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Smart Adaptive Mirror & Blind Spot Alert System for Scooters

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Abstract

Two-wheeler accidents have been rising sharply because of poor rear viewability, blind spots, and wrong mirror adjustments. Motorbike riders find it necessary to physically change mirror positions based on their sitting posture, which leads to distractions and accidents. In order to address this issue, a smart adaptive mirror & blind spot alerting system for scooters is developed that employs Artificial intelligence and embedded systems. This intelligent system adjusts its mirror automatically by analyzing the riding posture of the rider. Here, the system uses a webcam to capture the position of the motorbike rider, while Open CV and Media Pipe are used for analysis of shoulder and posture. Based on the detected posture of the rider, the angle of the mirrors is calculated. This value is communicated to Arduino UNO via pyFirmata technology. The system moves the mirrors based on the received command through servo motors. Moreover, ultrasonic sensors are employed for blind spot detection to prevent any potential accidents from happening around the scooter. In the event that any cars or objects approach dangerously close, the LED lights will warn the rider immediately. The system makes riding much safer with the use of AI posture detection and blind spot detection, thus ensuring enhanced rear visibility for the rider. The entire design is inexpensive, smart, and practical for implementation in the two-wheeler domain. This project illustrates a successful application of AI, Embedded Systems, and Computer Vision.

Keywords: *Smart Adaptive Rear-View Mirror System, AI Based Blind Spot Detection, Two-Wheeler Safety and Accident Prevention, Computer Vision for Vehicle Safety, Arduino Based Embedded Systems Projects.*

INTRODUCTION

Two-wheelers such as scooters and motorcycles happen to be one of the most popular modes of transport in the contemporary world owing to factors such as cost effectiveness, energy efficiency, and mobility. In cities where traffic is congested to an extent, millions of people rely on two-wheelers for traveling around. While two-wheelers facilitate convenient and economical travel, they are prone to accidents than four-wheelers since they offer minimal protection and low visibility.

Accidents occurring in two-wheelers are mainly a result of insufficient rear visibility. Two-wheeler drivers tend to rely extensively on their rear view mirrors when overtaking, turning, lane changing, or making their way through the traffic. The problem is that the rear view mirror becomes misaligned because of the driver's changing posture or vibrations in the roads, thereby requiring him to manually align them. Drivers tend to align the mirrors depending on their sitting posture.

Another important safety concern for two-wheelers is blind spots. Blind spots are the areas in which the rider of the two-wheeler cannot see vehicles coming from behind using rear-view mirrors. Vehicles coming from these regions will not be visible to the rider, and there are chances of severe accidents while changing lanes or taking a turn. The use of traditional mirrors cannot entirely remove blind spots in heavy traffic.

Since the emergence of the concept of Artificial Intelligence (AI), Computer Vision, and Embedded Systems, intelligent safety systems for transportation are gaining increasing popularity. Technologies such as OpenCV, MediaPipe, sensors, and microcontrollers can be effectively utilized to monitor and automate the process of riding.

Smart Adaptive Mirror & Blind Spot Alert System for Scooters: An Intelligent Safety Solution Using Posture Detection by AI and Sensor Integration

The system uses artificial intelligence for posture detection combined with embedded sensors. Based on the analysis of posture, the system automatically adjusts the rear-view mirrors of scooters. A webcam captures posture in real-time, MediaPipe, and OpenCV libraries analyze the shoulder movement, while the commands are processed in Arduino UNO to control the servomotor to move mirrors to their optimum positions. Also, blind spot monitoring technology is incorporated in the system using ultrasonic sensors. They keep an eye on the surroundings and check the presence of any obstacle or vehicle in the blind spot. When something is in the blind spot, the LED indicator alerts the user in time.

