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An Intelligent Rider Assistance System Using Machine Learning for Two Wheel Vehicles

Jisha Mariyam John, Hariharan R L

Abstract*:. As far as a rider is concerned, safety is the first priority while driving a vehicle. There have been significant changes over the years in the design of four wheeler in terms of security. During the design of vehicles manufacturers are incorporating many modifications to the existing model so that the security is more. But when the safety of motorbikes is concerned this is not true, as there exits some blind spots which are not visible to the rider through the mirrors. Blind spots are the rare quarter areas towards the rear of the vehicle on both sides, vehicles in the contiguous paths of the road may fall into these vulnerable sides and driver may not be able to see them using only the mirrors. In this paper we have introduced a new approach using machine learning tools to detect the obstacles and to alert rider and there by reducing the risk of collision. This system could reduce significant amount of risk that the rider is going to face because of the obstacles which are not visible through the mirrors.

Index Terms: Obstacle Detection, Ordroid, YOLO, Machine Learning, Road Safety

I. INTRODUCTION

Road traffic accidents (RTAs) had become an essential factor in public health and development problem in India. RTAs involve a high percentage of damages in human life at various levels. Although there are multiple measures had been taken to reduce accidents.

Over the years, there has been an observable change in the design of four wheelers in terms of its safety. Modifications were done to preexisting models to give more importance to the safety of its owners. But this is not true when it comes to the safety regarding motorbikes. There still exist dead points which are not visible by the rider through his mirrors. So we need a system to increase the safety of motorbike users by providing them alerts when there is a risk of collision.

In this paper, we attempt to put forward endeavors to make a framework which is streamlined for distinguishing hindrances in the blind spot of a bicycle working on city roads and highways. By blind spot, we mean the region behind the bicycle, which is ordinarily not noticeable in the side view mirrors. By and large, the vulnerable side is just distinguishable when the rider turns his head. The system uses a camera for continuous surveillance of the road from the blind spot of the bike. Using image processing techniques, the system continuously looks for any obstacles or other vehicles that are coming closer to the blind spot of the bike. If the distance of the object from the blind spot is less than a threshold value, the system alerts the rider and passes a message to the display fixed on the handlebar of the bikes with the image of the same. While taking a turn, the camera looks for any obstacles that are coming from the side to which the rider is turning. If there are no such obstacles, the system informs the rider that it is safe to take the turn. Otherwise, if the system detects the presence of some fast incoming obstacles, it alerts the rider about the same and informs the rider that it is not safe to take the turn suddenly. Since the number of motorcycles on roads is increasing every day and also the number of accidents is growing on a large scale, the proposed system helps to identify the probable chances of collision/accident that may take place by any obstacle hitting on the blind spot of the motorcycle and alerts the rider and thus it helps to reduce the chances of collision.

II. RELATED WORKS

Seon-Geol Kim et al. [1] proposed a method for detection of overtaking vehicles in the blind spot area at night time. A new feature of blobs that is due to the headlights of behind vehicle was adopted. The first step is to detect blobs in pre-defined two ROI (Region of Interest). After the bright blobs are detected, the next step is to estimate the motion vectors of them. When a vehicle is approaching the vehicle in the blind spot, the blobs are getting bigger and have the motion vectors with downward direction. The blobs that have a proper motion vector move to the next step and others are neglected. The third step is to make a group of blobs those are likely to comprise of a headlight of the single vehicle. The final step is to determine whether a vehicle is in the blind spot and generate an alarm signal.

Damien Dooley et al. [2] proposed a method for detecting and tracking vehicles in the blind zone using a single rear-mounted fisheye camera and multiple detection algorithms. Cameras offer significant advantages to radar systems such as more accurate capturing of lateral motion, higher resolution and lower unit costs. For vehicles approaching from the rear, the system operates by initially detecting an approaching vehicle using an AdaBoost classifier-based detection method trained to identify the front of a target vehicle. This method is computationally expensive and it adds a degree of noise toward the edge of the image, making classification based detection equally tricky.

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* Correspondence Author
Jisha Mariyam John*, Department of Computer Science and Engineering, Providence College of Engineering ,Chengannur, Kerala, India.
Hariharan R L, Department of Computer Science and Engineering, Providence College of Engineering ,Chengannur, Kerala, India.

