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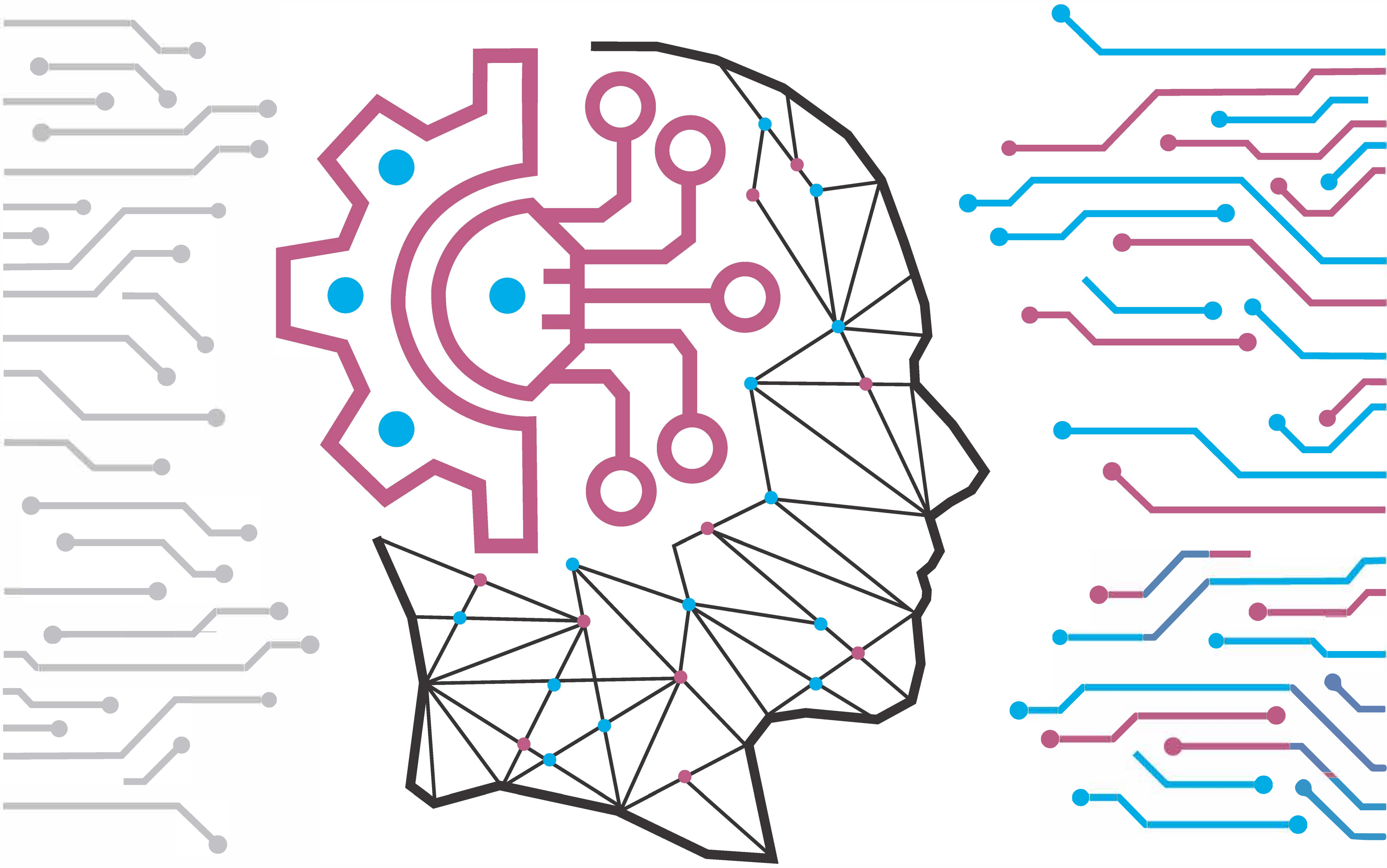