LITERATURE REVIEW

[1] Intelligent systems for automatically adjusting rearview mirrors have emerged as an active research domain for the field of intelligent transportation. Conventional rearview mirrors installed on scooters and motorcycles need to be adjusted manually as per the rider's posture and position. Lack of proper adjustment of mirrors often leads to poor visibility and thereby increase in the accident rate when maneuvering the vehicle. Literature survey conducted on automatic adjustment systems for mirrors has revealed that embedded systems like Arduino controller and servo motors may be utilized to adjust mirrors automatically depending on the rider's posture. This improves visibility and reduces distractions of the rider. In addition, the concept of intelligent mirrors is also discussed in literature that states how automatic adjustment of mirrors makes the system convenient and safe. Nevertheless, most of these systems consider only the aspect of mirror adjustments without considering any other safety features [1][4].

[2] Detection of blind spots is another area of extensive research undertaken in current automobile safety technologies as blind spots lead to most number of accidents. Blind spots refer to the areas around a vehicle that are not visible to the driver via rear view mirrors. In many studies, ultrasonic sensors have been implemented in order to detect other vehicles and obstacles within blind spots. These ultrasonic sensor based systems work by continuously monitoring the distances from objects and giving out alarms if a dangerous situation arises due to other vehicles entering that vicinity. It has been established through scientific studies that ultrasonic sensors are inexpensive, reliable, and highly efficient in providing real-time alerts in regard to obstacles in two wheelers and automobiles. Studies pertaining to visual obstructions in vehicular systems have indicated that low visibility is responsible for accidents occurring on roads, especially in urban areas where there are numerous vehicles [2][5][6][7].

[3] The recent developments in AI, CV, and HPE have led to the creation of intelligent rider assistance systems. Frameworks such as OpenCV are very common when performing operations like real-time video processing, image processing, and object tracking. Similarly, the MediaPipe framework can detect and estimate poses and body landmarks, which makes it suitable for rider posture analysis and shoulder tracking. Vision-based rider posture detection uses cameras to track the movements of riders and set mirror positions accordingly. The combination of these intelligent systems helps them perform real-time analyses of rider posture and adjust the mirror angles for maximizing visibility. It can be seen from the literature survey that current systems either focus on designing systems to help mirror adjustment or blind spot alert separately. However, very few works have incorporated AI-based rider posture detection with real-time blind spot alerts in one intelligent system. Hence, the Smart Adaptive Mirror & Blind Spot Alert System proposed incorporates all the above-mentioned concepts of CV, Embedded Systems, AI, and sensor technology.

METHODOLOGY

Materials/components

The methodology for the Smart Adaptive Mirror & Blind Spot Alert System can be segregated into different stages of image processing, body posture detection, mirror angle adjustment, blind spot detection, and alerting the rider accordingly. All the stages of the proposed system involve Artificial Intelligence, Computer Vision, Embedded Systems, and Sensor technology to help provide improved safety and visibility to the rider.

Firstly, a webcam is installed at the front dashboard area of the scooter which captures images of the rider in real-time. These images are then analyzed by utilizing the OpenCV and MediaPipe python libraries. MediaPipe analyzes the landmarks and tracks the shoulder posture and movements of the rider. After determining the correct shoulder posture of the rider, it computes the correct angle of the rear-view mirror that needs to be set up.

Arduino UNO is the primary controller in the system that takes commands from the computer via Python software and regulates the motion of servo motors attached to the rear view mirrors. The servo motors move depending on the degree angle determined by calculation, and consequently, the mirror positioning depends on the position of the rider. This way, there is no need to manually move the mirrors, hence reducing distractions for the rider.

Meanwhile, the ultrasonic sensors keep monitoring the blind spot zones on both sides of the scooter. In case another vehicle comes close to the preset blind spot zones, then

LEDs will light up to warn the rider about this. In other words, the rider gets an alert notification to help him or her take necessary measures to avoid any possible collision with the vehicle in the blind spot zone.