RizaAtiq et al. [3] suggested image processing algorithms for traffic counting, queue length, speed measurement and vehicle classification. Traffic counting algorithm adopted in this study is carried out by observing changes in pixels values in the middle of traffic lanes

Partha Narayan et al. [4] proposed a method for vehicle detection to control traffic using image processing. At first, this system converts RGB road images to HSV images and then it analyses the value readings which identify the brightness of the images, and it is used to determine whether it is a day time or night time image by comparing the value readings with a calculated threshold parameter. During day time, comparison is done between foreground image with the background image to extract the vehicles. During night time the intensity of the image is analysed to differentiate between headlights and ambient light. Finally, object counting methodology is used to count the number of vehicles and this proposed model is tested with different dataset. Prem Kumar Bhaskar et al. [5] proposed the method for detecting vehicle / traffic data from video frames. This method uses a unique algorithm for vehicle data recognition and tracking using Gaussian mixture model and blob detection methods. Pandu Ranga et al. [6] studied a method for vehicle detection and classification based on morphological technique. An efficient algorithm based on image processing using top view of vehicles according to their size is used for this purpose. Qun Lim et al. [7] proposed a method called Forward Collision Warning System, to overcome the pre-existing vehicle detection system that uses Support Vector Machine. SVM method is unreliable in terms of speed and real time applications. The nested Kalman firstly predicts distance then the velocity and time-to-collision based on You Only Look Once (YOLO) vehicle detection algorithm. The algorithm uses the vehicle width as a parameter to calculate its distance and velocity. The recursive nature of Kalman filter requires less computational power and the YOLO algorithm is used to achieve a faster real-time response. Kalman filter reduces false prediction by its recursive approach so increases the system's efficiency. Li Tan et al. [8] proposed an algorithm for multi-target tracking. It is achieved by the efficient expression of the target, and it is a process which positions the targets in the image sequence and finds the most similar candidate target area. The multi-target tracking algorithm works based on YOLO target detection and it applies VGG-Net model to extract the depth features. In the process of feature extraction, the ROI region is first divided according to the target detection result and then, pool and extracts the 1024-dimensional depth features of all targets in detection model. Then, the appropriate similarity metric algorithm is used to perform target matching and association between images so as to achieve multi-target tracking. Rumin Zhang et al. [9] proposed an algorithm that combines the YOLO object detection algorithm and the light field camera which is simpler than normal RGB-D sensor and acquires depth image and high-resolution images at the same in one exposure. The RGB Image rendered by the light field camera is taken as an input of the YOLO model which was trained base on nearly 100 categories of common objects. A light field camera, also known as plenoptic camera, captures information about the light field emanating from a scene, that is, the intensity of light in a scene, and also the direction that the light rays are traveling in space. Asha et al. [10] proposed a vehicle counting technique using YOLO and Correlation Filter. Processing of video is achieved in three stages by means of YOLO (You Only Look Once), first is detection, then tracking with correlation filter and finally counting. Vehicle counting is implemented by separating the dynamic part from the static part of the scene and this is accomplished using the background subtraction and blob analysis method, background subtraction combined with Kalman filter, Gaussian Mixture Model based background subtraction and particle filter based tracker. However, the background subtraction method has limitations while processing traffic data during heavy traffic conditions. It results in merging of vehicles during partial occlusion in the processed image data and predicting wrong bounding box. Expectation maximization is fused with a Gaussian mixture model to build the background model to improve the results. Background subtraction is then performed to extract the moving vehicles. The occlusions are handled using morphological features and color histograms. Vehicle counting for night-time videos has been proposed by extracting the bright regions (i.e. headlights), followed by the pairing of headlights, tracking, and counting. Shraddha Mane et al. [11] proposed the use of CNN to increase robustness of object detection. This is achieved by using tensor flow to detect moving objects and this data is passed to the CNN, this technique can detect the objects in harsh weather conditions and interferences. Object detection is done based on Background subtraction, which isolate foreground from background, then proper imaging techniques are used for pre-8 possessing. The CNN based moving object detection algorithm consists of two phase: Object detection and tracking. The video is feed to the system as an input. Frames are extracted for further processing. The two main algorithms object detection and object tracking is processed through deep learning methods. Apply the loaded tensor flow model on the image, the Tensor Flow based model test the image and return the location (x, y, w, h) of the object in the image. This is the process of object detection of Tensor Flow object detection algorithm. The success rate of this approach is better and it is applicable to RGB images

III. PROPOSED SYSTEM

The bike rider assistant system includes three modules:

- Odroid system.
- Vehicle detection system
- User interaction System

A. Odroid system

The hardware components used in the system are

Odroid-XU4:-Odroid-XU4 is a new generation of computing device. In our system, the real time video from the camera placed on the bike is passed on to the Odroid board for processing. The board also gets input from the distance sensor. Using YOLO object detection method, the system identifies obstacles in the camera and it also takes the input from the distance sensor and checks the distance of the detected obstacle from the bike. If the distance is less than the threshold value and if it keeps decreasing for a period of time, alert is given to the rider about the same.

