Development of mushroom bud-thinning strategy model based on deep learning and image processing

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Introduction

Mushroom bud-thinning is important to improve the quality of high-value mushrooms. Nowadays, most mushroom bud-thinning strategies depend on experienced mushroom farmers, lacking objective references. The purpose of this study is to develop a mushroom bud-thinning strategy model to standardize the bud-thinning strategy of mushroom farmers.

Mushroom bud-thinning issues

- Labor-intensive
- Hard to passing on experience
- Time-consuming
- Lacking objective references
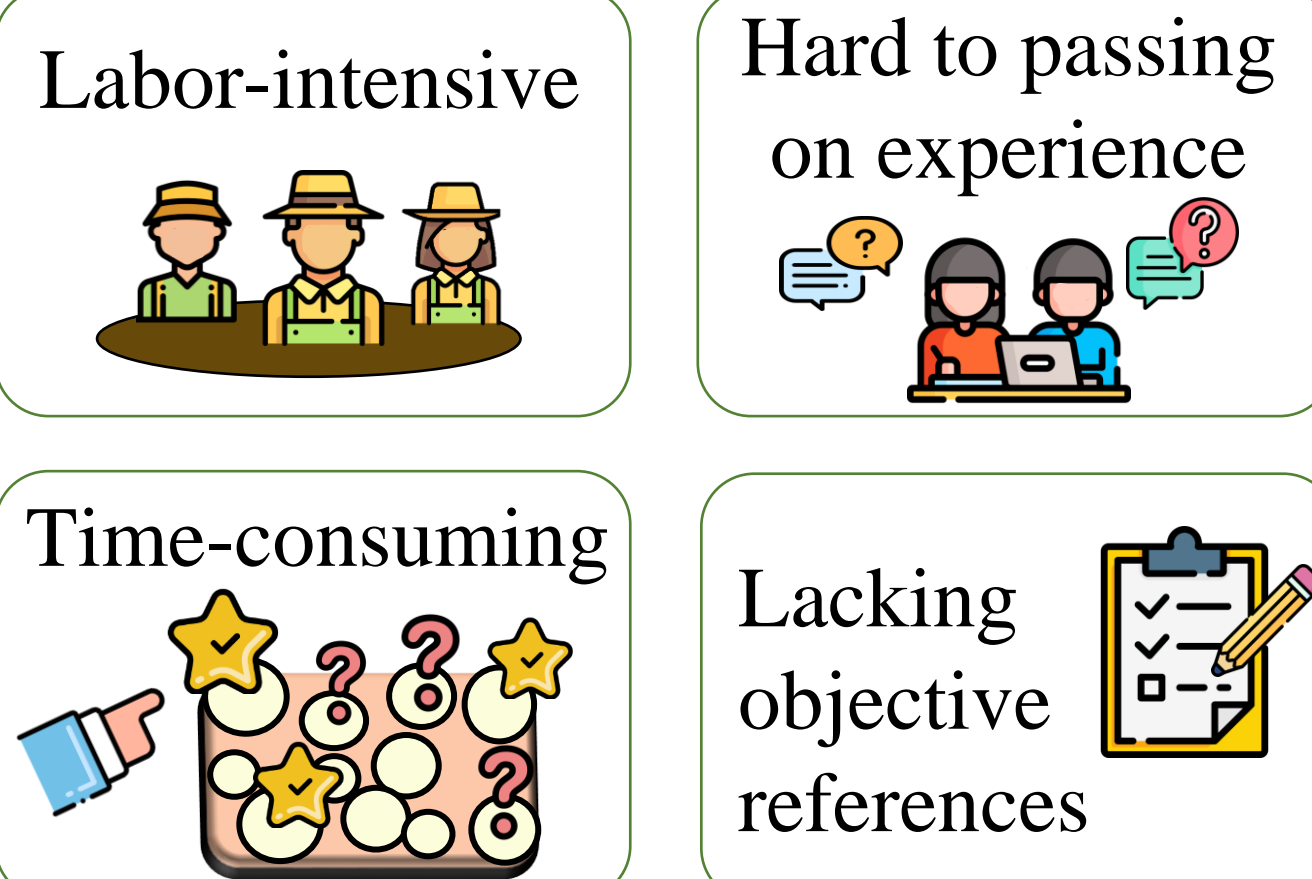
Data Collection

