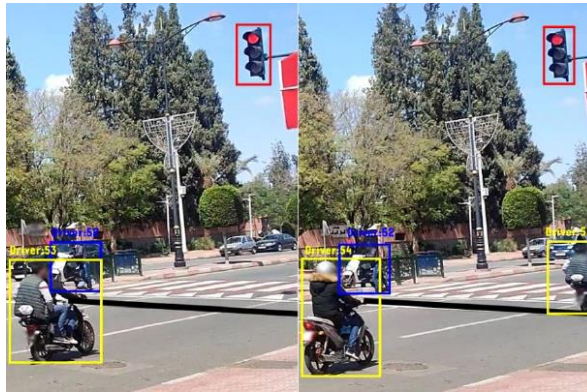


Fig. 3. Exemplar Bounding Boxes and Tracking IDs for Motorcycles and Mobile Phone Detection.

Figure 3 showcases exemplar bounding boxes and tracking IDs for motorcycles and mobile phone detection, illustrating the effectiveness of the integrated YOLOv8 and DeepSORT approach in accurately identifying and tracking these objects.

The bounding boxes highlight the spatial extent of detected motorcycles and mobile phones within the intersection, demonstrating the precision of the object detection

model. Additionally, the tracking IDs assigned to each object show the continuity of tracking across frames, indicating the ability of the DeepSORT algorithm to maintain object identity over time.

This figure provides a visual representation of how the proposed methodology successfully detects and tracks motorcycles and mobile phones, showcasing its potential for enhancing road safety through automated monitoring of rider behavior.

4 Results and Discussion

In the Results and Discussion section, we evaluated the performance of our model by comparing its results with manual counting methods for detecting mobile phone usage by motorcycle riders. The comparison demonstrated the effectiveness and accuracy of our approach in detecting instances of mobile phone usage, highlighting its potential as a reliable automated monitoring system.

Additionally, our analysis revealed interesting insights regarding the timing of high mobile phone usage by motorcycle riders. We found that the highest usage of mobile phones by motorcycle riders occurred during specific times of the day, such as during the midday period from 12:00 PM to 12:30 PM and the evening rush hours from 18:30 to 19:00. These findings are significant as they can inform the implementation of targeted interventions or awareness campaigns aimed at reducing mobile phone usage while riding motorcycles during these peak times, thus enhancing road safety.

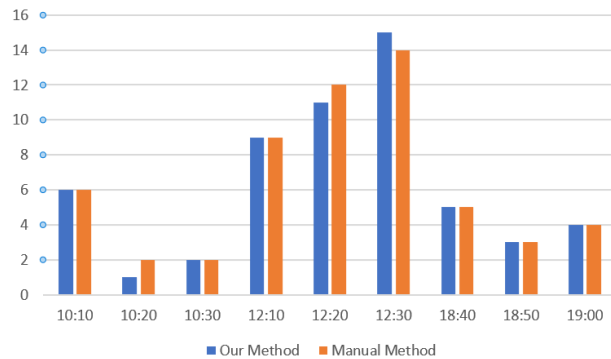


Fig. 4. Comparison of Motorcycle Detection Using Mobile Phones: Automated vs. Manual Counting Results

Figure 4 presents a comparison between our automated method for detecting motorcycles using mobile phones and manual counting. The table includes time intervals and the corresponding counts obtained using both our automated approach and the manual counting method.

The comparison demonstrates a strong agreement between the two methods, with consistent counts across most time intervals. This indicates that our automated approach

is highly effective in detecting motorcycles using mobile phones, producing results that align closely with manual observations.

While there are minor discrepancies in counts for some time intervals, the overall trend shows a high level of accuracy and reliability in our automated method. These findings underscore the robustness of our approach and its potential for accurate and efficient monitoring of mobile phone usage by motorcycle riders.

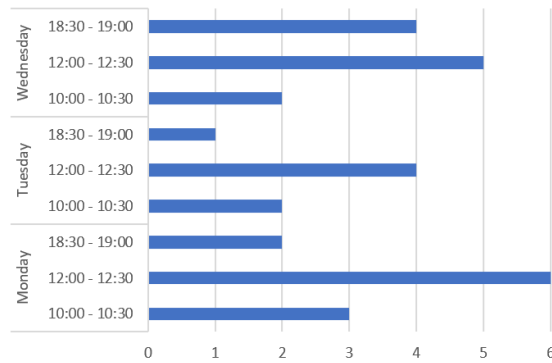


Fig. 5. Number of Cars and Motorcycles Passing Through the Intersection Over Time

5 Conclusion

Our study leveraged cutting-edge computer vision technology to assess mobile phone use among motorcyclists at key intersections in Marrakech. By implementing the YOLOv8 and DeepSORT algorithms, we successfully monitored and analyzed mobile phone engagement among riders, revealing critical usage peaks during midday and evening rush hours. The accuracy of our automated detection system was validated against manual counting methods, demonstrating high reliability and consistency. These insights not only enhance our understanding of rider behavior but also underscore the potential for technology-driven solutions to improve road safety. Future work should focus on refining detection algorithms and expanding the study to include diverse traffic conditions and broader geographic areas, aiming to generalize findings and support comprehensive traffic safety strategies.

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