Flowchart

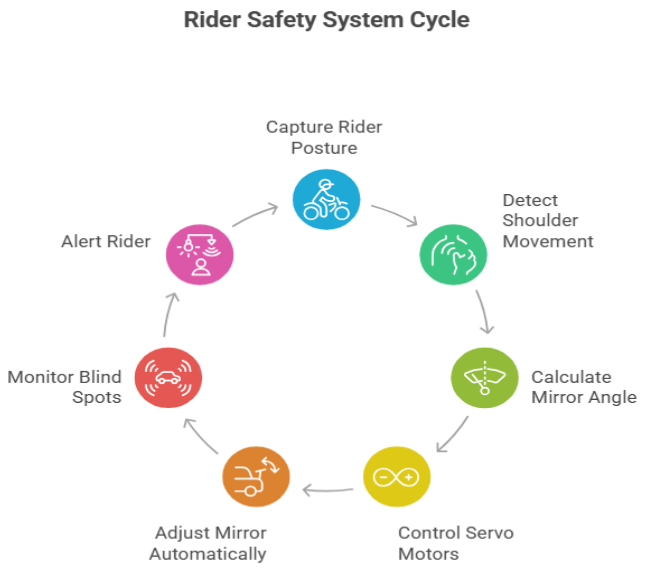


Figure 1.1 – System flowchart

Theory

Smart Adaptive Mirror & Blind Spot Alert System for Scooter employs Artificial Intelligence, Computer Vision, and Embedded Systems to ensure safe riding. The methodology involves auto-adjustment of the mirrors through the detection of the posture of the rider and blind-spot alerts via ultrasonic sensors. The system performs all processes in real time to improve rear-view visibility and prevent accidents that may be caused by wrong positioning of the mirrors or hidden cars.

The process starts with a webcam positioned close to the scooter dashboard to constantly take pictures of the rider. Image processing software such as OpenCV is used to capture video from the webcam in real time. This software analyzes frames to capture data from videos. MediaPipe software works together with OpenCV to perform rider posture detection by detecting the location of key body landmarks. MediaPipe detects landmarks to track shoulder movements.

Smart Adaptive Mirror & Blind Spot Alert System for Scooter uses Artificial Intelligence, Computer Vision, and Embedded Systems to guarantee safety during travel. The methods used include automatic adjustment of the mirror based on posture analysis of the rider and alerting for blind spots using ultrasonic sensors. All operations will be done in real-time for better visualization of the rearview mirror and avoiding accidents that could happen due to incorrect placement of the mirror or because there are hidden cars behind.

The process begins when a camera is installed near the scooter dashboard where it continuously takes photos of the rider. Software, like OpenCV, captures the live video from the camera and is used for frame analysis in order to get the information from videos. MediaPipe software operates with OpenCV to enable detection of rider posture through the detection of key points of the body. MediaPipe detects key points that allow tracking of shoulders' motion.

Apart from adjusting the position of the mirror, the system can also detect blind spots. Sensors that utilize ultrasonic signals are installed at both sides of the scooter. This sensor sends out ultrasonic sound waves and waits for the reflected waves to come back in order to calculate the distance of the object from the scooter.

When the vehicle or obstacle passes through the predetermined blind spot range, the Arduino sends alerts using LEDs to warn the driver about any imminent hazards. The warning is given instantly using LED lights to help the driver become aware of any threats on the road while changing lanes or making turns.

The methodology described in this paper involves posture detection, mirror adjustment, sensor-based measurement, and warnings sent by the rider. With all these processes integrated into one intelligent safety mechanism, the system helps increase rear visibility, rider awareness, and reduces the risk of having a blind spot.

Results and Discussions

The development of the Smart Adaptive Mirror & Blind Spot Alert System was successful through the use of Artificial Intelligence, Computer Vision, and Embedded Systems. This project could detect the position of the rider with OpenCV and MediaPipe and could adapt the rear-view mirrors using the servo motors programmed in the Arduino UNO.

