Project Assignment – 1
Research paper Review and Summary

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Architecture for determining the cleanliness in shared vehicles using an integrated machine vision and indoor air quality-monitoring system

Understanding the structure of research article:

After studying the paper Architecture for determining the cleanliness in shared vehicles using an integrated machine vision and indoor air quality-monitoring system Article I understood the importance of the headings. (Nilusha Jayawickrama, 2023)

- The article's abstract provides a synopsis. It provides us with a concise summary of the key points and concepts together with problem, methods to investigate, findings and conclusions.
- Key words used in the article for reference.
- Introduction to the problem question with background information and context. It gives us significant understanding and contribution of the research.
- The methods section describes the study's methodology in full, allowing readers to judge if the study was carried out correctly and appropriately.
- Results provides us with tables, figures, and graphs that show the study's conclusions. primarily gives us the solutions to the problem statement.
- The author outlined the study's and review's shortcomings, as well as suggestions for additional research and recommendations, in the Discussions section.
- The main conclusions, significance, and highlights are provided in the conclusion section, along with contributions to the field.
- References provides us with a list of the research sources used together with a correct citation and crediting them.

Moreover, a clean presentation that includes photographs, graphs, tables, visuals, and most significantly, side headings, with good font style, colours, and size.

Primary research Questions:

The author's study report provides answers to the following key research questions:

1. Is it possible to improve passenger comfort and cleanliness by using computer vision to reliably detect and anticipate the kind and location of remaining things in a shared vehicle?
2. How well does the algorithm that was created forecast remaining items in various light and shadow conditions?
3. How long does it take the algorithm to execute, from captured images to display the results in a remote server?
4. Can an indoor air quality unit identify air pollutants inside the car, and can a cleanliness level be determined from the IAQ index?
5. How accurate would this be in actual shared vehicles? Can the two-systems item detector and air quality monitor be utilized to detect relevant objects and create a level of cleanliness?
6. In order to increase the algorithm's precision and efficiency, how can the present dataset be increased by gathering information from actual shared vehicles that are already in use?

Summary of why the author considers them important:

The research, according to the author, is significant because it addresses a key problem with the use of shared vehicles, which is the hesitancy of passengers to use them due to levels of interior cleanliness resulting from leftover items from previous users. The project intends to improve passenger comfort and cleanliness by using a computer vision model capable of recognizing and predicting the type and position of remaining items in a shared car interior. The indoor air quality is also thought to be crucial for identifying certain air pollutants and creating an IAQ index that reflects a certain degree of cleanliness. The study's findings, which had an accuracy of 89% for specific classes of residual things and an accuracy of 91% for general classes of garbage and treasures, were seen favourably by the author. In addition, the author provides a private dataset of 1379 raw photos available to the public for use in future research and development. In order to increase the dataset's precision and applicability, the author plans to include data from actual shared vehicles that are really in use for the algorithm. (Nilusha Jayawickrama, 2023)

Methods used for the study:

The initial goal of the project was to create a system for evaluating the cleanliness of shared automobiles using integrated machine vision, and the second goal was to create a system for monitoring indoor air quality. A camera to capture input photos of the car, an algorithm to generate a prediction model to ascertain the level of cleanliness, and a system architecture for secure data transmission, execution, and storage make up the three parts of the system.

Using a single camera on one side of the rear cabin, the camera was intended to take pictures of the rear sitting area of the vehicle, including the floor and backrest. The camera module has to be simple to install, compact, modular for component replacement, long-lasting use, easy for troubleshooting, and affordable.

The study team combined a dataset they had collected themselves with pictures they had imported from Kaggle and the Trashnet. An open-source website called Kaggle gives users access to pre-existing datasets that may be used to develop unique prediction models.

The prediction model is based on the Efficientdet object detection model, which includes a weighted bi-directional feature pyramid network (BiFPN) that enables optimized feature fusion and offers the capability of uniformly scaling the backbone, feature network, and prediction network's resolution, depth, and width. The version of the Efficientdet object detection model that was employed in this investigation was initially trained using 100,000 images from the COCO dataset spread across 170 classes. In contrast to COCO's more general classes, the ones needed to achieve the prediction aims of the current system are more application specific. As a result, it was unable to implement the Efficientdet detection model directly in the system.

Overall, the study developed a system to assess the cleanliness of shared vehicles using an integrated approach of machine vision and inside air quality monitoring. The system made use of a camera module to take pictures of the vehicle's backseat, a dataset for computer vision detection, and a prediction model that expands on the Efficientdet object detection model.

Summary of the findings, limitations, and future research needed:

The study provided a methodology for assessing the level of cleanliness in shared passenger vehicles. The architecture included an interior air monitoring system to detect the levels of particular air pollutants within the vehicle, an in-car camera unit to capture images of the rear seating area, and a specially created algorithm based on the Efficientdet CNN-based object detection model.

The study assessed the effectiveness of the platform used to execute the implemented algorithm. The study indicate that the vision-based system had an overall accuracy of 89% across six different classes and a binary classification accuracy of 93% in its ability to identify objects in the vehicle's rear seating area. The study also developed IAQ indexes based on particular air pollutants to analyse the air quality inside the car, and the findings demonstrated that these indexes were capable of doing so effectively.

Although there were notable external causes of variation in the results, such as light levels and shadows, vehicle type, and camera placements, there were noticeable internal factors of specific errors in the data, such as false negatives caused by a lack of vision. These drawbacks imply that additional study is required to increase the system's accuracy and reliability as well as to test it in various real-world scenarios to determine how well it performs in various kinds of shared passenger vehicles.

Reference:

Jayawickrama, N., Ollé, E. P., Pirhonen, J., Ojala, R., Kivekäs, K., Vepsäläinen, J., & Tammi, K. (2023). Architecture for determining the cleanliness in shared vehicles using an integrated machine vision and indoor air quality-monitoring system. *Journal of Big Data*, *10*(1). https://doi.org/10.1186/s40537-023-00696-6