MAJALAH ILMIAH JOURNAL
LPPM Universitas Putra Indonesia YPTK Padang
Lubuk Begalung Highway, Padang, Sumatera Barat, Indonesia, Pos Code: 25221
Volume: 32, Issue: 2, Page: 137 - 142, 28/12/2025, e-ISSN: 1412-5854

Education on Innovative Computer Vision Technologies to Support Early Warning Systems for Rice Diseases

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Abstract

Rice plant disease is one of the main factors causing decreased productivity and threatening national food security. Farmers' limited knowledge in recognizing early symptoms of disease often leads to delays in treatment. This community service aims to develop and implement computer vision-based technological innovations in education to support early warning systems for rice diseases. The methods used include collecting rice leaf images in the field, digital image processing, and applying computer vision models to recognize visual patterns and detect disease symptoms in rice. The community service activities provided to students at Azrina Private Madrasah SMP Ibtidaiyah are carried out through training and mentoring as well as the introduction of technological innovations for agriculture as an early detection tool. The expected results of this community service are an increase in the understanding and ability of students at Azrina Private Madrasah SMP Ibtidaiyah in understanding how to identify rice diseases more quickly and accurately with computer vision-based technology, so that it can support appropriate decision-making in disease control and increase rice agricultural productivity sustainably. The impact/benefit provided in this service is that students can recognize and understand that computer technology can be useful in the agricultural sector, so that it is not limited to daily needs and styles but can be used in all sectors.

Keywords: Computer Vision; Object Identification; Segmentation; Deep Learning; Rice Diseases.

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1. Introduction

Rice is a strategic food commodity that plays a crucial role in maintaining national food security. However, rice productivity in Indonesia still faces various challenges, particularly pest attacks, including leaf diseases that directly impact yields and crop quality. Diseases such as leaf blight, brown spot, and bacterial blight pose a major threat because they spread rapidly and often go undetected early by farmers [1]. Lack of knowledge about early disease symptoms leads to delayed treatment, resulting in significant production losses. In recent years, the use of digital technology and artificial intelligence (AI) has begun to grow rapidly in the agricultural sector. AI, particularly computer vision, has been used to detect plant disease symptoms based on leaf images, providing fast and accurate results [2,3,4]. The integration of AI into the agricultural education system is believed to improve the understanding of farmers, students, and practitioners regarding disease identification, while supporting the transformation towards smart agriculture. Community service is also being conducted at the AZRINA PRIVATE MADRASAH SMP IBTIDAIYAH to provide students with knowledge and understanding of technological developments. Therefore, an automated plant disease detection system will utilize machine learning and deep learning, as well as publicly available plant image datasets. The role of computer vision in detecting disease symptoms in plants [5] is also reviewed. In addition, computer vision methods in plant disease detection and monitoring [6]. And has the development and transformation of plant disease detection research based on deep learning (DL) and machine learning (ML) [7].

Computer vision methods and machine learning algorithms for automatic detection and classification of plant leaf diseases. Leaf images, especially from tomato plants that have disorders or disease symptoms, then applying image processing and machine learning techniques to classify the condition of the leaves as healthy or diseased. This approach is important because it can help in early detection of plant diseases, accelerate diagnosis, and reduce crop losses by providing an efficient automated solution for modern agricultural practices [8,9]. Imbalanced data in the context of plant leaf disease detection using machine learning techniques. Datasets generally have a much larger number of samples for the healthy class than for a particular disease class, so special

Accepted: 20-10-2025 | Revision: 01-11-2025 | Publication: 30-11-2025 | doi: 10.35134

techniques are needed to prevent the model from being biased towards the majority class [10].

One innovation developed for educational purposes is the Agricultural Intelligence System (AIS). This technology is designed to automatically analyze rice leaf images and provide information on disease types, symptoms, and treatment recommendations. Through a visual and interactive approach, AIS is able to create a more effective learning experience than conventional methods that rely solely on text and static images [11]. Furthermore, this system can be used in training activities, practicals, and agricultural extension as a digital-based learning medium.

Agricultural Intelligence System (AIS)-based education is expected to improve digital literacy in agriculture, particularly for agricultural students, young farmers, and the general public. With increased access to AI technology, participants can learn to independently identify rice diseases, understand the visual characteristics of symptoms, and master simple analytical techniques based on Python and machine learning. Recent research shows that integrating AI into agricultural education activities significantly contributes to improving the understanding and speed of plant disease identification [12].

Given these conditions, it is crucial to develop innovative technology-based educational approaches that can enhance participants' knowledge and skills in recognizing rice diseases. Therefore, this program examines the use of Agricultural Intelligence System (AIS) technology as a modern educational medium to improve understanding of rice diseases effectively, systematically, and digitally oriented which is carried out in community service precisely at AZRINA PRIVATE MADRASAH SMP IBTIDAIYAH for students so that it can provide information, in-depth knowledge about technological developments that can touch the agricultural sector, students also make new knowledge about technological developments and not only limited to cellphones and social media.

