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AI-Based Performance Analysis of YOLOv8 for Computer User Health Monitoring: Posture, Drowsiness, and Eye Gaze Detection

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4BSCS-1

Abstract

Abstract

- The proposed paper aims to develop and analyze a multiple AI solution model for computer user health monitoring using YOLOv8 if it is an effective model or not.
- The multiple AI solutions for these focuses solely in posture, drowsiness and eye gaze.
- The measurement of performance of the model was measured in terms of mean Average Precision (mAP), Precision, and Recall.
- The conclusion of this study is that the YOLOv8 is indeed effective as it gives high mAP, precision and recall, hence rejecting the null hypothesis.

Introduction

Background of the Study:

- Continuous usage of computers can lead to habits such as improper posture, which is one related computer health issue.
- Improper posture can cause disturbances in the musculoskeletal balance and may disturb physiological processes other than the musculoskeletal system (Fathima et al., 2024).
- Developing a multiple AI solution model that uses YOLOv8 for computer user health monitoring.
- The multiple AI solutions for these focuses solely in posture, drowsiness and eye gaze.

Objectives

The objectives of this study are as follows,

1. To develop a model that uses YOLOv8 to monitor computer users' posture and detect unhealthy sitting positions.

2. To develop a model that uses YOLOv8 to identify signs of drowsiness.

3. To develop a model that uses YOLOv8 to analyze eye gaze patterns, when the eyes are close or not.

4. To evaluate the effectiveness of the model by its performance using mAP, Precision, and Recall.

Literature Review / Studies

Previous Applications of YOLO Models

- YOLOv3 was successful in demonstrating for detecting of fruits and other agricultural products with impressive accuracy and speed (Lawal, 2021).
- YOLOv4 has introduced afterwards wherein its performance in terms of accuracy and speed was better when it was put into use as a detector that identifies face masks, which will be effective for public health monitoring (Yu & Zhang, 2021).
- YOLOv5 further improved, giving greater speed and accuracy than YOLOv4 and YOLOv3, which just continues to improve the model itself as time goes by (Zhang et al., 2022).
- YOLOv8 is recently very reliant as it is recently being used in the medical field, where it was used to detect brain tumor and medical imaging (Patel et al., 2024).

Use in Health Monitoring and Ergonomics

- Traditional techniques have been highly based on the self-reported questionnaire or observational study. This kind of approach has often suffered bias from recall and measurement errors (Gao et al., 2021).
- Recent approaches have been the use of wearable devices, wherein it gives improved accurate, and objective ways of measuring physical activity and sedentary behavior. (Stefana et al., 2021).
- Another approach is by using computer vision wherein a recent study presented on detecting upper body sedentary behaviors with cameras to capture images of the user's posture (Guduru et al., 2021).

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Comparative Analysis of Object Detection Models

- Compared to other object detection models like Faster R-CNN and YOLO models, it was compared and results to that YOLO being better in performance making YOLO ideal for real-time applications (Abdulghani & Menekşe Dalveren, 2022).
- Then now YOLOv8 improves on its previous models when it comes to balancing of speed and accuracy (Mohan et al., 2024).

Challenges and Future Directions

- The challenges that can occur in object detection are such as customizing the dataset itself considering the variation of pixels, processing of low-resolutions, handling different sizes of multiple objects, the availability of the labeled data, and handling overlapping objects (Diwan et al., 2022).
- More datasets can result to better performance of a model.

Research Gap or Hypothesis

Research Gap

- **Limited AI multiple solution models:** Current AI models in health monitoring rarely address multiple issues simultaneously.
- **Focus on single health issues:** Recent studies focus on single health concerns, such as posture detection, using tools like IoT and MediaPipe (Sreevani et al., 2024).
- **Lack of integrated health solutions:** A comprehensive model for detecting posture, drowsiness, and disengagement (via eye gaze) is lacking.

Hypothesis

- **Null Hypothesis (H_0):** YOLOv8 does not effectively detect posture, drowsiness, and eye gaze in computer users with low mAP, precision, and recall, which makes it not a reliable model for computer user health monitoring.
- **Alternative Hypothesis (H_1):** YOLOv8 can effectively detect posture, drowsiness, and eye gaze in computer users with high mAP, precision, and recall, which makes it a reliable model for computer user health monitoring.

Methodologies

Dataset Collection

- The datasets that were used to train the models are from Roboflow which are already annotated and labeled with its specific class names.

Dataset Preprocessing and Augmentation

- Techniques such as stretching it by 640 x 640 and auto orientation were used before proceeding to the data augmentation.
- The techniques used in data augmentation varies per dataset with their specific purposes.

Model Training

- Using YOLOv8, the researchers trained their models with the annotated and labeled datasets.
- YOLOv8 is known for its reliability lately than other newer YOLO models such as YOLOv9 and YOLOv11

Evaluation Metrics

- The models were evaluated using metrics such as mAP/mAP50, precision, and recall.
- For more deeper insights of the model's performance, the researchers used additional metrics such as mAP50-95, Confusion Matrix, F1-Score, Box loss, Classification loss, and Distribution Focal loss

Data Splitting

- By dividing it into three separate parts: training data, validation data, and test data, we can be sure that the model doesn't just use the same datasets for training.

