AN INTELLIGENT COMMUNITY-DRIVEN MOBILE APPLICATION TO AUTOMATE THE CLASSIFICATION OF PLANTS USING ARTIFICIAL INTELLIGENCE AND COMPUTER VISION

Yifei Tong[1] and Yu Sun[2]

[1]Trinity Grammar School, 119 Prospect Rd, Summer Hill NSW 2130, Australia
[2]California State Polytechnic University,
Pomona, CA, 91768, Irvine, CA 92620, USA

ABSTRACT

How can the efficiency of volunteers be improved in performing bushcare in the limited amount of time able to be spent caring for each location every month [1]?

Bushcare is a volunteer activity with a high difficulty curve for volunteers just starting out as the crucial skill of distinguishing the native plants from the harmful invasive species only comes with experience and memorization [2]. The lack of ability to distinguish targeted plants will greatly reduce the efficiency of the volunteers as they work through the limited amount of time they have at each location each month while also discouraging newly joined volunteers from continuing this activity.

To assist newly joined volunteers, the majority of each would likely be from a younger demographic with a digital app that could help the user distinguish the species of plant, making it easier for them to start familiarizing themselves with both the native and invasive species in their area [3]. The user could simply have to take a picture of the plant they wish to identify and the software would use its image recognition algorithm trained with a database of different species of plants to identify the type of plant and whether it needs to be removed. At the same time, more experienced volunteers could continue to use this app, identifying errors in the app's identification to make it more reliable.

KEYWORDS

Flutter, Machine learning, Firebase, Image recognition.

1. INTRODUCTION

Bushcare is very important to the Australian ecosystem because its unique fauna and flora are being out-competed by invasive species from other ecosystems [4]. If left unchecked, the invasive species will spread and take on resources that the native species need to survive, causing them to die off and reduce the biodiversity of the entire ecosystem [5]. Bushcare works to remove the invasive plants from an area while caring for the native plant to try to restore the state of the ecosystem to its healthy original state [6]. Currently the issue is that there is a limited number of volunteers and an even more limited number of staff who can supervise the volunteers as they

David C. Wyld et al. (Eds): ARIA, SIPR, SOFEA, CSEN, DSML, NLP, EDTECH, NCWC - 2022
pp. 157-166, 2022. CS & IT - CSCP 2022 DOI: 10.5121/csit.2022.121513

work, meaning that each area will only get a few hours for volunteers to carry out their job each month.

The limited amount of time means that it is crucial for the team of volunteers to work efficiently in the time they are given. The majority of the volunteers are of the older demographic, who are very experienced in doing their job each time they work in the area. But there is a lack of new recruits as it is hard and time-consuming for new volunteers to remember that they need to be removed from the ecosystem and what to care for, causing there to be a lack of younger generation volunteers [7]. The process of learning what plants of native and what is harmful is frustrating as there is no clear rule to distinguish the two groups while the fear of accidentally removing native plants and causing more harm further discourages them.

To solve this issue, a mobile app could be used to identify the type of plants for the user while they are still inexperienced, which greatly helps new volunteers when they join, improving their experience and efficiency. This app would work by using a database of different plant species to train an algorithm to recognize the plant through image recognition, therefore allowing users to simply take an image of the plant with their phone and the app will identify the species of plant for them. This will help them work as they familiarize themselves with the types of plants in the ecosystem.

There are already many plant recognition software on the market also using image recognition to identify the types of plants captured by the camera of the phone and allowing the user to gain some information about the plane in front of them [8]. However, that software is all focused on gardening rather than bushcare, meaning there is a great desperation in need of new volunteers from what those apps can provide. Those apps focus on the needs for gardening, therefore the types of plants that these apps need to recognize are different from the types of plant that needed to be recognized for bushcare as the types of the plant being deliberately planted is different from the types of plant found in the wild. Those apps will have a wider range of plants worldwide to satisfy the needs of their targeted customers as gardening involves many plants from around the world that thrive in many different climates while only needing to focus on being able to recognize plants encountered when gardening. But bushcare has a more specific need in the types of plants that need to be recognized, only focusing on a specific area with a set climate but needing all plants in this area to be able to be recognized, therefore those apps might not be as accurate in recognizing the types of plants encountered in bushcare.

