

RESEARCH ARTICLE

Development of Artificial Intelligence-Supported Mobile Application Introducing Tree Species in Kastamonu

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Abstract

This study examines the development of an artificial intelligence-supported mobile application to introduce tree species in the Kastamonu region. Taking into account the rich forest structure of the region, the application allows users to identify tree species and provides information about the characteristics of trees, their industrial use areas and their resistance to diseases and pests. The application has a user-friendly interface and offers options to filter trees by leaf type or alphabetical order. Thanks to the Google Lens integration, users can determine the type of a tree by taking a photo and easily access relevant information. In addition, the learning process is supported with educational games specially designed for children. The Kotlin programming language and MVVM (Model-View-ViewModel) architecture were used in the development process of the application. Kotlin Coroutines were used for asynchronous data processing, Android Room library for data storage and Android Navigation Library for transitions between pages. The application prototype was tested on 50 children between the ages of 10-15 and a survey was conducted regarding user experience. According to the results, the application received generally positive feedback, especially the Google Lens integration and user-friendly interface were appreciated. Educational games were found to be interesting, however it was stated that they need to be developed further. As a result, this mobile application has the potential to be an important tool for nature education and the promotion of tree species. The study, which demonstrates the effective use of artificial intelligence and mobile technology in education, can be enriched with more comprehensive artificial intelligence solutions in the future.

Keywords: Artificial Intelligence, Education, Forestry, Google Lens, Mobile Application, Survey

1. Introduction

Trees are natural elements that reduce the effects of drought by balancing the structure of the soil, protect the environment and provide many benefits to the ecosystem. They increase productivity by transferring nitrogen from the air to the soil and play an important role in combating drought. They also reduce air pollution, protect from harmful rays with their shade and prevent noise pollution. While creating a food source with their nutritious fruits, they provide raw materials for the health, cosmetics and chemical industries. They also contribute to the protection of biodiversity by providing shelter for many living things. While ensuring the protection of the soil by preventing erosion, it is understood that afforestation is of vital importance when it is considered that 500 million tons of soil is lost due to erosion in Turkey every year [1, 2].

Kastamonu province is a region with a rainy continental climate, 61.5% covered by forests and consisting of rugged terrain. According to the data of the General Directorate of Forestry (OGM [Turkish]), there are 61,027 hectares of forest. Coniferous tree species include black pine, scots pine, fir and juniper; leafy species include beech, oak, hornbeam, chestnut, poplar and other leafy trees. Black pine, scots pine, fir, beech and oak are the most prominent in forest production. The area around Devrekani County is devoid of forest cover and is covered with sparse trees and bushes. In the inland areas where the altitude increases, beech and fir trees are common and podzolic soils are seen. While pine, fir and beech species dominate in the south of Inebolu and Cide counties, linden, chestnut, elm, hornbeam, myrtle, poplar, ash and wild pear trees are also found here and there. Pine species are dominant in the altitudes between Azdavay and Devrekani counties [3, 4, 5].

The use of technology in education allows students to learn information faster and more effectively, while also helping teachers to process lessons more efficiently and save time. It also contributes to students' digital development by providing them with knowledge about technology. Educational software and applications help students identify their strengths and weaknesses by supporting individual learning paths. However, it can be difficult to implement in regions where technological opportunities are inadequate. Therefore, it is important to use technology in education in a balanced and conscious manner [6].

Artificial intelligence (AI) is rapidly developing and widely used in many areas such as health, sports, transportation, education and more. It has a wide range of uses, from disease diagnosis to personalized recommendations in e-commerce, from autonomous vehicles in transportation to disease detection in agriculture. Artificial intelligence-supported technologies, especially in the field of education, make learning processes more efficient and transform modern education systems. Artificial intelligence, which is widely used in

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education in developed countries, helps improve students' individual learning processes, provide personalized learning experiences and facilitate teachers' teaching processes. Artificial intelligence-supported educational platforms can analyze students' knowledge levels, adjust the difficulty level of content and optimize the learning process according to individual needs [7].