Blind spot detection using ultrasonic sensors could detect any vehicle and obstacle within the range of detection. The LED indicator could signal the rider when there is something present at their blind spot range. The project could increase rear visibility and help prevent accidents because the rider will always be aware of their surroundings.

Performance wise, the combination of AI for detecting postures and blind spots can contribute to safety in two-wheeled vehicles. This project served as proof that an affordable project such as this could serve its purpose in the real world.

POSTURE DETECTION ACCURACY

This graph depicts the accuracy of posture recognition by the developed system using OpenCV and MediaPipe techniques. The accuracy rate increased through several iterations of testing and finally achieved about 95%. This means that the system can recognize rider posture and shoulder movement in real time.

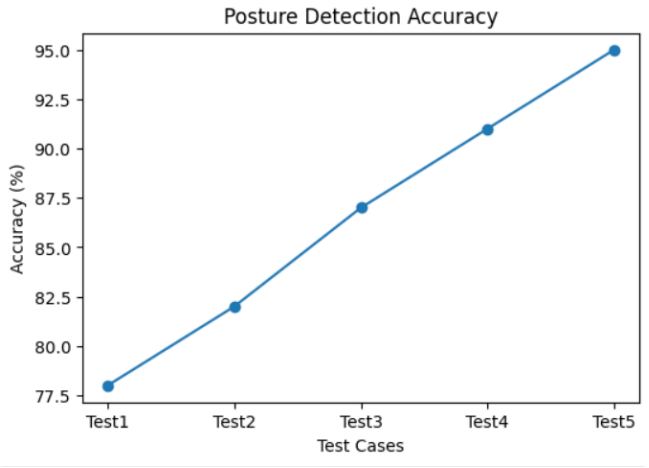


Figure 1.2 Figure shows the accuracy of rider posture detection using OpenCV and MediaPipe in different test cases.

MIRROR ADJUSTMENT RESPONSE TIME

The chart below indicates the response time needed to automatically adjust the mirror. With increased optimization of the system, there was a considerable reduction in the mirror adjustment time. Reduced response time is beneficial to the rider as it enables real-time adjustment of the mirror.

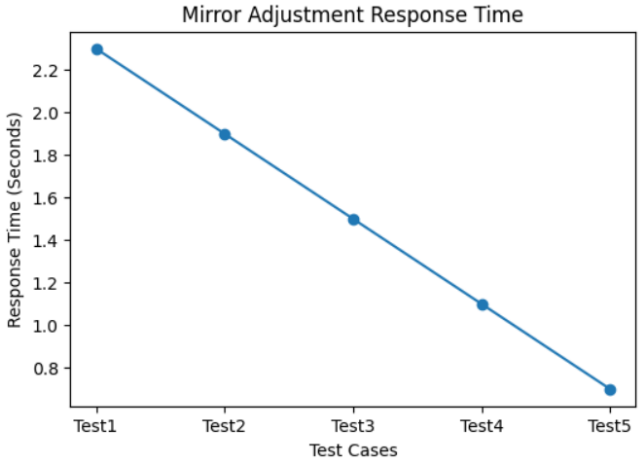


Figure 1.3 Figure shows the time required for automatic mirror adjustment during different tests.

BLIND SPOT DETECTION EFFICIENCY

The graph above depicts the effectiveness of the use of ultrasonic sensors in vehicle or obstacle detection from various ranges. It was evident that the use of ultrasonic sensors is highly effective in vehicle or obstacle detection within near and moderate ranges.