2. Methods

The tools used in this community service activity are tailored to the needs of educational implementation and the implementation of Agricultural Intelligence System (AIS) technology. The tools used include:

1. Laptop/Computer: Used as the primary device to run the AIS application, process the rice leaf image dataset, and display educational materials to participants.
2. Smartphone Camera/Digital Camera: Used to capture live images of rice leaves in the field. These images are then used as a real-world example in a disease detection demonstration using an AIS system.
3. Projector and Presentation Screen Used to display materials, tutorial videos, detection processes, and AIS analysis results to students during education and training sessions.
4. Internet / Wi-Fi network is needed to download AI models, perform system updates, synchronize data, and support interactive demonstrations for students.
5. The AIS application serves as the primary software used to detect rice diseases based on images. This system includes a visual interface, AI modules, and educational features.
6. Learning Modules and User Guides in the form of teaching materials, leaflets, or pocket books containing explanations of rice diseases, steps for using AIS, and examples of disease symptoms.
7. Rice Leaf Sample (Field Sample) Used as practical material and direct demonstration for students to observe real disease symptoms.
8. Field Work Table and Supporting Equipment Such as baseboards, cutters, rulers, or stationery to support direct observation and collection of leaf samples.

The materials used in community service activities with the theme "Technology Innovation Education based on the Agricultural Intelligence System (AIS) to Increase Understanding of Rice Diseases" include:

1. AIS Software: A Python-based application consisting of computer vision, machine learning, and a rice disease education interface.
2. Rice Leaf Image Dataset: Images of healthy rice leaves and those infected with diseases such as leaf blast, brown spot, and bacterial blight, used as educational materials and disease detection demonstrations.
3. Educational Materials/Learning Modules: Includes slides, leaflets, and AIS user guides explaining: types of rice diseases, visual symptoms, causes, and control efforts.
4. Evaluation Form/Questionnaire: Used to assess students' understanding before and after the educational activity.

Participants in the community service carried out at MADRASAH SWASTA AZRINA SMP IBTIDAIYAH included students in grade 12 or grade 3 with a total of 30 participants. As well as the time and duration of the implementation of this community service started at 09.00 to 12.00 WIB, with 3 hours of implementation, students were given an introduction and in-depth knowledge of understanding the development of innovation from computer vision-

based technology in detecting diseases in the agricultural sector.

3. Results and Discussions

The results and discussion of the educational material provided by the presenters to students at AZRINA PRIVATE MADRASAH IBTIDAIYAH SMP (Junior High School), were very engaging and full of students' curiosity about technological developments. The education directly focused on the agricultural environment in which they live: rice. Rice is a source of income that residents can cultivate, providing both income and a natural resource that significantly supports the food sector. This education also included knowledge of computer vision-based technology, which can be used to identify and classify rice diseases early.

Some of the educational materials provided at AZRINA PRIVATE MADRASAH IBTIDAIYAH SMP are shown in Figure 1 below:

Figure 1. Introductory greeting to students
Source: Azrina Private Madrasah, Elementary School

Figure 1 above shows the opening and introductory greeting given by the speaker to the students. The students' high level of enthusiasm is evident.

The material will be presented live using an LCD projector and presentation screen, as seen in Figure 2 below.

Figure 2. Education for students regarding the development of Computer Vision Technology for rice diseases

Figure 2 above demonstrates the warm interaction between the presenter and the students of AZRINA PRIVATE MADRASAH IBTIDAIYAH SMP. The material presented concerns technological developments, specifically in identifying rice plant diseases using innovative computer vision technology. Computer vision (CV) is a branch of science that focuses on digital imagery, meaning the data used is digital, including photos, videos, and other visual forms. The images are processed using several supporting methods, such as image segmentation. After these processes are completed, the algorithm is implemented in the Python programming language and integrated into an Android application. The application the presenter created and taught the students is shown in Figure 3 below.

Figure 3. Healthy Rice Disease Detection Application realized in Python to Android

In Figure 3 above shows the detection of rice objects identified as healthy with a percentage level of 73.24%. The results of the rice detection above have not been confirmed as healthy because they have a percentage level of 26.75% indexed (bacterial blight) and 0.01% (leaf blast). The results of diseased detection can be seen in Figure 4 below.

