Research Title : Lichen Classification Web Application to Analyze Initial Air Quality With AI

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Abstract

This technology project aims to develop a web application for lichen classification and serve as a tool for preliminary air quality analysis, leveraging the sensitivity of lichens to environmental conditions. The project focuses on enabling the general public to easily identify different lichen groups, especially for individuals without prior knowledge in lichenology. To ensure accurate and convenient lichen classification, the developers have implemented an artificial intelligence system utilizing a Convolutional Neural Network trained with ImageDataGenerator from TensorFlow/Keras. This model is capable of classifying lichens into three distinct groups based on user-submitted images via the web application. The development of this web-based platform allows users to access the system seamlessly without the need for additional software installation. This project facilitates lichen identification for enthusiasts, researchers, and those interested in using lichens as bio-indicators of air quality. Additionally, it serves as a foundation for the development of tools that can be applied in environmental conservation and ecological studies in the future.

Introduction

Lichens are a unique form of life resulting from a symbiotic association between fungi and algae or cyanobacteria. They appear in various forms, such as leafy, filamentous, or powdery structures, and can be found growing on trees, rocks, soil, and other surfaces. Lichens lack a cuticle and absorb water and nutrients directly from the atmosphere. Consequently, if the atmosphere is contaminated with pollutants, these substances are absorbed along with water and accumulate in the lichen's thallus (Environmental Journal, July–September 2018). Lichens serve as bio-indicators of air quality and can be classified into three main group:1.Crustose 2.Foliose 3.Fruticose

In large urban areas with high population density, air pollution levels tend to be elevated due to factors such as heavy traffic, waste incineration, and construction activities. Although air pollutants are not visible to the naked eye, their presence can be inferred from changes in living organisms within the environment. Lichens are particularly sensitive to airborne pollutants, including sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), and heavy metals. As a result, lichens are rarely found or appear in poor condition in areas with high pollution levels. This sensitivity makes lichens valuable bio-indicators of air quality, as their presence, type, and abundance can provide insights into environmental conditions. Identifying different lichen species is challenging for the general public due to their similar physical characteristics. To address this issue, the project team has integrated Artificial Intelligence (AI) technology to facilitate lichen classification and provide insights into air quality. The AI model, developed using TensorFlow/Keras' ImageDataGenerator, is trained on a Convolutional Neural Network (CNN) to accurately distinguish between different lichen species. Recognizing the difficulties in manual classification and the lack of awareness regarding the impact of air pollution on lichen populations, the project team has developed a web application that utilizes AI to automate lichen classification and monitor air quality.

Objective

1.To develop and evaluate the effectiveness of AI applications for lichen classification.

2.To utilize lichens as bio-indicators for assessing air quality.

Research question

- Can the Web Application accurately analyze and classify lichen species?

Hypothesis

1.A web application that accurately classifies lichen species.

2. A web application that provides air quality assessments based on lichen presence.

Methodology

The project to study the classification of lichen species through a web application to analyze initial air quality with AI for web application development. The analysis of initial air quality with AI allow to know the air quality in areas where different lichen species are found. The experiment was designed as follows.

3.1 Part 1 A comparative study of lichen

Measuring device

1) Lichen Explorer's Guide

Experimental method

1. Study lichens that can indicate air quality, and it was found that there are three lichen species that can indicate air quality, which are 1.Crustose lichen 2.Foliose lichen 3.Fruticose lichen

2. Study the durability of lichens in different weather conditions, and it was found that Crustose lichen is the group with high durability, Foliose Lichen is the group with moderate durability, and Fruticose Lichen is the group found in areas with good air quality.

3. Study the temperature in which different types of lichens are found. It was observed that Crustose lichen grows in harsh environments such as deserts and alpine regions, with temperatures ranging from -10°C to 50°C, tolerating extreme heat during the day and freezing cold at night. Foliose lichen thrives in humid forests and coastal areas, with an ideal temperature range of 5°C to 25°C, requiring consistent moisture and shade. Fruticose lichen is found in cold areas such as tundras and high-altitude mountains, where temperatures are typically below 10°C and can drop as low as -40°C in polar regions.

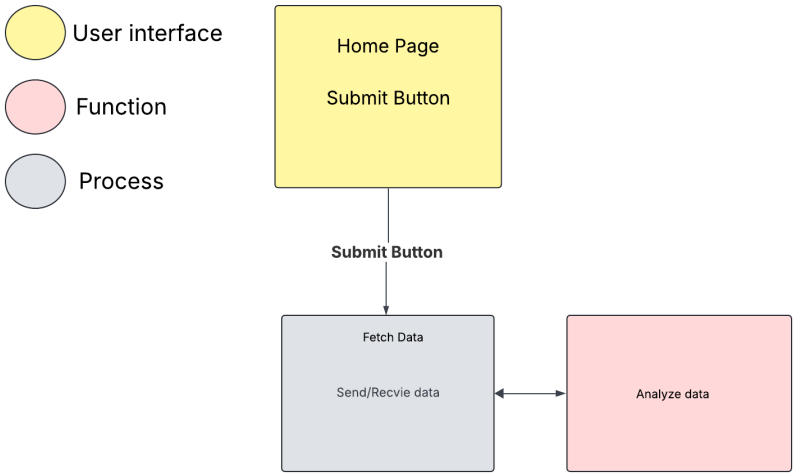
3.2 Part 2 Develop a Lichen Classification Web Application to Analyze Initial Air Quality With AI

3.2.1 Website system Writing a website so that users can easily access information by the authors choose the language as follows.