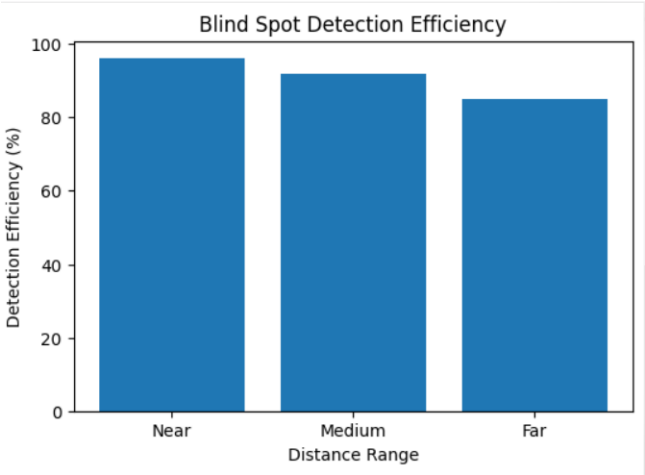


Figure 1.4 Figure shows the efficiency of ultrasonic sensors in detecting nearby vehicles and obstacles.

OVERALL SYSTEM PERFORMANCE

This graph illustrates the effectiveness of various modules within the system. It can be seen that posture detection, mirror adjusting, sensor monitoring, and alarm creation were highly effective during testing. The data clearly shows that the system works effectively as a smart safety measure for scooters.

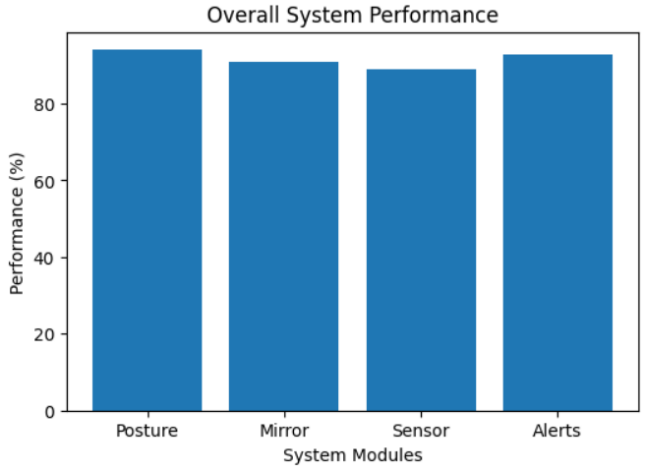


Figure 1.5 Figure shows the overall performance of posture detection, mirror adjustment, sensor monitoring, and alert system.

Future Scope

The Smart Adaptive Mirror & Blind Spot Alert System may be further improved through the application of Artificial Intelligence and IoT technologies. In the future, the system may use voice-based alerts instead of LED lights to notify users about approaching vehicles and obstacles. Machine learning algorithms may assist in recognizing the type of vehicles like car, truck, bus, or bike that approach. The mirror system may be integrated with smartphones to send notifications and control the system settings using Bluetooth or Wi-Fi. Other useful features may include GPS tracking and accident detection.

The system may also be improved using wireless smart mirrors, cameras, and machine learning techniques to enhance posture and obstacle detection. For example, night vision cameras and brightness adjustment features may increase visibility in poor lighting conditions. In addition, the future version of the system may provide cloud-based data storage capabilities and real-time traffic analysis features for efficient smart transportation systems.

Thus, after further development, the proposed mirror system may become part of advanced intelligent transportation systems and may work not only for scooters and motorcycles but also for other electric vehicles.

CONCLUSION

Smart Adaptive Mirror & Blind Spot Alert System for Scooters is an advanced safety device invented through the application of concepts in Artificial Intelligence, Computer Vision, and Embedded Systems. This innovative technology manages to detect rider posture through OpenCV and MediaPipe and automatically adjusts the rear view mirrors through the use of servo motors connected to Arduino UNO. Furthermore, the system manages to detect blind spot zones using ultrasonic sensors, which give real-time LED alert signals to the rider about approaching cars and other vehicles or obstacles.

The smart mirror and alert system for scooter helps improve rear view visibility of the rider and minimizes the rider's effort and distraction when adjusting rear view mirrors manually. Therefore, the system is not only efficient and practical but affordable too. Future advancement in the invention will make it a more intelligent system with many additional smart features. The technology offers an innovative way to minimize road accidents among other advantages.

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