TF Mini LiDAR (ToF) Laser Range Sensor: The TF Mini LiDAR laser range sensor is a unidirectional laser range finder. It works on the time-of-flight (ToF) technology. The LiDAR sensor is equipped with special optical and electronic devices. It integrates a versatile algorithm for indoor and open air application condition. It has superior performance in distance measurement. The LiDAR laser range sensor can be used in automation in a variety of machine control situation. It is light weight, has low weight and uses only low power. The LiDAR range sensor has a maximum detection distance of 12m. The laser sensor supports 100Hz sampling resolution, within 6 meters. It has strong anti-interference, and can work well in outdoor light. The field of view of the laser sensor is 2.3 degrees. Interface used in the laser sensor is UART (TTL) communication interface. It has a minimum resolution of 5mm. It is 42mm x15mm x16mm in size and has a weight of 4.7g

In the system, the TF Mini LiDAR laser range sensor is fixed on the back of the bike. The distance of the obstacle which has been detected is measured and the value is passed 11 on to the Odroid board. The distance of the obstacle from the bike is continuously monitored and the value is passed on to the board. If the distance value is less than the threshold value and the distance of the obstacle keeps on reducing with time, then an alert is given to the rider.

Camera: The camera used for continuous video surveillance in the system is Logitech C310 HD webcam. It has a maximum resolution of 720p/30fps. It has a fixed focus and lens technology is standard. The field of view of the camera is 60 degrees. The camera is 12 enabled with Logitech RightLight2 technology which enables the camera to capture videos even in low-light conditions. It has size of 21 x 7.6 x 15.2 cm and it has 249g weight.

Automatic Boost Buck Step-up Step-Down Converter Module: Automatic boost buck step-up and step-down convertor with input range 3-35 V and output range of 1.25-30V. It has a maximum current of 4A and conversion ratio of 92%. Its frequency is 50 KHz and has output ripple of 40mV. It also has low ESR Sanyo filter SMD capacitor and another LC filter unit

B. Vehicle detection system

Vehicle detection system requires a set of software to be installed on the odroid board. The list of softwares used in the system are:

NumPy: NumPy is a library for the Python programming language. NumPy supports large, multidimensional arrays and matrices and it gives a huge collection of high-level mathematical functions for working on these arrays.

SciPy: SciPy contains varieties of sub packages which help to solve the most common issue related to Scientific Computation. SciPy is the most used Scientific library only second to GNU Scientific Library for C/C++ or Matlab. SciPy 15 contains routines for computing integrals numerically, solving differential equations, optimization, and sparse matrices. The SciPy library is one of the center bundle that make up the SciPy stack. SciPy library provides numerous easay to use and proficient numerical routines, for example routines for numerical integration, interpolation, optimization, linear algebra and statistics

Matplotlib : Matplotlib is a plotting library for the Python programming language and its numerical mathematics augmentation to NumPy. Matplotlib gives an object-oriented API for installing plots into applications using broadly useful GUI toolkits like Tkinter, wxPython, Qt, or GTK+.

Pillow: Python Imaging Library (PIL) is otherwise called as Pillow in new versions. It is a free library for the Python programming language. Pillow includes support for opening, manipulating, and saving wide range of image file formats

h5py: The h5py package is a Python interface to the HDF5 binary data format. The h5py package lets the user to store enormous amounts of numerical data, and these datas can be effectively controlled from NumPy

TensorFlow: TensorFlow is a free and open-source software library for dataflow. It is also suitable for differentiable programming over a range of tasks. TensorFlow is a representative math library, and it can likewise be used for machine learning applications such as neural networks.

Keras: Keras, which is written in Python is an open-source neural-network library. It is equipped for running as the top end of TensorFlow, Microsoft Cognitive Toolkit, Theano, or PlaidML. Keras was intended to empower quick experimentation with deep neural networks

YOLO: You only look once (YOLO) is a state-of-the-art, real-time object detection system. YOLO can deal with images at 30 Frames per second in a Pascal Titan X, which is a graphics card and has a mAP of 57.9% on COCO dataset which is an excellent object detection dataset with 80 classes, 80,000 training images and 40,000 validation images. COCO is a largescale object detection, segmentation,and captioning

Fig.1. Hardware connection

dataset.YOLOv3 is an extremely fast and accurate version of YOLO. Prior detection systems repurpose classifiers or localizers to perform detection. They apply the model to an image at multiple locations and scales. High scoring regions of the image are considered detections.

