Comparison Between Machine Learning–Based Coral Identification and Traditional Manual Interpretation Using Living Coral Reef Imagery from Xio-Liu-Qiu Island, Pingtung, Taiwan

Project Background

Coral reefs are among the most biodiverse marine ecosystems on Earth and serve as important indicators of environmental change. Monitoring coral reef health commonly relies on estimating coral cover and identifying coral colonies from field surveys or high-resolution imagery. However, traditional coral identification and reef coverage estimation largely depend on manual interpretation, which is time-consuming and can vary among observers. Recent developments in artificial intelligence (AI) and machine learning have provided new opportunities for automated ecological monitoring. Image recognition techniques can potentially identify coral colonies and calculate reef coverage more efficiently from high-resolution images. Despite these advantages, the reliability and accuracy of AI-based coral identification compared with traditional manual interpretation remain insufficiently evaluated, particularly in complex reef environments.

Project Objectives

This undergraduate summer research project focuses on comparing the differences between AI-based coral identification and traditional manual interpretation using high-resolution imagery from living coral reefs in Xiao-Liu-Qiu Island, Pingtung, Taiwan.

The specific objectives include:

1. Establishing a labeled coral image dataset from high-resolution images of living coral reefs in Xiao-Liu-Qiu Island.
2. Applying machine learning techniques to automatically identify coral colonies.
3. Estimating coral reef coverage using both manual interpretation and AI-based recognition.
4. Quantitatively comparing the results from the two approaches to evaluate differences in identification accuracy, efficiency, and potential biases.

Methods

Students will use high-resolution underwater photographs or orthomosaic images of coral reefs collected from Xio-Liu-Qiu Island. Coral colonies will first be manually identified and annotated to create a reference dataset.

Machine learning models (e.g., convolutional neural networks or image segmentation models) will then be applied to detect coral colonies automatically. Coral coverage and spatial distribution will be calculated using both manual interpretation and AI-assisted recognition. Statistical analysis will be conducted to evaluate differences in coral identification accuracy and reef coverage estimation between the two methods.

Expected Outcomes

The project is expected to produce:

- A labeled coral reef image dataset from Xio-Liu-Qiu Island
- AI-based coral identification results
- A quantitative comparison between AI recognition and manual interpretation
- A preliminary workflow for applying machine learning in coral reef monitoring

What will be learned from doing this project:

This project provides interdisciplinary training for undergraduate students in coral reef ecology, marine environmental monitoring, image analysis, and machine learning applications. Students will gain hands-on experience in ecological data interpretation and basic AI techniques while contributing to innovative approaches for coral reef monitoring and conservation.

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屏東小琉球現生珊瑚礁影像機器學習辨識結果與傳統人工判讀之差異比較

計畫背景

珊瑚礁是全球生物多樣性最高的海洋生態系之一，也是監測海洋環境變遷的重要指標。評估珊瑚礁健康狀態時，通常需要透過野外調查或高解析度影像來辨識珊瑚群體並計算珊瑚覆蓋率。然而，目前多數珊瑚辨識與覆蓋率估算仍依賴人工判讀，不僅耗時，也可能因不同觀察者而產生判讀差異。隨著人工智慧（AI）與機器學習技術的快速發展，影像辨識已逐漸應用於生態監測領域。利用 AI 模型可望從高解析度影像中自動辨識珊瑚群體並計算覆蓋率，大幅提升分析效率。然而，在複雜的珊瑚礁環境中，AI 辨識結果與傳統人工判讀之間的差異與準確度仍需要進一步評估。

計畫目標

本暑期大學生研究計畫以屏東小琉球現生珊瑚礁為研究區域，透過影像分析方法，比對 AI 辨識結果與傳統人工判讀之差異，評估兩種方法在珊瑚辨識與覆蓋率計算上的可靠度。

主要研究目標包括：

1. 建立小琉球現生珊瑚礁影像之標註資料庫。
2. 利用機器學習模型進行珊瑚群體影像辨識。
3. 分別利用人工判讀與 AI 辨識計算珊瑚礁覆蓋率。
4. 透過統計分析比較兩種方法在辨識準確度、效率與結果差異上的表現。

研究方法

本研究將利用小琉球現生珊瑚礁的高解析度水下影像或攝影測量所建立的正射影像作為研究資料。首先由學生進行人工標註珊瑚群體，建立訓練與驗證資料集。接著利用機器學習影像辨識模型（如卷積神經網路或影像分割模型）進行 AI 辨識分析，自動辨識珊瑚群體並計算覆蓋率。最後將 AI 辨識結果與人工判讀資料進行統計比較，以評估兩種方法在珊瑚辨識與覆蓋率估算上的差異。

預期成果

本研究預期成果包括：

- 小琉球現生珊瑚礁影像標註資料庫
- AI 珊瑚辨識分析結果
- AI 辨識與人工判讀結果之比較分析
- 建立珊瑚礁影像 AI 分析之基礎流程

學生將會學到：

本計畫結合珊瑚礁生態、海洋環境監測、影像分析與人工智慧等跨領域知識，使學生透過實際研究學習影像處理、資料分析與 AI 模型應用，培養跨領域科學研究能力。