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EXTENDED ABSTRACTS

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ASSISTED APPROACHES FOR FOREST AND NON-FOREST GROUND TRUTH ANNOTATION IN SATELLITE REMOTE SENSING IMAGES

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ABSTRACT

This paper presents a methodology for enhancing ground truth annotations in satellite remote sensing images using Python and OpenCV's SimpleBlobDetector. Focusing on a dataset from Chini Lake, Malaysia, the study adjusts threshold values and employs additional algorithms to reduce noise. The findings demonstrate significant accuracy improvements, with an average of 97.60% using the DeepLabV3+ algorithm. This paper highlights the importance of robust ground truth annotations for ecological monitoring and suggests future research directions.

Keyword: ground truth, forest, non-forest, forest monitoring, annotation

1. INTRODUCTION

Ground truth is essential in scientific research, data analysis, and machine learning, serving as a reliable benchmark for validation (Jelas et al., 2023). Establishing ground truth requires rigorous methods to navigate constraints and uncertainties. This research focuses on iteratively processing blobs of various sizes using Python, leveraging the SimpleBlobDetector method from OpenCV. The aim is to detect and enhance blobs within images by employing markers and fillers, particularly targeting residual noise.

2. METHODOLOGY

The data was collected from Google Earth Pro, focusing on Chini Lake in the Pekan District, Pahang, Malaysia. Figure 1 shows acquisition from December 31, 2000, centered at coordinates 3°22'32.82"N latitude and 102° 36' 11.18"E longitude. This data spans a range of 137,500 meters from the Earth's surface to the satellite, ensuring comprehensive coverage.

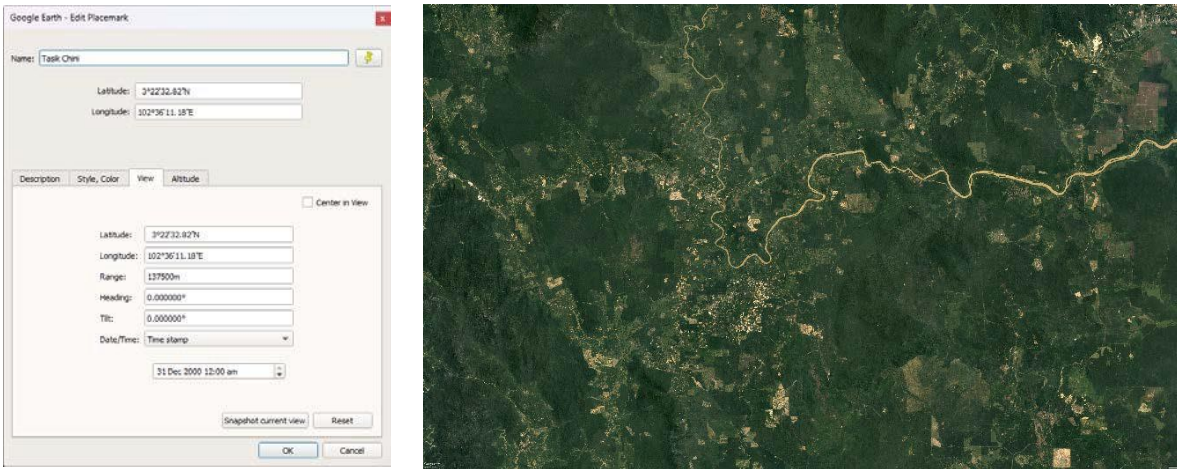
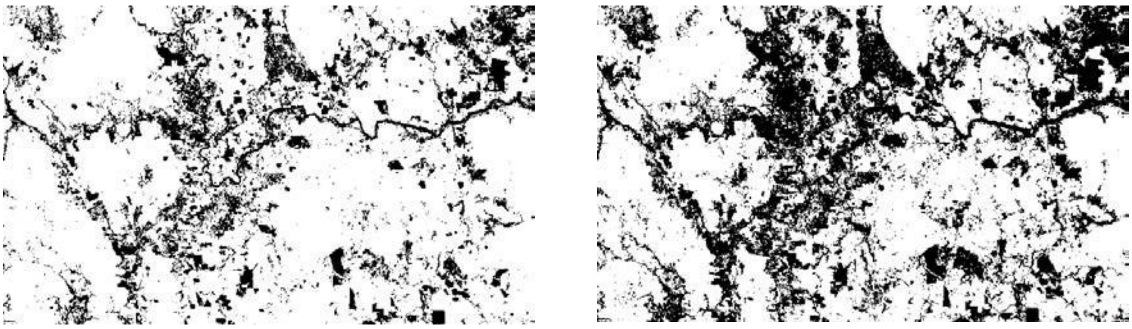