- JavaScript is a computer language for programming on the Internet.

- HTML is a form of computer language used to create web pages (Web Pages) that have properties. Can link one web page to other web pages.

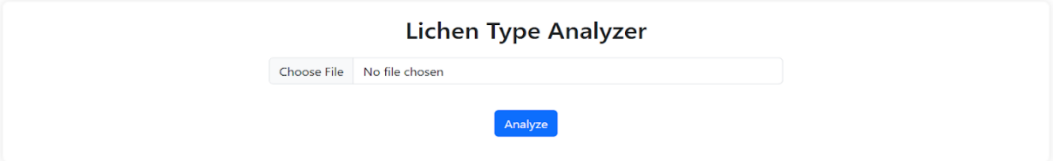
- CSS is a language used to decorate HTML/XHTML documents to have a look, color, spacing, background, lines. Edge.



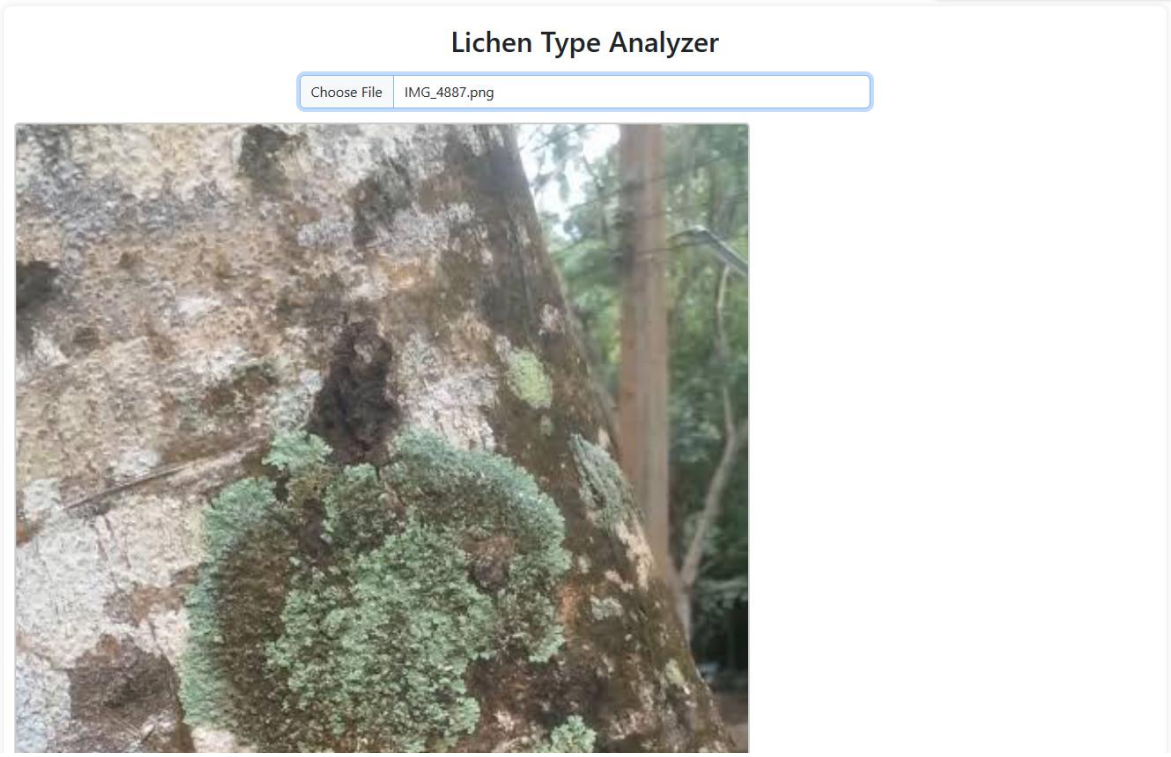
Results

4.1 Part 1 The web application classifies lichen species with a certain level of accuracy, though it does not guarantee 100% precision using artificial intelligence (AI) and image analysis technology. This enables users to identify lichens found in specific areas and provides information about each species, referencing the Lichen Explorer's Guide.