A bigger problem is that after the plant is recognized by existing plant recognition apps the information is not helpful in the situation of bushcare. When those gardening apps recognize the plant captured, it gives the species of the plant and some information about the plant and how to care for the plant, which is mostly redundant to new volunteers to bushcare [9]. Rather than the species of the plant, more useful information would be if the plant is invasive and needs to be removed and information that would be helpful is how to properly remove a plant in areas such as whether the roots need to be removed or if the seeds need to be bagged.

In this paper, the process of creating the app that would help improve the efficiency of bushcare volunteers is very similar to the other commercial apps used to identify plants for gardening. Our goal is to develop an app that would be easy to use for new volunteers doing Bushcare to help them to work more efficiently during their inexperienced phase when they are just starting out. Our method is inspired by many other image recognition algorithms that have gained popularity in recent years.

First, the basic structure of the app was made on android studio using the flutter software development kit. The app contains a camera page where an image of plants was taken for the

software to identify the plant, and the main page was made for users to navigate to different pages like the calendar for upcoming bushcare schedules and other special events or to navigate to the personal profile page.

We also used Firebase to allow users to make personal accounts with their email. This would allow the account to be tracked when sending feedback to errors in the algorithm and potentially be used to track which bush care site a user goes to for automatic reminders or to share the picture of the different species of plants captured.

Then lastly, the image recognition algorithm is put in to process the image captured by the camera. A preexisting database for different species of plants is used to train the algorithm which could be added to as an error in the images captured to could help the algorithm to become more accurate.

The use-ability of the app has been tested to ensure that the app would be effective in solving the problem with new volunteers. The app has to be convenient for users to make sure that it would be used easily for anyone to assist them when they don't have the necessary knowledge for bushcare. The convenience of the app provided with other features is also important in making the process of going to bush care easier which would help to attract younger volunteers into joining this activity. We tested the working of the different accounts and the working of the application with Firebase, making sure that it is storying the different accounts and communicating with the application properly so that when the algorithm runs into an error, the user can report it and Firebase would be able to record from which user the error came from [10]. We also tested to make sure the camera would work on any phone as different phones have different dimensions or sizes of images for the camera. To ensure that all phone cameras would work, the application crops the image to a set size the algorithm could process therefore uniforming the input. As we have run into some problems setting up the code for the camera we haven't had time to flash out the image recognition algorithm yet. We have run some tests with images saved on the computer and run it through the algorithm and the result of the image recognition is not accurate enough to be used effectively for its purpose.

The following part of this report is organized into the following sections: Section 2 contains challenges encountered during the process of designing and testing the product; Section 3 describes the solution used to solve the challenges listed in section 2 in order to finish the app; Section 4 presents the experiments we did and the relevant details; Section 5 presents related works. And finally, Section 6 includes concluding remarks as well as listing the further work to be done in this area.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Limit Amount of Time

It is currently hard for new volunteers to work efficiently in the limited amount of time spent caring for each area's plant life. There is no rule classifying what plant is native and which is invasive so the skill to distinguish what needs to be removed from the local environment can only be achieved by slowly familiarizing ourselves with the plants in the area and remembering the different types of plants present. This is a very slow process that could take up to a few years to fully familiarize oneself with the plant lives of casual volunteers. This means new volunteers are usually just told a few common plants that need to be removed each time and only focus on the

species they are shown. This means that many other invasive species are left unchecked and would just fill the space cleared out by the volunteers and reduce the efficiency of the work.

2.2. Lack of New Volunteers of a Younger Age

The demographic of bush care is mostly made up of volunteers of older age as there is a lack of new volunteers of a younger age. The difficult learning curve at the start discourages many new volunteers from continuing causing there to be a lack of interest from the younger generation as there is not a common sight for young people to be part-taking in it. Apart from the difficulty in familiarizing themselves with the plant and the frustratingly long amount of time, volunteers might also be afraid that they might be doing more damage than good. In areas where there is a more diverse range of plants, new volunteers can't be told just a few types of plants to focus on and often just feel like they are removing random plants without knowing whether they are removing harmful plants or native plants and causing more damage than good, which further disparages them from continuing.