A. User interaction System

User interaction system includes hardwares and software that are necessary to interact with the user. The various hardwares and software in the system are:

Display: In this rider assistant system, display is used to show the live video from camera to the user. So here we use mobile phone as display to view the live video. Using python flask we create a local port address and that can be access through the local wifi. User can access the port when the bike is on and he will get the live video through that phone.

Buzzer Alert: Buzzer is used to rely an alert message to the rider when a vehicle comes in proximity of the vehicle. This alert message is produced by the odroid. Odroid processes the live video from camera and the software checks for presence of vehicles in the live video and if found the vehicle is recognized, when such a vehicle is detected the LiDAR sensor is used to measure the distance between the vehicle and rider. And when that distance reaches a threshold value the buzzer produces sound.

Python Flask :Python Flask is used to display live video stream from the camera. Flask is a small scale web framework written in Python. It is classified as a miniaturized framework because it does not require specific tools or libraries. It has no database abstraction layer, form validation, or any other segments. Python flask contains development server and debugger and integrated support for unit testing [12][13]. The live video stream from camera is processed and the object recognized video is given as output to the display using Wi-Fi. This connectivity is ensured by using Flask, both the display and Odroid are to be connected on same Wi-Fi and Flask creates a GUI interface for viewing the processed video.

The strategy that works well with the streaming feature of Flask is to stream a sequence of autonomous JPEG pictures. This is called Motion JPEG, and is used by many IP surveillance cameras. This technique has low latency, however the quality is not the best since JPEG compression is not very effective for motion video. Flask provides local support for streaming responses through the use of generator functions. A generator is a specific function that can be hindered and resumed. This is a function that runs in three stages each returning a value. Using generator function, we can display the videos.

Combining three modules together we get out completed Rider Assistant System. As per the Fig.1 , the system takes inputs from the camera (live video) and LiDAR (live distance), and are given to Odroid. Odroid XU4 is a new generation computation device that offers open source support. Here the board runs on an Ubuntu 16.04 OS. Some software that supports objection detection and image processing libraries are installed on Odroid XU4. Using OpenCV libraries system take the live stream from the camera and then use TinyYOLOv3 model to detect vehicles in it. NumPy, SciPy, Matplotlib, h5Py, TensorFlow, Keras Etc. are used with YOLO to detect and recognize vehicles.

Odroid detects vehicles from the live streaming video from the camera, also takes distance from the LiDAR sensor, if the distance less than threshold and Odroid detect a vehicle an alert is generated through the buzzer. This helps the rider be more vigilant. The videos from camera are live streamed through a local host shared by Odroid via its digital port in digital system [14]. Using Flask we create a micro framework, though it rider can access the live video on any device that supports HTML connected on the same port address as the one Odroid broadcasts on. Hardware components and its use is shown in Fig.2.

IV. RESULTS AND DISCUSSION

The system can be used on every vehicles which runs on some form of energy/power source. But this system is more necessary in a motorbikes where the safety of the rider is less compared to other vehicles such as cars, jeeps etc. Also, it is easy for motorbike rider to easily avoid collision once it is detected since the space it requires is small which makes the system highly efficient in avoiding collisions on motorbike. The blind spot and disadvantage of side view mirrors are compensated with our proposed system.