With the development of technology, artificial intelligence-supported plant identification applications have become widespread in order to identify plant species and facilitate care processes. These applications provide great convenience especially for botanical enthusiasts, farmers and nature lovers. Thanks to artificial intelligence and machine learning technologies, users can analyze plant photos to determine their species and access detailed information about plants. **LeafSnap Plant Identification**, one of the prominent applications in this field, identifies plants according to leaves, flowers or fruits using an artificial intelligence-supported algorithm. The application, which has a large database, offers practical use thanks to its user-friendly interface. However, it may have difficulties in identifying rare or exotic plants and may require a paid version to access its advanced features [8]. **Plantify: Plant Identification** application guides users in plant cultivation by providing care guides as well as plant identification. While it stands out with its ability to detect plant diseases using artificial intelligence, it may have limitations in identifying some rare species. Although the user interface may seem complicated at times, it is a useful tool for plant enthusiasts with the care suggestions it provides [9]. Another popular application, **Plantum - Plant Identification**, not only identifies plants but also provides disease detection and care suggestions, making plant care processes easier for users. While being able to follow the development of plants with machine learning technology offers a great advantage, the disadvantages of its free version are that it is quite limited and the database is updated slowly [10]. Developed for nature lovers and scientists, **iNaturalist** is a comprehensive nature observation application that is not limited to plant identification but also helps to identify animal and fungal species. Having a database that is constantly updated with user contributions makes a great contribution to scientific research. However, the AI-supported recognition system requires human verification in some cases and does not provide direct plant care guides [11]. On the other hand, **PlantNet**, another important application that supports scientific research, is notable for being free and having a wide botanical database. Although it performs plant identification using artificial intelligence and image processing technology, its user interface is less user-friendly than commercial applications and does not offer additional features such as plant diseases or care guides [12].

The study of Suriyabutr and Yasri [22] and focuses on teaching plant diversity to students. In order to make this more efficient, they developed an educational card game having the concepts of plant taxonomy, distinctive characteristics, phylum and several examples of local plants. Lindemann-Matthies et al. [23] also developed a card game related to a lecture on plant diversity, which the players are required to find out the plant species by asking yes/n questions to the opponent. Rodrigues et al. [24] implemented a mobile application for game-based learning related to nature conservation. The application aims at providing awareness towards nature by treasure hunt games, integrating multimedia and augmented reality resources. The study of King et al. [25] developed a mobile application for undergraduate students in order to evaluate the viability of mobile game-based learning quest. The students are required to complete the quest related to disturbance ecology that include instructional, location-based and question- and answer-type of tasks. After completing the quest, students provided feedback via an online survey.

This study was developed as a mobile application to introduce tree species in Kastamonu region and provide detailed information about these trees. The application includes the characteristics of the trees in the region, their seed status, species, industrial usage areas and the disease or pest threats they face. In addition, there are photos of the general appearance of the trees, their leaves and pest threats. The application, which also emphasizes educational use, has an educational games section for children. In this way, children will have the opportunity to learn about the trees in Kastamonu in a fun way. While the application aims to appeal to a wide age group, it also aims to be a useful tool in the field of education. In addition, thanks to the Google Lens integration, artificial intelligence can analyze a tree that users take a photo of with image processing techniques, then detect the relevant species and direct the user to the matching species in the application database.

The paper is structured as follows: in Section 2, the data that belong to each tree, front-end techniques and back-end methods are explained comprehensively. Then in Section 3, the survey as an evaluation method of the mobile application is explained and the results are given. Finally, we conclude the paper with Section 4.

2. Materials and Methods

2.1. Data Source

In this study, photographs of the trees were taken on-site in the regions where the trees grow. These photographs consist of the general appearance of each tree, its leaves, seeds and, if any, its fruit. In addition to the photographs, general information about each tree, its characteristics, seed and fruit status, industrial usage areas and information about disease and pest threats were obtained from the official websites of Kastamonu General Directorate of Forestry [13], Kastamonu Governorship [14] and similar websites, articles about tree species [15-17] and textbooks.