2.3. Recognize All The Plants

In order to help new volunteers recognize the types of plants the algorithm needs to be able to recognize all the plants that could be found in the area. For the algorithm to do this, there needs to be a database of all the plants present in the area to train the algorithm to recognize them. But as we are not a commercial organization with a large number of resources, we do not have the resources to gather a big enough database of plants ourselves, and doing it manually would be way too time-consuming.

3. SOLUTION

This application is an image recognition software that would serve as a personal assistant to new volunteers, helping them classify the different species of plants while they work to develop their own knowledge about the plants. Apart from the main function of identifying plants from the camera page of the application, there are also a few other parts that are made to improve the experience of the user and to motivate more younger volunteers to stay in bushcare after they start. The application has a login and sign-up page to allow users to create their personal account of the app with their email which allows more personalization for each user to make their experience more convenient. The Application stores the different accounts by communicating with Firebase, powered by google. The application also has a calendar page that is going to show all the bush care times and locations as well as any special event that will be happening. There is also a function to share the plants a user has captured with other users of the app. These functions are made to try to make the bushcare experience more suited for the younger generation to encourage a younger demographic to join bushcare volunteering. The application is made with android studio using the google open-source development kit, flutter, and implementing dart to create sections of the application.

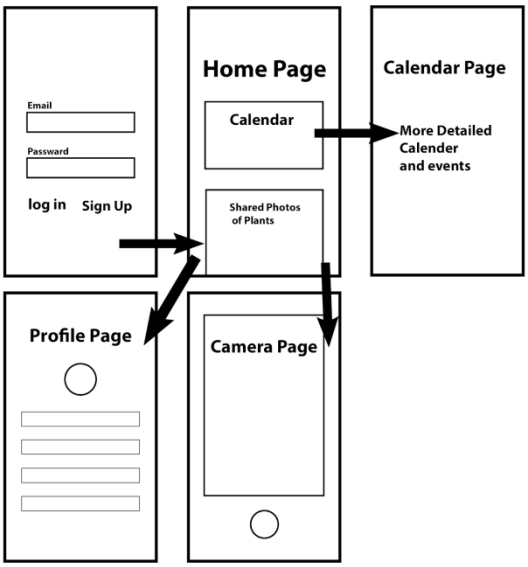

Figure 1. Overview of the solution

The log-in page works by communicating with the firebase platform with all the user information stored on it. As shown in the code snippet below, the application is linked to a firebase platform where all the information about already existing users is stored. The application checks if the email interns already exist on the firebase, and then it checks if the password is correct. If both are correct then it lets the user enter their own personalized account of the application where they can continue using the app.

```
if(_formKey.currentState!.validate()){

  try{

    await FirebaseAuth.instance.signInWithEmailAndPassword(email: email, password: password);
    showSnackBar("login Successful ...");
    submitLock = false;

    Navigator.pushAndRemoveUntil(

        context,
        MaterialPageRoute(builder: (context) => HomePage()),
            (route) => false,
    );

  }
  on FirebaseAuthException catch(e){

    if (e.code == "use-not-found"){
      showSnackBar("Email i Incorrect");
  } else if (e.code == "wrong-password"){
      showSnackBar("Password is Incorrect.");
    }
    else{
      showSnackBar("Unknown Error.");
    }
    }
}
submitLock = false;
```

Figure 2. Screenshot of code 1

Similarly, the sign up page also communicates with the Firebase platform but as it is creating a new user and storing the information the sign up page uploads the information about the new user to Firebase rather than checking the information stored on Firebase. When the new user enters the email and password into the text boxes on the sign up page, the application communicates to

Firebase and checks if the email is already in use or valid before checking if the password meets the requirement. If everything is up to standard it stores that information as a new user on Firebase to allow them to log in the future and let the user into the home page.

```
Container(

  child: TextFormField(
    controller: confirmPasswordTextFieldController,
    validator: validateConfirmPassword,
    decoration: const InputDecoration(
      labelText: "Confirm Password",
      contentPadding: EdgeInsets.only(left: 20.0),
    ),
    obscureText: true,
  ),

  color: const Color.fromRGBO(200, 200, 200, 100),
  margin: const EdgeInsets.only(left: 40.0, right: 40, bottom: 20,),

),

ElevatedButton(
onPressed: onSignupButtonPressed,
child: const Text('Get Started'),
),
]
```

Figure 3. Screenshot of code 2

The camera page uses a dart in Flutter to capture the image with the camera of the phone. The dart package called image picker was first imported into the application at the top of the code to enable the application to capture images. When the image is captured it is first cropped to the right size for the application to process while the time when the image is captured is also recorded. The image is given three values: description, specious, and whether it is invasive or not, and given to the algorithm to process.

