

Image-Based Pili (*Canarium ovatum*, Engl.) Fruit Variety Classifier App: An Approach to Enhancing Teaching Biodiversity and Crop Science

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Abstract: This paper introduces an image-based Pili fruit variety classifier application for teaching biodiversity and crop science courses. For this study, the project uses Pili (*Canarium ovatum*, Engl.) as the pilot species in developing a non-invasive image-based classifier. The application not only provides insights into biodiversity but also showcases AI's potential in agricultural education.

Keywords: Pili, *Canarium ovatum* Engl, Biodiversity Education, Crop Science, Image Analysis, Computer Vision, Machine Learning, Variety Classifier

1. Introduction

The rise of technology has significantly impacted teaching and learning methods, with AI being a key technology that mimics human cognitive functions. AIED (Holmes and Tuomi, 2022), or AI for education and learning, has made significant advancements in fields like computer vision, natural language processing, and robotics. Data-driven AI, also known as Machine Learning, has been successful in automating solutions in fields like biodiversity and crop science. Biodiversity and crop science courses are incorporating technologies to enhance students' learning experiences, such as NEIDE (de Mandez Neto et al., 2021), Code.org's AI for Ocean, the i-Bird App (Kurniawan et al., 2020), and Agro-AI (Orn et al., 2020). Other approaches include mobile learning (Jeno et al., 2017), augmented reality (Savtiri et al., 2019), and other technologies.

The Biology and Agribusiness programs at Partido State University in Camarines Sur, Philippines, aimed at incorporating modern technologies into their curriculum. Their goal is to explore Artificial Intelligence in identifying crop varieties and evaluate AI tools as an alternative to expensive DNA markers. The study focuses on the pili plant for precision, specificity, and resource efficiency, aligning with the region's programs and production efforts. This approach encourages targeted interventions and agricultural efforts.

2. Materials and Methods

This study collected 1,600 ripe pili fruit samples from seven different varieties. The samples were obtained at the Albay Research and Development Center, located at the Department of Agriculture Field Office V in Buang, Tabaco City (13.3105014, 123.6432488). The sample collection comprised of fruits from the following varieties: Lanuza, Laysa, Magayon, Magnaye, Mayon #1, M. Orolfo, Orbase, and a set of cultivars. Fruit and shell images were acquired using an ad-hoc image acquisition system with controlled lighting, distance, and angle. Collected image samples underwent cropping, resizing, and background cleaning. The researchers produced two (2) separate datasets, one for each fruit and shell.

The researchers used a convolutional neural network (CNN) to model a classifier with 8 classes, 32 batch sizes, and 100 epochs. Images were augmented with Keras's ImageDataGenerator before training. The model's performance was evaluated using accuracy, precision, recall, specificity, and f-measure. The Android Development Platform was used for practicality and portability. H5 models, from the model's best performance results, were converted to Tensorflow Lite using float16 quantization. The Rapid Prototyping method was used for software development, allowing users to select from various Fruit and Shell models and choose image capture mode.

After the development of the application, the researchers conducted a consultation and output presentation with pili experts before implementing it. The application was further tested on a class of 57 students and three (3) faculty members of Partido State University who had taken courses in systematics, crop production, and crop science. A questionnaire was developed beforehand, applying the ISO/IEC 25010 (ISO 25010, n.d.) criteria focusing on usability, acceptability, and reliability. The evaluation results were summarized using the averaging and percentaging methods.

3. Results

The "Pilifier" mobile application, designed for portability and practicality, features two buttons: Shell and Fruit, corresponding to two models developed during the study. The application integrates the trained models from the pili fruit and shell varieties dataset. The application also allows users to retrieve or capture pili fruit samples, display results based on the highest confidence score, and assess the similarities or differences in the subject sample (Figure 4).

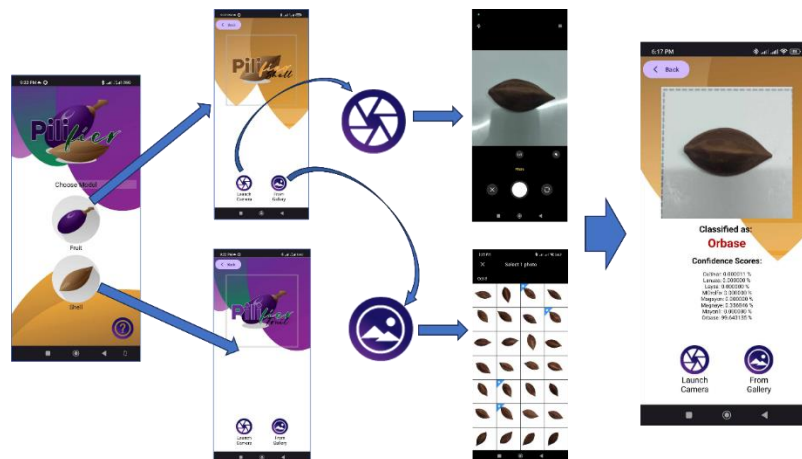


Figure 4. The flow of the navigation of the Pilifier app

Table 3 shows respondents' responses on acceptability, usability, and reliability. 88.33% rated the app as highly acceptable, 85.83% as usable, and 84.16% as reliable.

Table 3. Summary of evaluation questionnaire results conducted to classes of students and selected faculty members

No.	Indicator/ Question	1	2	3	4	5
1	How satisfied are you with the overall design and layout of the mobile app? (Acceptability)			3.3%	6.7%	90.0%
2	To what extent do you find the app's features and functionalities relevant and useful for your needs as a student or teacher? (Acceptability)				13.3%	86.7%
3	How easy was it for you to navigate through the different sections and buttons of the app? (Usability)				6.7%	93.3%

4	How satisfied are you with the responsiveness and speed of the app in providing results or information? (Usability)	16.7%	78.3%
5	How reliable do you consider the accuracy of the app in identifying different pili fruit varieties? (Reliability)	5.0%	13.3% 81.7%
6	How confident are you in using the app for educational purposes, such as identifying pili varieties for research or learning activities? (Reliability)	1.7%	11.7% 86.7%

4. Conclusion and Recommendation

The study suggests that technology and innovative methods can improve biodiversity and crop science education. The researchers developed a mobile app (Pilifier) for classrooms, implementing a variety classifier. The app was found to be acceptable, usable, and reliable. Through tests, students and faculty members found the app to have great potential in delivering modern learning modes and an alternative to expensive laboratory apparatus. The researchers hope that the Pilifier and any other AI-based applications will enhance learning, engage students with the environment, and spark interest in artificial intelligence. Future plans should consider user feedback, active learning, supplemental data, and innovative approaches to enhance learning experiences both inside and outside the classroom.

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