Results and Discussions

Posture Model Metrics

mAP50 for Posture

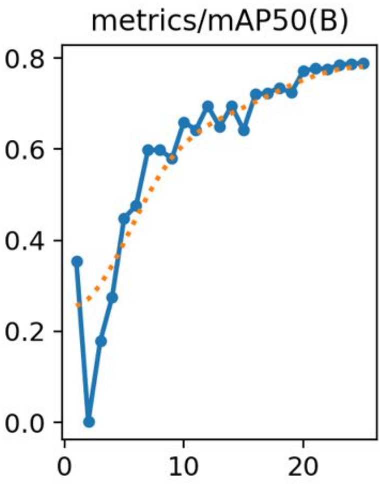

Figure 1: mAP50 - Confidence Curve for Posture

- **mAP50 epoch 1 ≈ 0.35424 or 35.4%**
- **mAP50 epoch 24 ≈ 0.78798 or 78.8% (optimal)**
- **mAP50 epoch 25 ≈ 0.789 or 78.9%**
- **This improvement indicates the model's enhanced ability to accurately localize and classify objects with moderate performance sustaining within the final epochs.**

Precision for Posture

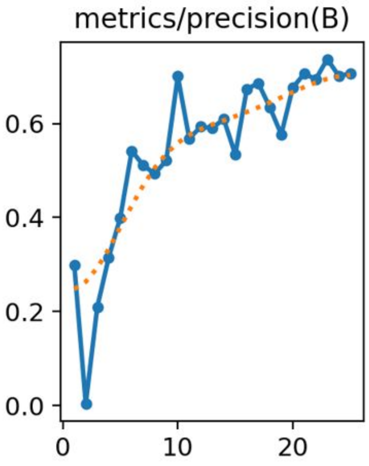

Figure 2: Precision for Posture

- **Precision epoch 1 ≈ 0.29952 or 30.0%**
- **Precision epoch 24 ≈ 0.70137 or 70.1% (optimal)**
- **Precision epoch 25 ≈ 0.70614 or 70.6%**
- **This indicates that as the training progresses, the model becomes better at identifying correct posture classes, but it could have an improvement to have a higher precision overall.**

Recall for Posture

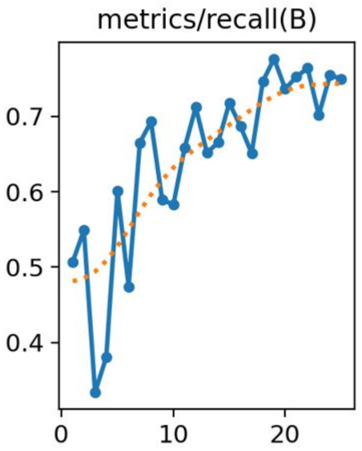

Figure 3: Recall for Posture

- **Recall epoch 1 ≈ 0.50708 or 50.7%**
- **Recall epoch 24 ≈ 0.75461 or 75.5% (optimal)**
- **Recall epoch 25 ≈ 0.7502 or 75.0%**
- **This implies that the model improves at capturing relevant instances as training goes on, but improvements can be done as it may still be able to achieve a higher overall recall.**

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Drowsiness Model Metrics

mAP50 for Drowsiness

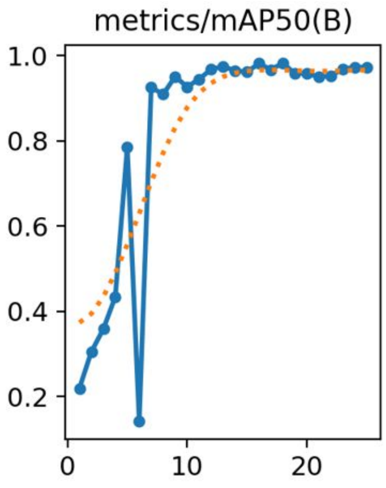

Figure 4: mAP50 for Drowsiness

- **mAP50 epoch 1 ≈ 0.21902 or 21.9%**
- **mAP50 epoch 25 ≈ 0.97229 or 97.2% (optimal)**
- **This improvement indicates the model's enhanced ability to accurately localize and classify objects with high performance sustaining within the final epochs.**

Precision for Drowsiness

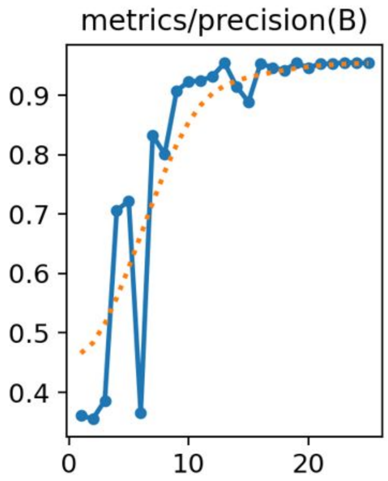

Figure 5: Precision for Drowsiness

- **Precision epoch 1 ≈ 0.36134 or 36.1%**
- **Precision epoch 25 ≈ 0.95448 or 95.4% (optimal)**
- **This indicates that as the training progresses, the model becomes better at identifying the correct drowsy class, wherein this model is highly effective at it.**