4. EXPERIMENT

4.1. Experiment 1

To ensure that the users can log in to an account for better personalization of the app and so that we can track user information when information is sent in from the users we had to test whether the Firebase platform is storing user data and communication with the application properly. This would be important for the image recognition algorithm too as it would bet the users report any incorrect output of species of plant and therefore increase the database we can train the algorithm with. To test this, We had several accounts to test that Firebase is able to store the accounts effectively and check the information stored through firebase directly. Then we checked the application would let users in smoothly while also preventing duplicate emails from signing up so causing problems with the system.

The application was able to successfully send the new accounts created to Firebase and access them when the information is required for logging in users. The wait time for users to load in isn't significant and fairly easy to use as it is very similar to any other login or the sign-up page for other programs. The application also was able to successfully check with Firebase to stop any email that already exists to crest second accounts by signing up again and checking the strength of the password to ensure that it is to strong enough.

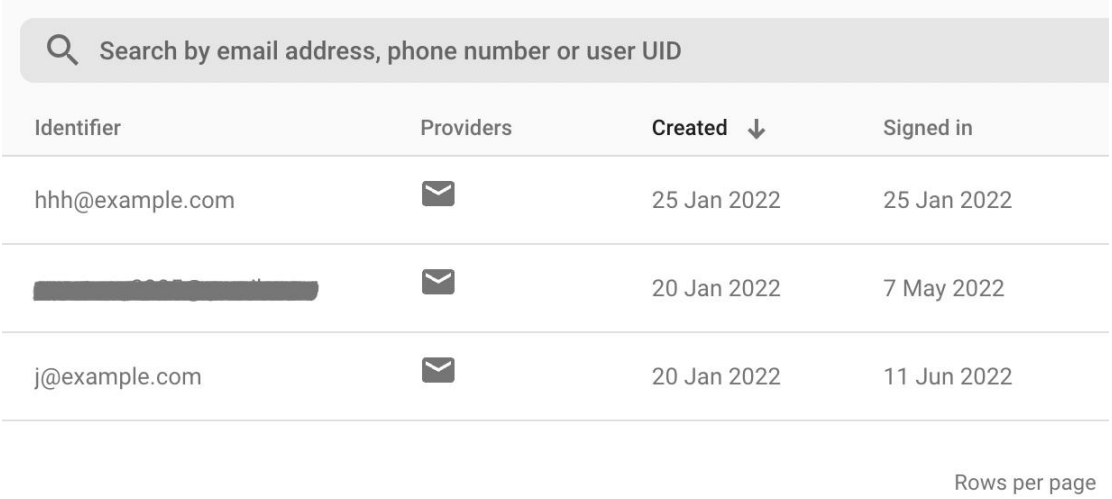

Figure 4. Screenshot of information

We tested the image capture function to ensure that both the camera of the phone could be accessed by the application to capture the image of the plants to be processed by the algorithm and also that the image could be sent to the Firebase with the correct information like time taken and its location. The ability to capture images is crucial to the application as it is the input that would enable the rest of its function to be carried out. We needed to check that the application could upload the images taken to the Firebase platform where its content was checked straight through Firebase. The application needed other data such as the time the image was taken, the location it was taken at and the user id that sent the image to Firebase while also leaving space for the algorithm to determine whether the image continued an invasive plant and the species of the plant.

We captured a large number of images with computers as they emulated the mobile app of the program and uploaded them to the Firebase platform to be stored and eventually communicated the algorithm to be processed. The information uploaded to Firebase was checked directly through Firebase storage where all the information was stored. All images were able to successfully have the time taken, the location it was taken from, and the user id of the account that uploaded the image to Firebase while leaving space for the algorithm to eventually fill in the species of the plant and whether it is invasive. In this process, we also deduced that we needed to crop the images to a uniform size to enable this process to function.