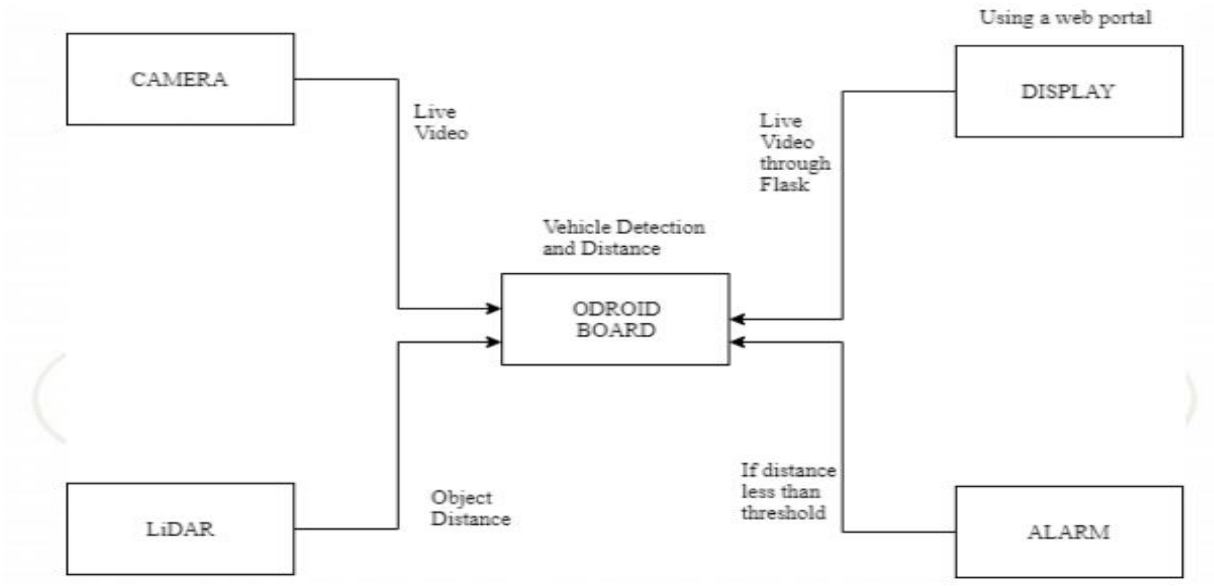

Fig.2. Hardware Components and its use

Vehicles coming through the blind spot are detected, usually a rider has to adjust his mirrors in order to get his desired view or he has to turn around to get the desired view and this is dangerous to do when the vehicle is in motion. Our system eliminates this hazard by detecting the vehicles coming and alerts the rider. The rider can be vigilant and take precautions to avoid collisions, this can also act as a security feature and record videos too.

YOLO has been selected as the vehicle detection model because of its efficiency and accuracy in real time. It uses COCO dataset that contain large amount of data. Here we specifically use TinyYOLOv3 which is faster than YOLO due to its architecture in layers. Vehicles can be detected with accuracy between 40% and 100%.

Camera records the video and the algorithm works to detect the object in the video. If the object detected is listed as an obstacle, then the distance of the detected obstacle from the blind spot is measured. LiDAR sensor is used to measure distance due to its high accuracy, its measurement ranges from .15 meters to 12 meters. So it can accurately identify object distance. Then distance of the obstacle from the vehicle is compared with the threshold value. If the distance is less than the threshold value, then an alert is given to the user.

The live video streaming with the obstacle detection can be seen on the user's mobile phone. By hearing the warning alarm, the rider can understand that there is an obstacle which is near his bike and there is a possible chance of collision. By viewing the video in his mobile screen which is fitted to the bike using a mobile holder, he can see the obstacle without even turning back and can easily avoid the possible collision. The alarm resets when the distance of the vehicle goes above the threshold value. It can also be set to give warning to the rider for a few seconds and then stop until the alarm is reset. This helps to avoid continuous warning alarm in traffic where there will be vehicles behind the bike but the chances of collision is very small. The system is small and compact since its components are small and therefore can easily be fixed on a bike without looking bulky. The efficiency of the system can be increased by using high quality cameras which can capture videos at high resolution which in turn helps in increasing the detection ratio.

V. CONCLUSION

Proposed rider assistant system helps to avoid collisions by warning the rider about any probable chance of collision by detecting obstacle that may hit the bike at its blind spot. The system detect obstacles continuously from the blind spot of the bike , and in case if any obstacle is found it looks for the distance and if the distance is less than threshold, the system warns the user and streams the live video into the users mobile phone screen. This helps the rider to find the obstacle without turning back and thus reduce the chance of accident that may occur while turning back and the rider can do necessary steps to avoid collision. The future scope of the rider assistant system includes using sensors to find the various parameters of the bike such as oil condition, air pressure etc. to know the condition of the bike and inform the rider whether a service is required or not. Also, the current fuel available in the fuel tank can be found out by using sensors and the available mileage details of the bike is used to find the average distance the bike will travel with the available fuel and information can be given to the user about the same.

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AUTHORS PROFILE

Jisha Mariyam John, has completed her degree in Computer Science & Engineering from Cochin University. She did her Masters in Computer Science from MG University, Kerala. She is currently working as Assistant Professor in Computer Science department in Providence College of Engineering, Kerala. She has a teaching experience of more than four years. She has published her works in various international journals. Her areas of interest include ML, Discrete Mathematics, Data Science and Image processing.

Hariharan R L has completed his degree in Computer Science & Engineering from Kerala University. He did his Masters in Networking from VIT. He is presently working as Assistant Professor in Computer Science department in Providence College of Engineering, Kerala. He has a teaching experience of more than three years and industrial experience of one year. His areas of interest include Machine learning, Network security and cryptography, Data Science