Using a web camera to collect 200 mushroom bag images. The collected images are sent to experts to predict bud-thinning strategies.
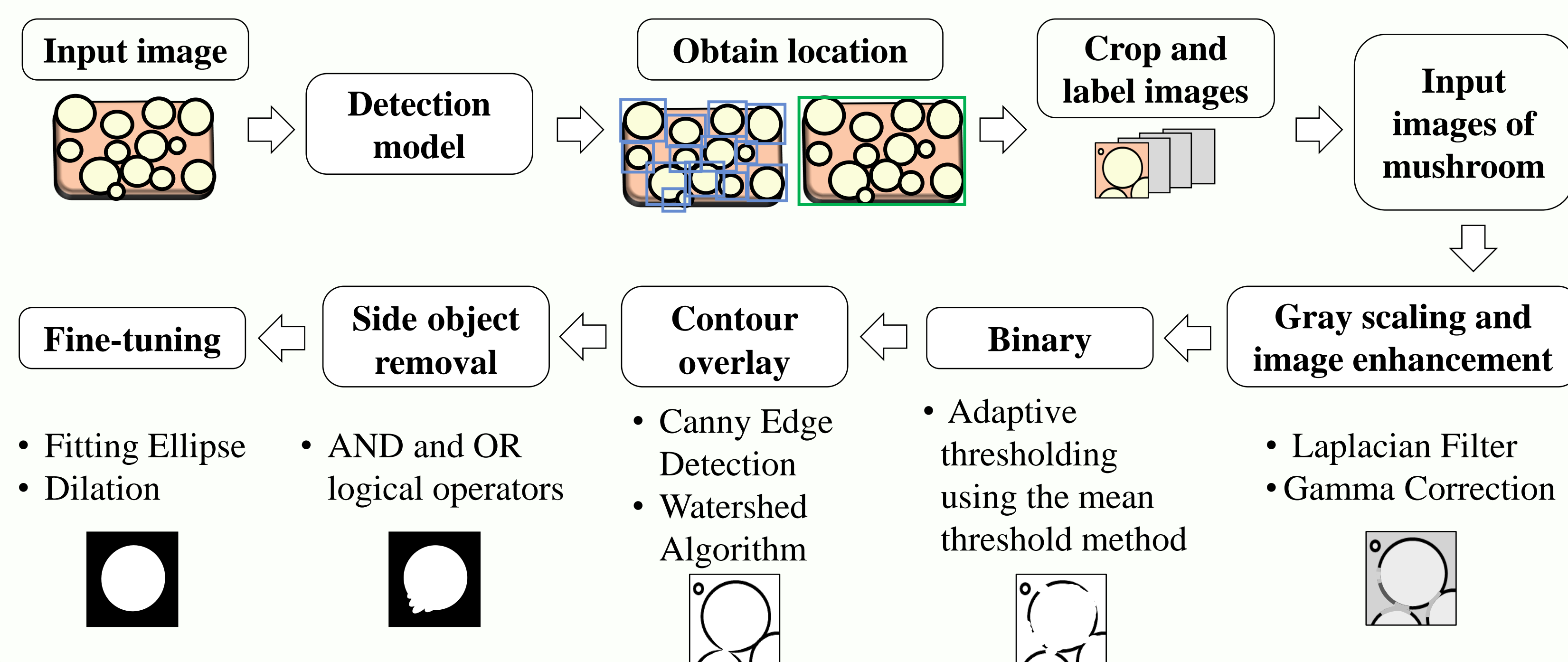
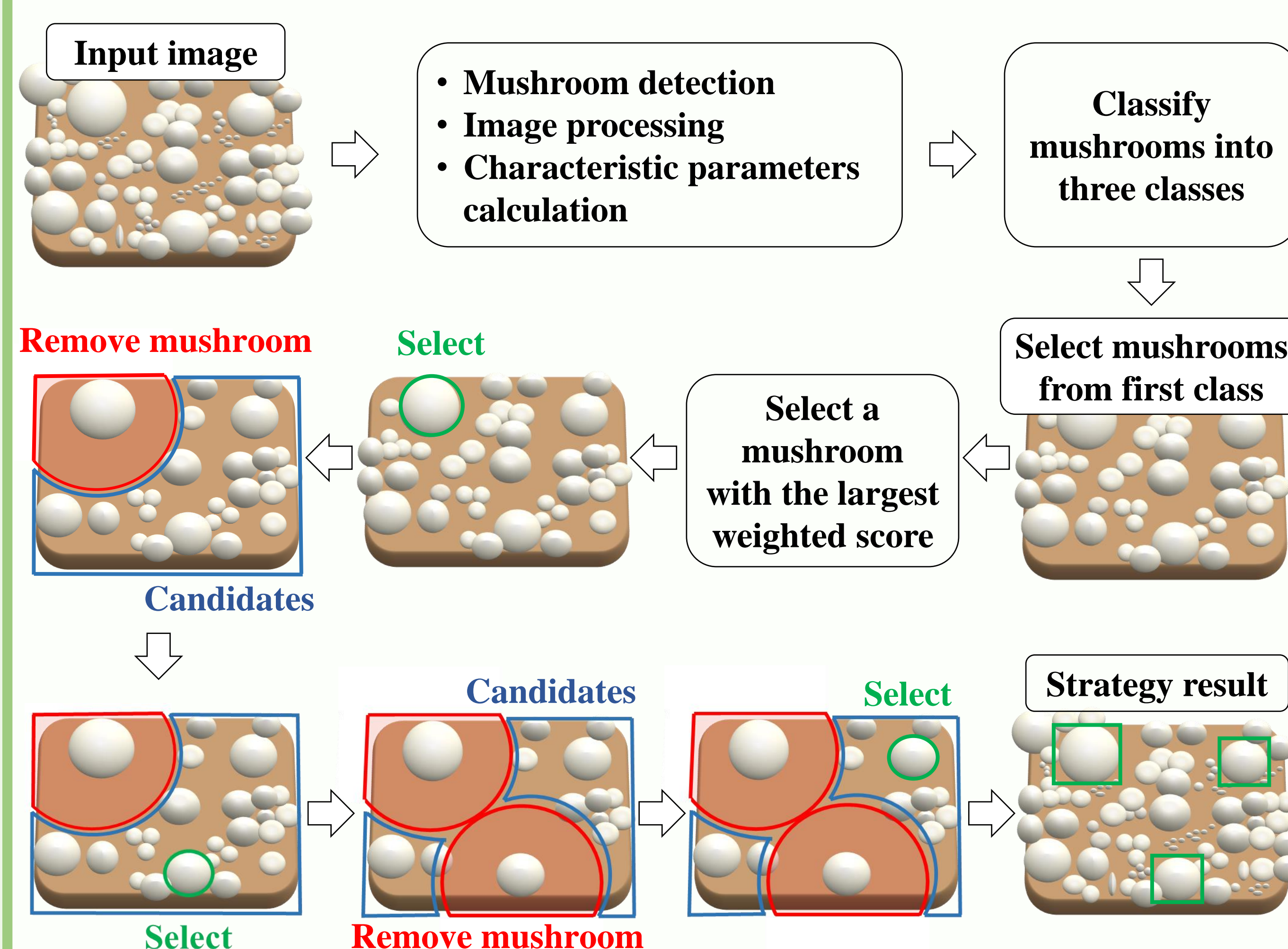Image of mushroom bag