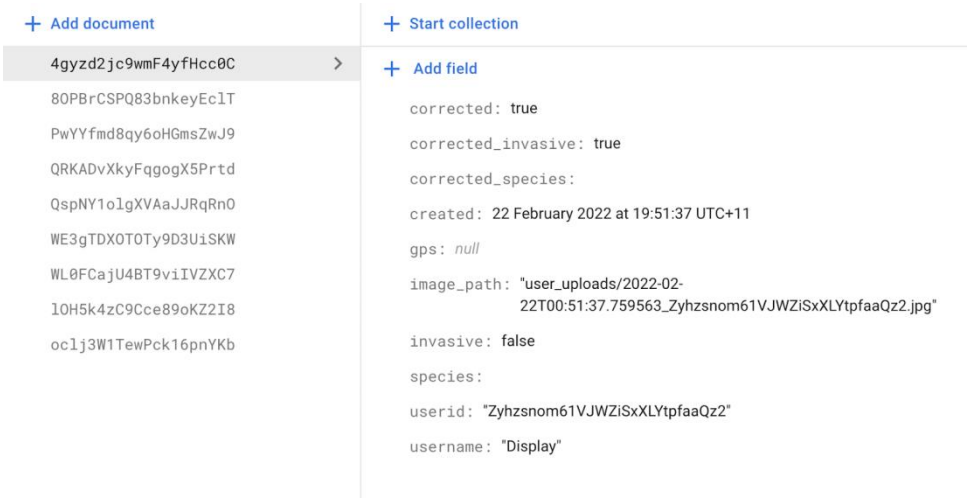

Figure 5. Screenshot of add document

As we have run into difficulties making sure that the capers of the application would function properly for the application to work and proper images to be uploaded to the algorithm to be processed and so we haven't had enough time to properly set up the image processing algorithm. We have tested the algorithm by manually uploading images to it and the result is not yet as accurate as needed for the application.

The result of the experiments conducted was mostly satisfactory as it confirms the result that we wanted to see. The experiment proves that the app is functioning properly, doing its intended job and therefore able to connect to other parts of the application and function smoothly to achieve its intended purpose. The app is convenient enough for users and therefore will improve the experience of the new volunteers when starting out bushcare. The algorithm is still not ready for use but it is still being perfected and it will still be worked on as the app is officially put out for people to use as users will upload more images to the database of the algorithm to develop and become more accurate.

5. RELATED WORK

This paper aims to produce an algorithm for plant recognition for the use of agriculture, aiming to improve the sustainability of producing crops by reducing laborious tasks from humans and to make a more accurate judgement [11]. This research is different from this project as it also focuses on the health of the plant and with a further step of determining how healthy the plant is and outputting the best environment and nutrient level for the plants to develop. The research focuses more on plants on the macro level while this project focuses more on individual plants. Furthermore, this research is lightly technical, providing a lot of information for the user while our application tries to simplify information for the convenience of everyday users.

This paper aims to use image recognition to detect plant disease to assist humans in caring for those plants [12]. This paper uses MATLAB as its primary processing tool and uses the linear progression model to detect whether the plant is diseased. This research is highly technical, using the coloration of the plant's leaf, isolating parts of the leaf with unnatural coloration, and determining if the plant is diseased. This research differs from our project as it focuses more on whether the plant is diseased rather than the species of the plant. Also, the algorithm focuses more on processing images in a more controlled environment while our application has to be able to process images taken on the field.

This paper researches image recognition algorithms to reduce human mistakes and improve efficiency in plant identification, disease detection, and diversity preservation [13]. It focuses on comparing the effectiveness of different methods of image recognition in the application of identifying the types of a plant from its leaves, listing out a great variety of methods to compare. This research has similar purposes to our application, used to improve efficiency and improve plant diversity in the environment but goes more in depth into the faults and merits of many different methods.