2.2. Application Front-End Design

The design of the application is user-friendly and easy for everyone to use. In the interface of trees, photos of trees in the database are shown to the user. Trees can be filtered by leaf type or sorted alphabetically. The tree detail page includes information such as leaf type, seed status, industrial usage areas, disease and pest threats and related visuals of the relevant tree. Another feature is that users can favorite the trees they are interested in. In the educational games section, which was designed especially for child users, it was tried to provide users with information about various features of trees. In this games section, there are various tests such as recognizing tree species, recognizing trees from leaves and learning the industrial usage areas of trees. The activity diagram of the application is shown in Figure 1.

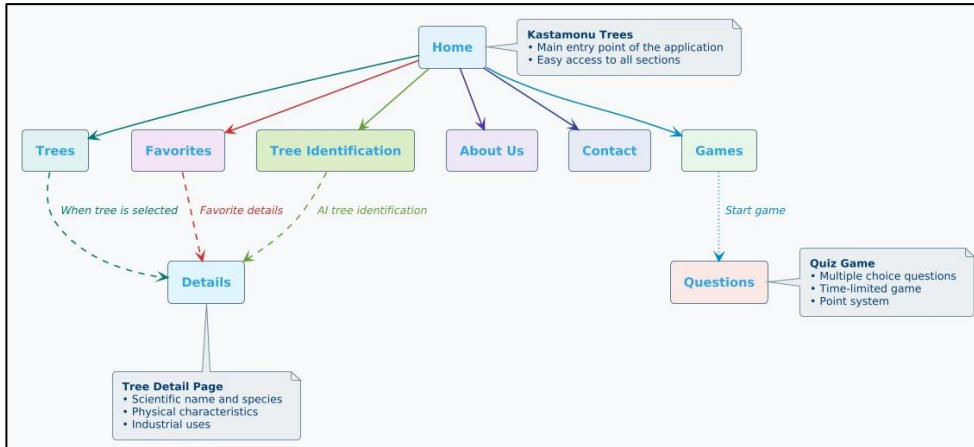


Figure 1. Activity diagram of the application

The application design uses Android’s Material Design library. Responsive design has also been applied to the design to ensure compatibility on devices with different screen sizes. Thus, the application can work on both smartphones and tablets. Examples of the application’s interface are given in Figure 2 and Figure 3. As seen in Figure 2 (the picture on the left), the tree species with their names and leaf types are listed. It can be both sorted in alphabetical order and listed according to their leaf types. When a tree is selected by the user, the details of that tree (the picture on the right in Figure 2) appears.