Figure 1 Data collected from Google Earth Pro focusing on Chini Lake in Pekan District, Pahang, Malaysia.

In pursuit of initiating an assisted approach for annotating forest and non-forest ground truth within satellite remote sensing images, the methodology algorithm by Jelas et al. (2023) is leveraged. However, upon assessing this approach with the specific data in Figure 1, it was discovered that the original threshold value of 82.0, determined using Otsu's method, was not optimal for the dataset. Consequently, the decision was made to reduce the threshold by 10.0% to a value of 73.0, as illustrated in Figure 2.



(a) Threshold Image at 82.0 using Otsu's method (b) Threshold Image at 90.0% of Otsu's method

Figure 2 Comparison between threshold image with 100.0% (82.0) and 90.0% (73.0) Otsu's method

Figure 2(b) demonstrates a significant enhancement in both the accuracy and relevance of ground truth annotations within the specific context of the data captured over Chini Lake, in contrast to Figure 2(a). Nevertheless, residual noise persists in Figure 2(b), highlighting the necessity for further refinement to generate a more precise and robust ground truth representation. Therefore, additional algorithms using Python-based SimpleBlobDetector from OpenCV are proposed to refine the ground truth annotation further.

```
Algorithm 1: SimpleBlobDetector with marker and filler

Get  the  process_image

Initialize diameter_size to 1.00

While diameter_size <= 3.00:
    Run SimpleBlobDetector on the process_image and store
detected blobs

    For each detected blob:
        Copy the original_image as original_image_copy
        Copy the process_image as refine_image

        Count the number of color1 pixels in
original_image_copy and store it as original_color1_pixel

        Calculate marker size as diameter_size * diameter

        Draw a color2 marker on the blob's coordinates in
refine_image
        Fill the marker with color1

        Count the number of color1 pixels in the updated
refine_image and store it as updated_color1_pixel

        Calculate pixel_changes as updated_color1_pixel -
original_color1_pixel

        If pixel_changes <= 1000:
            Update process_image with refine_image
        Else:
            Keep process_image as original_image

    Increment diameter_size by 0.25
```

```
Algorithm 2: Running the SimpleBlobDectector

Algorithm 1 will be run 8 times as follows:

1. process_image = inverted image where forest = black & non-forest = white where color1 = white & color2 = black

2. process_image = non-inverted image where forest = white & non-forest = black where color1 = white & color2 = black

3. process_image = inverted image where forest = black & non-forest = white where color1 = black & color2 = white

4. process_image = non-inverted image where forest = white & non-forest = black where color1 = black & color2 = white

5. process_image = inverted image where forest = black & non-forest = white where color1 = white & color2 = black

6. process_image = non-inverted image where forest = white & non-forest = black where color1 = white & color2 = black

7. process_image = inverted image where forest = black & non-forest = white where color1 = black & color2 = white

8. process_image = non-inverted image where forest = white & non-forest = black where color1 = black & color2 = white
```