6. CONCLUSIONS

This project tries to solve the problem of it being very hard for new volunteers to pick up bushcare as an activity as there is a steep learning curve to distinguishing the different plants that need to be removed from the native plants that are being protected. This application aims to help new volunteers to classify the different plants with image recognition to improve their efficiency when first starting bushcare while improving their experience to keep more new volunteers from leaving from being discouraged by the steep learning curve. This app allows the user to take images of the plants they see and determine the species of the plant and whether it is an invasive plant with the image recognition algorithm [14]. The app allows users to sign in to their personal account and therefore allows them to share images of the plants they have captured or report any errors there are in the application or the results of the algorithm. The application also shows the calendar of all the volunteering/events for bushcare for the convenience of the user. All the extra functions serve to increase the experience of the users as an attempt to increase the number of volunteers of a younger demographic to join bushcare [15].

Currently, the app is still very limited and basic. The accuracy of the algorithm could be improved as there is only a very limited amount of images in the database and the algorithm is not optimized. But this could be improved as people start using the app, taking pictures of more plants to be added to the database and improving the algorithm by correcting any errors in results. The image-sharing function is also not very practical at the moment as it does a clear function, later could be a system of challenges asking the user to capture a number of plants to motivate them and give the image-sharing function a purpose.

Some future work includes adding more descriptions to the species of plant, namely how to effectively remove the different invasive species, including whether the roots need to be removed and seeds are a concern. Further work needs to be done to improve the image recognition algorithm by adding more images to the database and correcting any mystics made by the algorithm to make it more accurate.

REFERENCES

[1] González, Eduardo, and Antonio Alvarez. "From efficiency measurement to efficiency improvement: the choice of a relevant benchmark." European Journal of Operational Research 133.3 (2001): 512-520.

[2] Shelef, Oren, Peter J. Weisberg, and Frederick D. Provenza. "The value of native plants and local production in an era of global agriculture." Frontiers in plant science 8 (2017): 2069.

[3] García, Eugene E., Bryant T. Jensen, and Kent P. Scribner. "The demographic imperative." Educational Leadership 66.7 (2009): 8-13.

[4] Dwyer, John M., Rod Fensham, and Yvonne M. Buckley. "Restoration thinning accelerates structural development and carbon sequestration in an endangered Australian ecosystem." Journal of Applied Ecology 47.3 (2010): 681-691.

[5] Peltzer, Duane A., et al. "Understanding ecosystem retrogression." Ecological Monographs 80.4 (2010): 509-529.

[6] Reidy, Margaret, Winkie Chevalier, and Tein McDonald. "Lane Cove National Park Bushcare volunteers: taking stock, 10 years on." Ecological Management & Restoration 6.2 (2005): 94-104.
[7] Rostoft, Siri, and Tanya Petka Wildes. "Time to stop saying geriatric assessment is too time-consuming." Journal of Clinical Oncology (2017): 2871-2874.
[8] Sharma, Sapna, et al. "A review of plant recognition methods and algorithms." International Journal of Innovative Research in Advanced Engineering 2.6 (2015): 111-116.
[9] Abd Rahim, N., F. A. Zaki, and A. Noor. "Smart app for gardening monitoring system using iot technology." system 29.04 (2020): 7375-7384.
[10] Khawas, Chunnu, and Pritam Shah. "Application of firebase in android app development-a study." International Journal of Computer Applications 179.46 (2018): 49-53.
[11] Abdullahi, Halimatu Sadiyah, R. Sheriff, and Fatima Mahieddine. "Convolution neural network in precision agriculture for plant image recognition and classification." 2017 Seventh International Conference on Innovative Computing Technology (INTECH). Vol. 10. Ieee, 2017.
[12] Sun, Guiling, Xinglong Jia, and Tianyu Geng. "Plant diseases recognition based on image processing technology." Journal of Electrical and Computer Engineering 2018 (2018).
[13] Huixian, Jiang. "The analysis of plants image recognition based on deep learning and artificial neural network." IEEE Access 8 (2020): 68828-68841.
[14] Richmond, Nicola J., Peter Willett, and Robert D. Clark. "Alignment of three-dimensional molecules using an image recognition algorithm." Journal of Molecular Graphics and Modelling 23.2 (2004): 199-209.
[15] Pollak, Robert A., and Terence J. Wales. "Demographic variables in demand analysis." Econometrica: Journal of the Econometric Society (1981): 1533-1551.