Expert prediction of bud-thinning strategy

Deep Learning and Image Processing

➢ Using YOLOv4 to training mushroom and mushroom bag detection model.
  - Train quantity: 100 images; test quantity: 25 images
  - Training type: mushroom and mushroom bag
➢ Through image processing to separate foreground and background from mushroom images.
➢ Calculating characteristic parameters of each mushroom, including size, roundness, weighted score, actual distance and growing position.

Input image → Detection model → Obtain location → Crop and label images → Input images of mushroom

Fine-tuning ← Side object removal ← Contour overlay ← Binary ← Gray scaling and image enhancement

- **Fine-tuning**
  - Fitting Ellipse
  - Dilation
- **Side object removal**
  - AND and OR logical operators
- **Contour overlay**
  - Canny Edge Detection
  - Watershed Algorithm
- **Binary**
  - Adaptive thresholding using the mean threshold method
- **Gray scaling and image enhancement**
  - Laplacian Filter
  - Gamma Correction

Strategy Algorithm

Establishing a mushroom bud-thinning strategy algorithm according to characteristic parameters and the farmers' experience.

Input image → • Mushroom detection • Image processing • Characteristic parameters calculation → Classify mushrooms into three classes → Select mushrooms from first class → Select a mushroom with the largest weighted score → Remove mushroom / Select (Candidates)

Candidates → Select / Remove mushroom → Strategy result
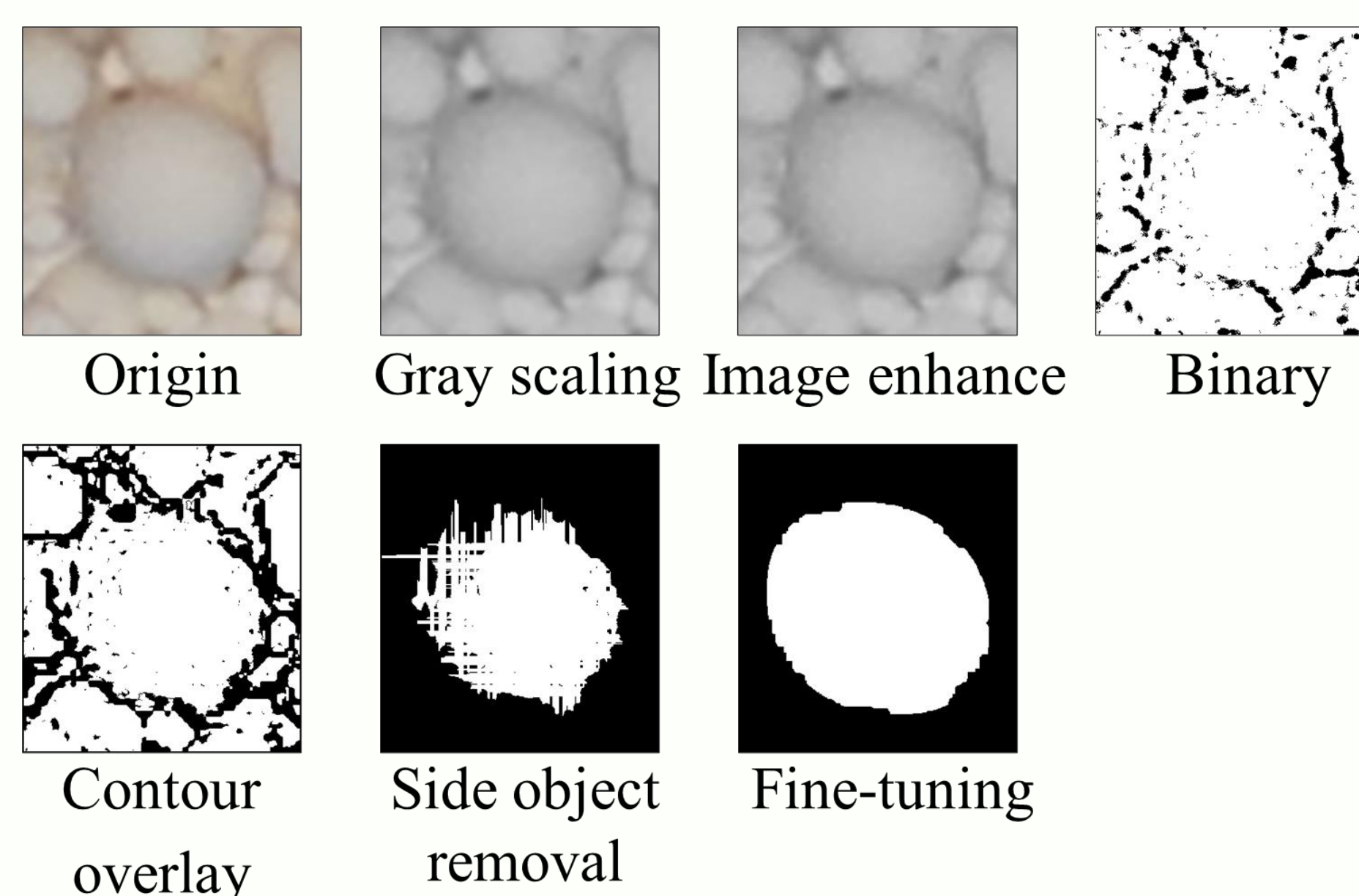
Results and discussion

Deep Learning

➢ Mushroom bag have better result due to the size and density.
➢ The total precision, accuracy, and mAP are 82%, 75% and 93%, respectively.

| Type	Precision	Recall	AP/mAP
Mushroom	81%	75%	86%
Mushroom Bag	100%	100%	100%
Total	**82%**	**75%**	**93%**

Image Processing

➢ Outlines of mushroom can be found even the mushroom has unclear outline or grow intensively.

