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*Abstract*—Mechanical object detection has recently become one of the crucial parts of the industry. The merge of deep learning offers a method to detect these objects. However, the small size of mechanical objects faces the challenge of achieving high average precision. To address this issue, this paper presents an improved YOLOv10 framework for mechanical parts. We propose a new attention mechanism modified SimAM (M-SimAM) to extract the significant features, which is integrated into the Head component of YOLOv10. This additional detection Head is introduced to improve the performance of small-size object detection. The proposed method is trained with the Mechanical Parts Computer Vision Project dataset and achieves mean Average Precision (mAP) at IoU threshold 50 scores of 90.8%. The experiment result illustrated that the proposed method has better accuracy than others.

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# Introduction (*Heading 1*)

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1 ARTICLE YOLOV5

1 ARTICLE YOLOV7

Introduce Yolov10:

New component:

* PSA
* C2fcib
* scdOWN

# PROPOSED SINTERING DETECTION METHOD

Although YOLOv10 is state-of-the-art for object detection, there are still areas that need improvement to achieve higher accuracy. Mechanical parts such as nuts, bolts, or bearings in the working site are often either small or tiny in size. For the original model, the recognition of such mechanical parts may fail due to insufficient extraction of local and global information. It leads to missing objects during the real-time detection task. Therefore, we proposed the new YOLOv10s model with an attention mechanism to address this issue. This mechanism can learn and calculate the information from input data to output data automatically, which enhances the ability to detect small-size or minimal-size objects.

## NEW YOLOV10s ARCHITECTURE

The proposed method is the improved YOLOv10s model, which combined to M-SimAM mechanism. The overall network architecture of the proposed method is shown in Fig. 1. First, the backbone from YOLOv10s to extract the mechanical part feature maps.

The backbone ‘s feature aggregation is collected based on PANet in the neck.

Next the modified SimAM (M-SimAM) is integrated into the Head to enhance the crucial information in neuron networks before classifying the object and calculating loss function. It effectively mitigates information loss, consequently increase the accuracy of detection task.

For the input image, it is scaled the originally size to 640x640. Next these feature maps are downed sampling in Neck part, the output feature map shape is 20x20, 40x40, and 60x60 to detect multiple objects with specific size.

## MODIFIED SIM-AM (M-SimAM)

* Replace activation function from sigmoid to Hswish
* Add channel shuffle at the end of SIM AM method
* Optimal parameter g in channel shuffle network

Identify applicable funding agency here. If none, delete this text box.

| **Independent Variables** | Value | Parameters | mAP@50 |
| --- | --- | --- | --- |
| Output channel (*g*) | 2 | 8069448 | 86.9% |
| 4 | 8069448 | 90.4% |
| 8 | 8069448 | 90.3% |
| **16** | **8069448** | **90.8%** |
| 32 | 8069448 | 90% |

1. Comparision Result

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Method | Parameters | mAP@50 | | | | Precision | Recall | F1 | mAP@50 |
| Bearing | Bolt | Gear | Nut |
| YOLOv5s (1) | 7.2M | - | - | - | - | 88.5% | 80.3% |  | 88.2% |
| YOLOv5m (1) | 21.2M | - | - | - | - |  |  |  | 90.1% |
| YOLOv8s | 11.1M | 86.2% | 89.1% | 73.6% | 93.6% |  |  |  | 85.6% |
| YOLOv9s | 9.7M | 89% | **91.6%** | 82.8% | 96.8% |  |  |  | 90% |
| YOLOv10s | 8M | 91.5% | 89.8% | **82.9%** | **97.9%** |  |  |  | 90.5% |
|  |  |  |  |  |  |  |  |  |  |
| Ours | 8M | **91.8%** | 90.5% | 82.2% | 97.8% |  |  |  | **90.8%** |

# EXPERIENCE RESULT

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## DataSet

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## Experiment Results

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Our experimental results are published at <https://github.com/MAK1647/ACOMPA_2024_MECHANICAL_PART_DETECTION.git>

#### Loss

FDF

Loss org

Loss our

#### Matrix Point

Org

Ours

## Visualization of the Prediction Result

Besides manifold comparision for proposed YOLOv10s with M-SimAM via the metrics of mAP, P, R, and F1 score. The example of the detection results is shown in Fig.

# Conclusion

This study presents an improved new base on YOLOv8s, which integrated the I-GAM module. The I-GAM module has chosen the activation function from Sigmoid, ReLU to H-swish, and optimized the hyper-parameters to enhance the quality of parameters and achieve the best accuracy. The experimental result demonstrates that the proposed method achieves the best mAP@90 at 91.1% and a speed of around 31 FPS. Nevertheless, there is still a limitation in detecting PPE with a very small anchor box in a crowded region and disorderly environment. We will keep enhancing the algorithm's detection accuracy and implement it on the production line.

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