Recall for Drowsiness

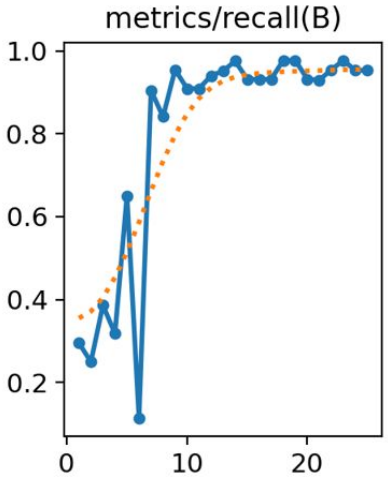

Figure 6: Recall for Drowsiness

- **Recall epoch 1 ≈ 0.29545 or 29.5%**
- **Recall epoch 25 ≈ 0.9532 or 95.3% (optimal)**
- **This implies that the model has a high effective ability in capturing relevant instances as it even improves as training goes on.**

Eye Gaze Model Metrics

mAP50 for Eye Gaze

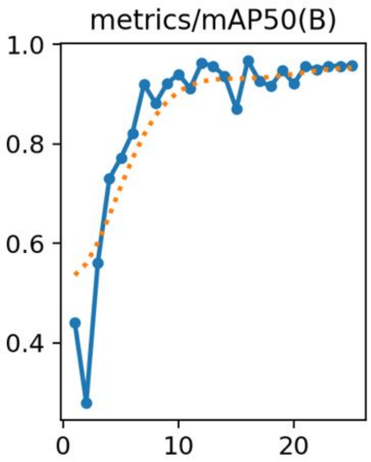

Figure 7: mAP50 for Eye Gaze

- mAP50 epoch 1 ≈ 0.44136 or 44.1%
- map50 epoch 22 ≈ 0.9496 or 95.0% (optimal)
- mAP50 epoch 25 ≈ 0.95751 or 95.8%
- This improvement indicates the model's enhanced ability to accurately localize and classify objects with high performance sustaining within the final epochs.

Precision for Eye Gaze

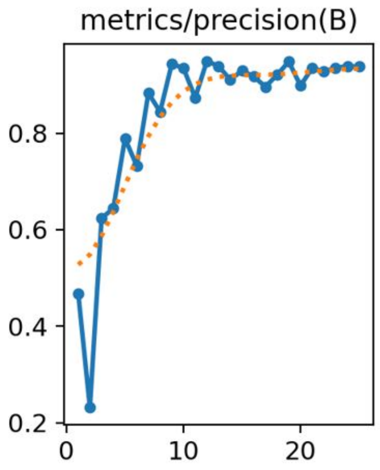

Figure 8: Precision for Eye Gaze

- **Precision epoch 1 ≈ 0.46839 or 46.8%**
- **Precision epoch 22 ≈ 0.9274 or 92.7% (optimal)**
- **Precision epoch 25 ≈ 0.95751 or 95.8%**
- **This depicts that as training goes on, the model improves its ability to recognize the appropriate eye gaze class, which makes the model effective in doing the task.**

Recall for Eye Gaze

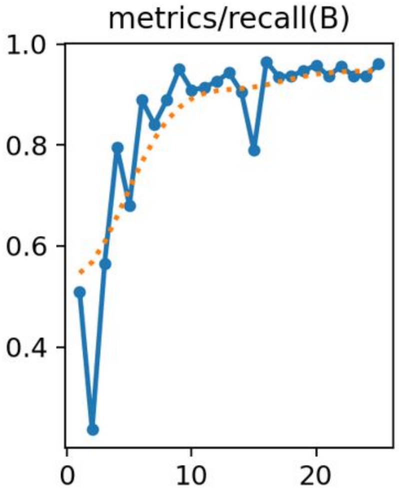

Figure 9: Recall for Eye Gaze

- **Recall epoch 1 ≈ 0.50877 or 50.9%**
- **Recall epoch 22 ≈ 0.95586 or 95.6% (optimal)**
- **Recall epoch 25 ≈ 0.96053 or 96.1%**
- **Given that it even gets better with training, this suggests that the model has a high effective ability to capture relevant instances.**

Conclusion

Conclusion

- This research aimed to develop and evaluate an object detection model using the YOLOv8 architecture to accurately identify and classify health related issues of computer users. The researchers used 3 models and combined it into one for deployment, and the study concludes that the YOLOv8 is effective for computer user health monitoring, which therefore rejects the null hypothesis. This study can help in assisting computer users to keep their health in check and avoid any issues concerning their well-being.

Model Results

Posture Detection Model

Drowsiness Detection Model

Eye Gaze Detection Model

Figure 10: Model Results from Roboflow

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