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Crowdsourcing for the identification and conservation of the floral diversity of Nepal: A technological perspective

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Abstract

Nepal is rich in biodiversity in terms of both flora and fauna. While significant effort has been given to the conservation of wild animals, rare or otherwise, same cannot be said for the floral diversity of the country. In fact, due to significant challenges, the floral diversity of the country remains largely unexplored. The system proposed in this paper tries to overcome those challenges by using technology to aid the collection of information about the floral diversity of the country by crowdsourcing at a local level, using the image data collected for the plant identification by using machine learning or through expert users/volunteers.

Keywords: Plant identification, machine learning, crowdsourcing, floral diversity, citizen science.

1. Introduction

Variation in altitude, climate and topography as well as a unique geographical has endowed Nepal with diverse plant and animal species making it one of the richest countries in terms of biodiversity in the world, given its small size. With an area that only makes up for 0.1% of the total land area of the world, Nepal is home to around 6,391 flowering plants, out of which more than 300 species are endemic [1]. Apart from housing more than 2% of flowering plants of the world, Nepal also has 3% of the pteridophytes and 6% of the bryophytes of the world flora [2].

Although the floral biodiversity is an important part of every ecosystem andis vital to the continued existence of all living beings , it is largely neglected as compared to faunal biodiversity in Nepal in terms of both exploration and conservation. Although identification and conservation of important plants has been carried out around Kathmandu valley and selected conservation areas, the remote areas are yet to be fully explored.

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Conservation efforts implemented in any country largely depends on the accurate information they have about the floral diversity itself [3]. In case of Nepal however, the same geographical conditions which have endowed Nepal with such rich floral diversity have also created challenges in the their identification and conservation. About 63 % of the endemic flowering plants of Nepal grow in high Himalayas which means that it might not always possible for experts to visit the site for its identification and the local people might not be aware about its identification and importance. Although the difficult geography and lack of facilities may hinder experts from being present on site, through the use of technology, we could empower local people to take action for the identification and conservation of the plants especially medicinal herbs and endangered species through indirect communication to experts or expert system via crowd sourcing platform.

With advancement in technology, crowdsourcing has seen wide spread use, especially in the time of emergencies like Natural disasters. Crowdsourcing through Social Media and Crisis mapping used during the most devastating disasters like the Haiti Earthquake of 2010 and 2105 Nepal earthquake by not only raising funds for the victims but also facilitating indirect communication between rescue and relief workers and the victims [4, 5, 6]. Apart from disasters, crowdsourcing is used by business ventures for cheap and profitable marketing and it is also the core of many applications like Be My Eyes, an application to assist blind people [7, 8].

Existing websites like ispot, iNaturalist and Discover Lifemake use of crowdsourcing for the identification of organisms. *Zilli* et al. [9] proposes crowdsourcing through a smartphone application to monitor endangered species like New Forest cicada by detecting its mating call. Pl@ntNet, a smartphone based plant recognition application allows users to identify plants by photographing them. Leafsnap is another plant recognition application that uses image of the leaf for identification. Similar to Leafsnap, Flora Finder uses leaves for identifying the plant. However, Flora Finder uses both automatic recognition as well as manual recognition of the plant [10].

However, the local people living in the remote parts of Nepal will be less inclined to use these global platforms mainly due to language barrier as people in those areas may not be familiar with English language. So for the system to be widely accepted in Nepal, it would require an additional crowdsourcing functionality or translation system for translating the content from English to Nepali.

The approach proposed in this paper uses makes use of technologies like machine Learning along with crowdsourcing at local level to facilitate data collection,identification and conservation of floral diversity in the country.

2. Use of Machine Learning in Plant Recognition

With advancement in computer vision, we are now able to recognize objects with high level of precision. In case of plants, two of the most used organs for recognition are leaves and flowers. Apart form leaves and flowers researchers have also proposed methods for identification of plants based on their bark and fruits [11, 12, 13]. Usually, the expert systems will classify the plant based on feature extraction from single organ like leaf or flower of the plant. However, Nhan *et al.* [1] shows that multi-organ images can be used for more accurate identification of plants by using fusion schemes. Study on use of neural networks for multi-organ plant identification has also shown that multi-organ identification are more efficient as compared to single organ identification techniques [12].

In single organ plant identification, Ye *et al.*, [14] describes a web-based application that uses image processing for plant identification based on the features of its leaves like leaf apex angle, leaf base angle, and leaf width-height ratio. Ehsanirad [15] used image processing for identification of plant based on the texture of its leaf. On a different approach, Wu *et al.* [16] used Probabilistic Neural Net-work (PNN),image and data processing techniques to identify plants based on the features of the leaves. Hsu *et al.* [8] proposed an interactive flower recognition system that uses

color and shape features to identify the flower. Apart from leaves and flowers, tree bark can also be used for classification of tree species [11].