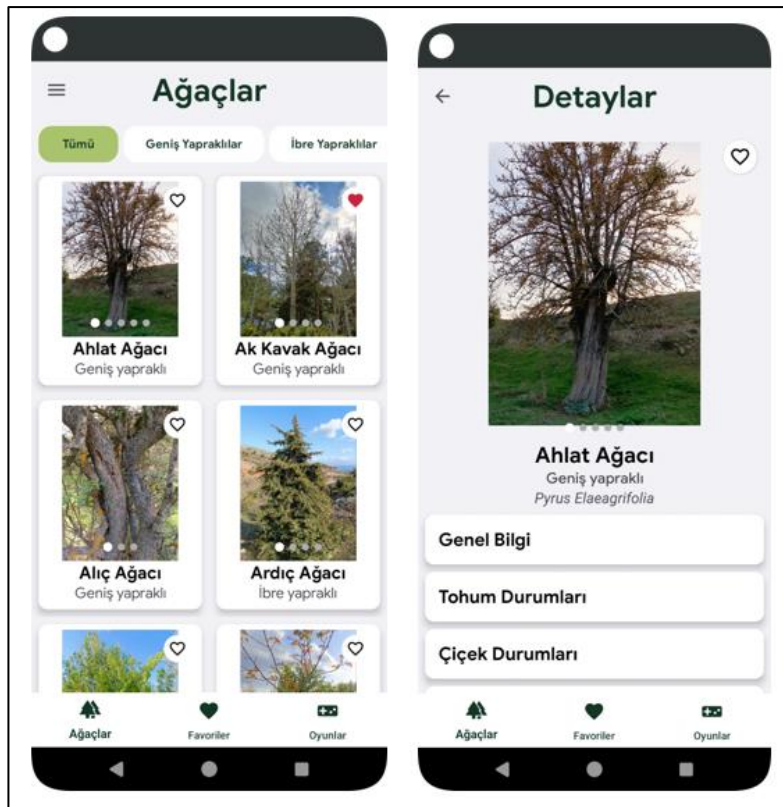


Figure 2. Example of application interfaces: Trees and Detail pages

The picture on the left in Figure 3 shows the tree species that are listed as the user favorites. The picture on the right in Figure 3 is a screenshot of a quiz game in the mobile application which is both fun and educational for especially children in order to learn the tree species.

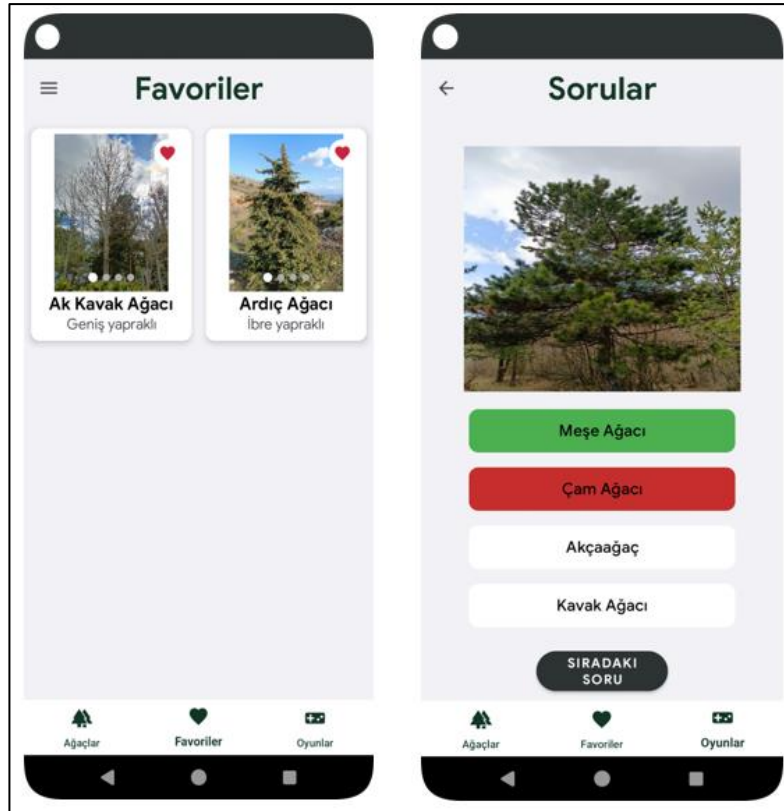


Figure 3. Example of application interfaces: Favorites and Game pages

2.3. Application Back-End Development

The application was developed using Model-View-ViewModel (MVVM) technique, which is the architectural pattern of the Kotlin programming language. MVVM separates the user interface (View), data and business logic (Model) and the connection between these two (ViewModel); making the code more modular and testable [18]. Kotlin Coroutines [19] library was used to process data asynchronously and to run the application quickly. With this library, operations such as loading tree details, viewing photo galleries, and image analysis with Google Lens are performed asynchronously. Android Room [20] library was used to store the data in the device. Data were kept in the device so that users could use the application offline. Android Navigation Library [21] was used to provide transition between pages and content.

3. Results and Discussion

In order to test the prototype of the application, children between the ages of 10 and 15 were asked to complete an evaluation survey. The survey was completely anonymously and no personal information was requested from the users. The survey was applied to 50 people and they were asked to use the application for 5 minutes and fill out the survey. The applied survey image is given in Figure 4.

When the responses to the open-ended 9th question in the survey (***“Is there an area you would like the application to be developed in? (Please specify)”***) are taken into consideration, the participants stated that they found the photos and information about trees in the application useful and that they generally enjoyed the games. When we look at the general evaluation of the survey, it is seen that the application received 4.0 points out of 5 from the users. In the scoring, 1 point is given for the most negative answers such as “Very Bad” and similar while 5 points is for the most affirmative ones such as “Very Good” and similar. The general percentages of the participants’ responses to the survey are given in Table 1.