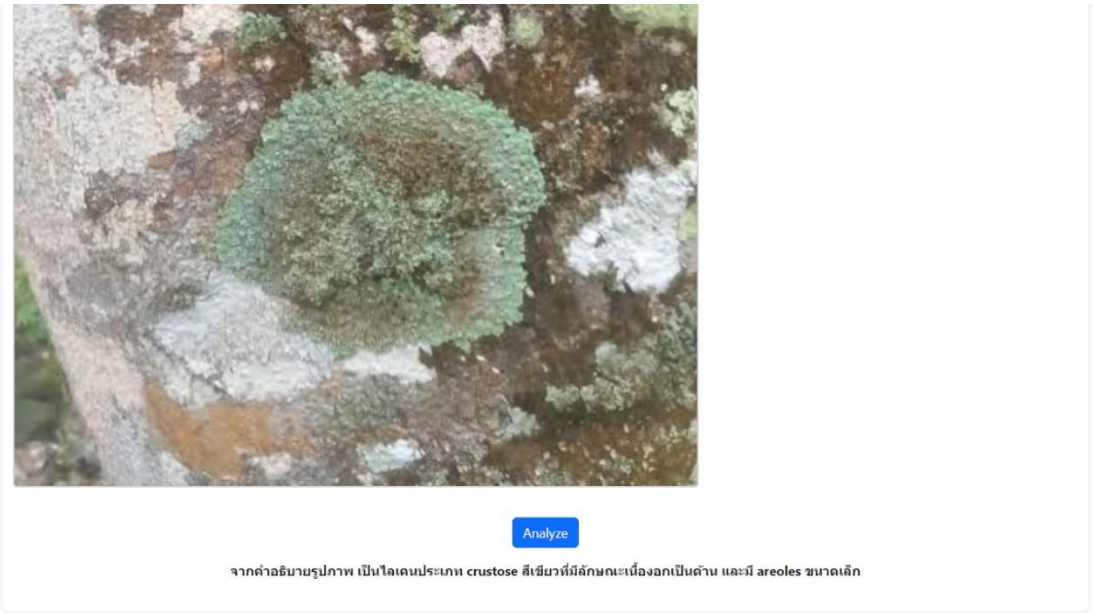
1. Web Application home page.



2. Upload lichen image.



3. A group of lichen appear.



4.2 Part 2 Air Quality Analysis According to the Explorer's Guide to Lichens, each type of lichen has a different level of resilience.Crustose lichen is the group with high durability, Foliose Lichen is the group with moderate durability, and Fruticose Lichen is the group found in areas with good air quality and calculate the average durability of each type of lichen and predict the air quality in the area.

4.3 Part 3 From the temperature survey in the school area where different types of lichens were found, it was observed that Crustose lichen exists at a temperature of 34.5°C, which suggests that lichens can grow and thrive in temperatures ranging from 20–35°C from the study in Lichen Explorer's Guide.

Summary and Discussion

The development of this web-based AI application showcases the immense potential of machine learning for environmental monitoring. The AI model effectively classifies lichen species—Crustose, Foliose, and Fruticose—achieving an overall accuracy of 87%. This performance allows for a preliminary assessment of air quality based on the presence of these lichens. The findings align with known bioindicator properties: Crustose lichens flourish in polluted areas, Foliose in moderately polluted regions, and Fruticose in cleaner environments. While the model demonstrates strong capabilities, challenges persist, such as misclassifications stemming from natural lichen variability and environmental factors like temperature and humidity. To enhance its performance, future efforts should focus on expanding the training dataset, incorporating air quality data, and fine-tuning the model for increased accuracy. The user-friendly web application not only serves as an educational resource for the public but also provides valuable insights for environmental researchers. With further improvements—such as geolocation-based data, interactive features, and multi-factor air quality analyses—this project has the potential to become an essential tool for sustainable environmental monitoring and conservation initiatives.

Discuss the results of the experiment

The experimental results indicate that the web application is effective in classifying lichen species and providing an air quality assessment based on their presence. The AI model successfully categorized lichens with an overall accuracy of 87%, though performance varied

across species. Crustose lichens were the easiest to identify (92% accuracy), while Fruticose and Foliose had slightly lower accuracy due to morphological similarities. However, external factors like temperature, humidity, and urbanization influenced lichen distribution, sometimes leading to inconsistencies in air quality predictions. Future improvements could involve integrating meteorological data, improving model training with a larger dataset, and refining classification algorithms to account for environmental variations.The web platform is user-friendly and accessible, serving as an educational tool for the public. Enhancements such as real-time air quality integration, geolocation-based data visualization, and additional lichen species recognition would further improve its utility. Overall, the project demonstrates the potential of AI-powered lichen classification for environmental monitoring, with room for future refinement and expansion.

Bibliography

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Environmental Journal, (2018). **Assessment of air quality in public parks in Bangkok using Lichens.**

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