Origin | Gray scaling | Image enhance | Binary

Contour overlay | Side object removal | Fine-tuning

Bud-Thinning Strategy Model

➢ By adjusting the weight of parameters, the size of mushroom is more important than the roundness of mushroom.
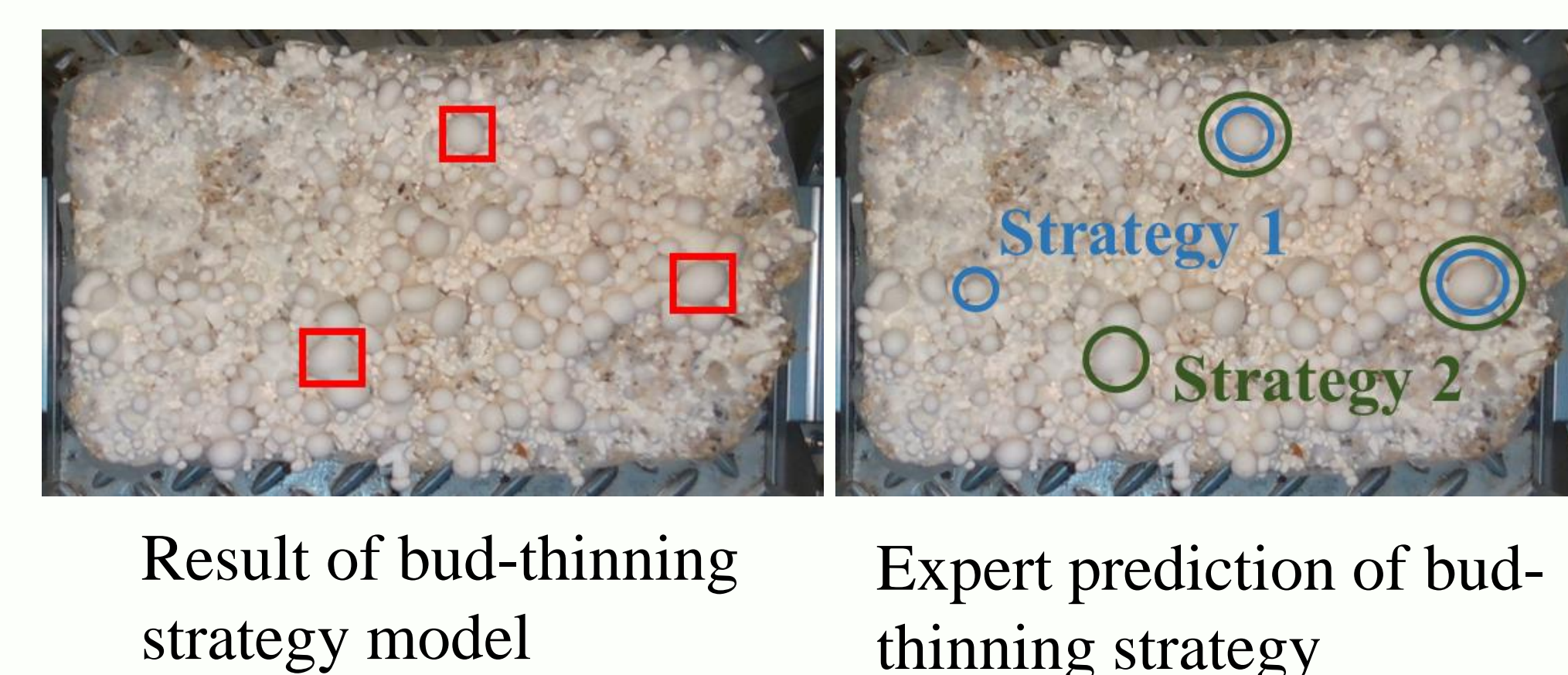
Result of bud-thinning strategy model

Expert prediction of bud-thinning strategy

Strategy 1
Strategy 2

Conclusion

➢ This study bases on deep learning and image processing to develop a mushroom bud-thinning strategy model.
➢ This model is capable of providing similar strategies, made by accomplished and experienced farmers.
➢ In the future, this model could be utilized in augmented reality glasses so that mushroom farmers can obtain convenient bud thinning strategies even in narrow mushroom houses.