Evaluation Survey of the study “Development of Artificial Intelligence-Supported Mobile Application Introducing Tree Species in Kastamonu”

Dear Participant, this survey was prepared to evaluate the user experience of our mobile application developed to introduce trees species in Kastamonu. Your answers are very important to us. Thank you for your participation.

Age:
Gender:
Educational Status:

Evaluation Questions

1. How would you rate the overall ease of use of the application?

It's very easy
 Easy
 Medium
 Hard
 It's very difficult

2. What do you think about the interface and design of the application?

I liked it very much
 I liked it
 Medium
 I didn't like it
 I didn't like it at all

3. How did you find the adequacy of the information given about tree species?

Very sufficient
 Enough
 Intermediate level
 Insufficient
 Very inadequate

4. How successful did you find the tree species recognition feature with Google Lens integration?

Very successful
 Successful
 Intermediate level
 Failed
 Very unsuccessful

5. How would you rate the quality of the photos and images in the application?

Very good
 Good
 Medium
 Bad
 Very bad

6. What did you think of the educational games offered by the application?

Very useful
 Useful
 Intermediate level
 Useless
 Very useless

7. How would you evaluate the performance and speed of the application?

Very fast
 Fast
 Intermediate level
 Slow
 Very slow

8. Indicate whether the application causes errors or crashes.

I have never experienced
 I have experienced it very rarely
 I have lived sometimes
 I have often experienced
 I lived constantly

9. Is there an area you would like the application to be developed in? (Please specify)

10. Would you recommend the app to others?

I definitely recommend it
 My suggestion
 I'm undecided
 I don't recommend it
 I definitely do not recommend it.

Figure 4. The visual of the evaluation survey

Table 1. The general percentages of the participants’ responses to the survey

Questions	1 Point	2 Point	3 Point	4 Point	5 Point	Average Point
Q1	0%	12%	20%	30%	38%	3.94
Q2	4%	4%	22%	34%	36%	3.94
Q3	0%	12%	18%	24%	46%	4.04
Q4	0%	6%	26%	34%	34%	3.96
Q5	6%	6%	10%	36%	42%	4.02
Q6	0%	12%	22%	26%	40%	3.94
Q7	4%	4%	20%	26%	46%	4.06
Q8	2%	8%	18%	34%	38%	3.98
Q10	2%	8%	14%	44%	32%	3.96

Considering the results, as understood from the responses given to the second question, where the application interface was evaluated, the participants were generally satisfied with the application design. The third question asked about the adequacy of the information given about tree species, and it was understood from the responses that this information was generally sufficient. The results of the fourth question, where the Google Lens artificial intelligence tool was asked, indicated that this feature was appreciated. The sixth question requested the evaluation of educational games; although they were generally appreciated, it was concluded that these games needed to be developed a little more.

4. Conclusions

In this study, a mobile application was developed that introduces the tree species in Kastamonu and provides detailed information about these species. In addition to introducing local tree species, the application offers innovative features such as educational games and Google Lens integration to make learning about these trees fun for users. Recognizing tree species by taking photos with artificial intelligence-based image processing allows users to learn more efficiently and interactively.

In the evaluation of the application prototype, the feedbacks received from children aged 10-15 show that the application leaves a generally positive impression in terms of design and content. Users who participated in the survey found the user-friendly interface of the application and the visual content it offers very useful. Participants especially liked the integration of Google Lens technology into the application and it was emphasized that this feature facilitated the tree recognition process. In addition, the part of the application supported by educational games was also met with interest, but some users stated that these games need to be developed further.

As a result, this application has the potential to be an important tool in the field of education and nature discovery. User feedback suggests that the application has a generally successful design and functionality, however needs some development. In future versions, the content of the application can be further enriched and more comprehensive solutions can be offered with artificial intelligence technologies. This study shows how the use of technology and artificial intelligence in education can become an effective tool, especially in the context of nature and environmental education.

Ethics committee approval and conflict of interest statement

This article does not require ethics committee approval and has no conflicts of interest with any individual or institution.

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