3. Proposed System

The proposed system consists of an end user smart phone application that can be used to photograph the plant of interest. A machine learning system classifies the plant based on the features extracted from the picture. If the system is successful in identifying the plant, information about the species is displayed in the user screen along with its status(IUCN categories from least concern to extinct). If the system is unable to classify the system, it will categorize the plant as unclassified. Botanical experts can manually identify the plant through the system as well as verify the identification made by others.
The proposed system consists of the following sub systems:

3.1. End user application

User can interact with the system through a smart phone application which will have functionalities to take picture of the plant, verify the identification made by other users as well translate desired content into Nepali/ English language. The data collected by the user about the plants is stored in the database along with its location.

3.2. Machine Learning Model

A machine learning model trained to identify plants based on multiple organs is ideal for the proposed model. The training data set can be obtained from the existing databases that contain images of various plants (preferably of Nepal) maintained by organizations like '*Flora of Nepal'.*

3.3 Translation system

Translation system is important component of the system and a machine translation system is ideal for the proposed model. However highly accurate machine translation system for English to Nepali translation and vice versa has yet to be perfected. So, a feasible translation system for the proposed model makes use of crowdsourcing by asking users/volunteers to translate possible content for the system.

The overview of the proposed system is shown in Fig 1.

4. Limitations and Future Work

The proposed model is a general working system of how citizen science can be used in the context of Nepal to learn more about its biodiversity (flora) and take the first step towards conserving it. Since this paper only describes how existing technology harnessed for our benefit without going into the specifics , limitations exist not only in the system itself but in the technologies used in the system. Here are a few limitations and enhancements for further works on the system:

(1) This paper does not mention the possibility and cost of adopting the system in Nepal which is critical for it to succeed. So technical and economic feasibility should be the first step before adopting the system in practice.
(2) The system lacks review functionality to assure the accuracy of the information in the system. A verification system that measures the degree of correctness of the information based on the agreement of majority of the users can be added to the system.

(3) The machine learning model for the proposed system has not be specified in this paper. A review of the existing system can be done to find the most suitable model or a custom model can be designed for the purpose.

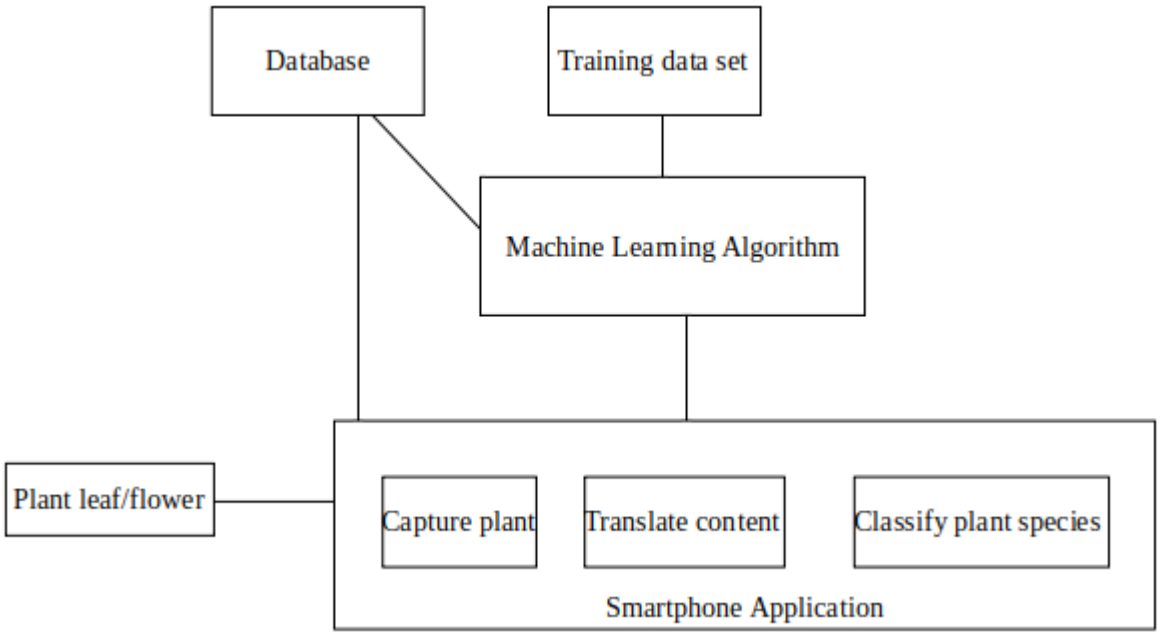

Fig 1: System overview

5. Conclusion

This paper presents an overview of a system that combines citizen science with trending technologies to identify and collect information about the plants of Nepal, an important first step towards the conservation of the floral diversity of the country. The system can also be useful in cultivating learning spirit in the general public through active participation in familiarizing themselves with the plants in their surroundings. Use of machine learning model along with human experts to identify the plant ensures that the users would not have to wait significant time for identifying a single plant whereas the translation functionality widens the scope of use of the system.

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