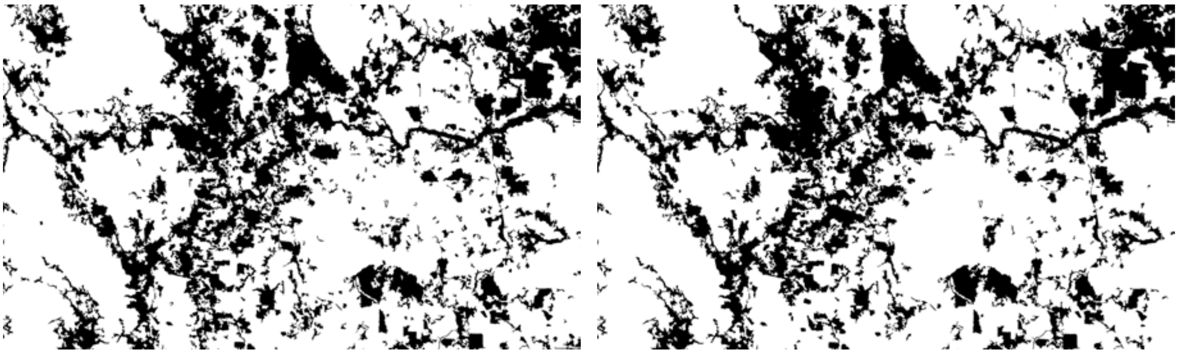
Algorithm 1 aims to detect and enhance blobs within an image by utilizing markers and fillers. It iterates through a loop, detecting and processing blobs of various sizes. Initially, the algorithm employs the SimpleBlobDetector method, with parameter values detailed in Table 1, to detect blobs in the current image. For each detected blob, it calculates the number of color1 pixels in the original image, draws a marker with color2 on the refined image, and fills it with color1. If the pixel difference is below a predefined threshold (1000), indicating minimal alteration, the refined image replaces the original in subsequent processing; otherwise, the original image remains unchanged. Throughout the iterations, the marker's diameter increases incrementally to accommodate blobs of progressively larger sizes.

Table 1 SimpleBlobDetector Parameter Values (Font size10)

Filter Parameter Value	**Threshold**	**Area**	**Circularity**	**Convexity**	**Inertia**
Minimum	0.000001	0.000001	0.000001	0.000001	0.000001
Maximum	200	1000	1000000	1000000	1000000

In line with Algorithm 2, Algorithm 1 is executed eight times, each time with variations in the initial image (referred to as process_image) and the colors used for markers and fillers (color1 and color2). This approach aims to comprehensively analyze and enhance blob detection across different configurations of the input image and color settings.

3. FINDINGS



(a) Initial ground truth annotation (b) Final ground truth after expert refinement

Figure 3 Comparison between initial ground truth annotation and final ground truth.

Figure 3(a) depicts the initial ground truth annotation generated by combining the proposed algorithms with the algorithm by Jelas et al. (2023). The process took 1 hour, 39 minutes, and 25 seconds. Despite being produced through assisted approaches, the initial ground truth remains susceptible to inaccuracies, particularly false annotations caused by cloud cover. Figure 3(b) presents the meticulously refined final ground truth, verified through thorough data cleaning and validation, which involved expert manual comparison.

The final ground truth shown in Figure 3(b) is partitioned into 224×224 pixels images, resulting in a total of 756 tile masks. Subsequently, a random selection comprising 70% of these masks is utilized as input for training the DeepLabV3+ deep learning algorithm. This approach yields an outstanding average accuracy of 97.60%.

4. CONCLUSION

This research contributes to the development of robust and accurate ground truth annotations for satellite remote sensing imagery, facilitating improved analysis and decision-making in ecological and environmental monitoring applications. Future work may extend the methodology to broader geographic regions and incorporate additional machine-learning algorithms for further refinement and validation.

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Jelas, I. M., Zulkifley, M. A., & Abdullah, M. (2023). Automated Ground Truth Annotation for Forest and Non-Forest Classification in Satellite Remote Sensing Images. In 2023 4th International Conference on Artificial Intelligence and Data Sciences (AiDAS) (pp. 331-336). IPOH, Malaysia. doi: 10.1109/AiDAS60501.2023.10284683.

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