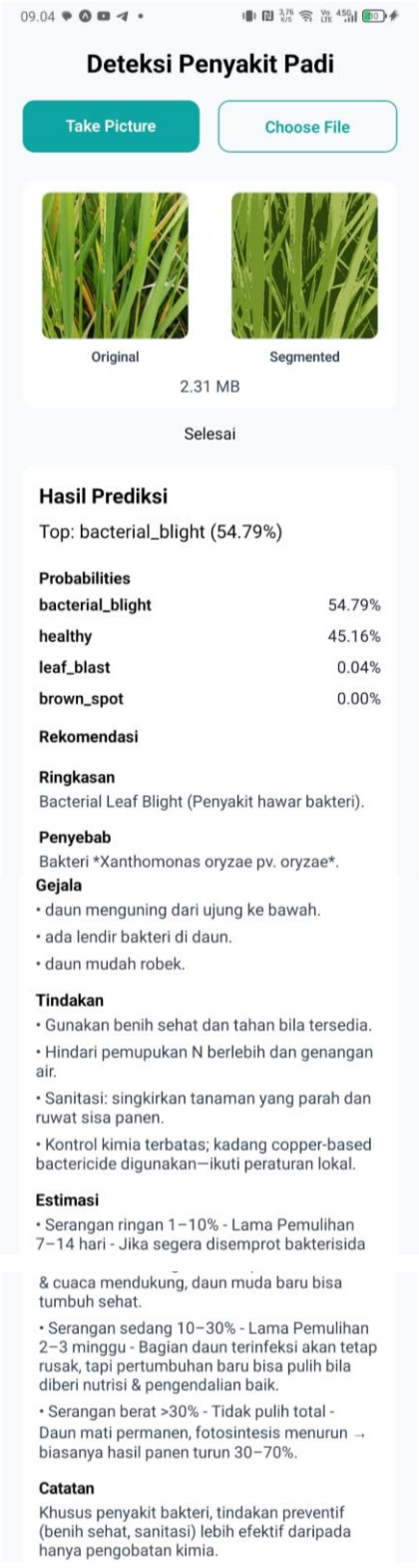

Figure 4. Rice Disease Detection Application that Detected Disease (bacterial blight) and Realized in Python to Android

Based on the figure 4 above, it can be seen that the detection results can identify disease (bacterial blight) on rice leaves. The identification results also provide information that supports farmers in understanding the results of rice disease detection, including the detection accuracy value, information on detection results in the form of category types (healthy, bacterial blight, leaf blast and brown spot), there is a summary that provides information, there are symptoms given, and there are actions given to farmers for the detected rice so that they can direct farmers to success in managing their rice and avoid rice diseases, and there are also notes as information on substances or actions given to rice. After the education was given, the presenter closed the education to the students by taking a group photo as documentation and can be seen in figure 5 below.

Figure 5. Closing of Computer Vision Technology Innovation Education for Rice Diseases

Figure 5 above shows the educational session has concluded and continued with a group photo of documents. However, based on the understanding gained by the students of AZRINA PRIVATE MADRASAH IBTIDAIYAH SMP, *a visual pretest will be conducted directly with the students, cumulatively with an average score that has a RGB range of 0-35 (red/don't understand), 36-65 (green/understand), and 66-100 (blue/very understand).*

Based on the visual pretest given by the presenter, almost all of the 30 students understood the material. Of these, 26 students answered the questions well and fell into the very understanding category, while

approximately 4 students fell into the understanding category due to their relaxed attitude during the education.

The visual pretest results provided by the presenter can help address system deficiencies. However, the speaker felt that the material at AZRINA PRIVATE MADRASAH IBTIDAIYAH SMP could be applied visually or asked directly and each other to give a grade that already had a category. *Based on the percentage, 86.6% understood very well, 13.3% understood, and 0% did not understand.*

4. Conclusions

The results of community service for students at AZRINA PRIVATE MADRASAH SMP IBTIDAIYAH (Islamic Junior High School) demonstrated a highly motivating and enhanced understanding. This education focused on developing knowledge in rice disease detection technology. Visual assessments conducted by instructors on students after the educational program provided simple alternatives and assessed the partners' competencies. The visual assessments yielded high percentages, with 86.6% receiving a very good understanding, 13.3% receiving an understanding, and 0% receiving a poor understanding. This concludes that the students have a good understanding of the material on computer vision innovation for rice diseases and technological developments.

Acknowledgments

The author would like to express his gratitude to Potensi Utama University for their assistance in this community service and to the partners who have provided support in carrying out this community service.

Funding Information

The implementation of this community service activity is funded by individuals and various other funding sources.

Author Contributions Statement

Contributor Role Taxonomy (CRediT) to recognize individual author contributions, the contributions made can be seen in the following table.

Name of Author	C	M	So	Va	Fo	I	R	D	W
Wahyu Saptha Negoro	✓	✓	✓	✓	✓	✓	✓	✓	✓
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