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MOBILE INTELLIGENT DECISION SUPPORT SYSTEM MELANI (MEDICINAL PLANT IDENTIFIER) DEVELOPMENT

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Abstract

The Development of MELANI (Medicinal Plant Identifier) Mobile Intelligent Decision Support System is a study on the design and development of an application for learning medicinal plants. Generally the purpose of this research is to knowing the design and development of MELANI (Medicinal Plant Identifier) Mobile Intelligent Decision Support System application, and also to get review from experts and response from it's users. Design and development method was used as the research methods together with the use of research design based on a knowledge base that is in line with existing problems as well as the use of creative methods in solving these problems,, in which focused on product design and development in the form of MIDSS applications, followed by a series of assessments, trials, and revisions to the product. Technique that was used for data gathering were interview, questionnaire, and observation while data reduction, data display, and conclusion was used as data analysis technique. This research resulted in the development of MELANI (Medicinal Plant Identifier) Mobile Intelligent Decision Support System in the form of Android application with the use of Artificial Intelligence (AI) technology in helping it's users identifying and learning medicinal plants in the field.

Keywords: *Design and Development, Artificial Intelligence, Mobile Intelligent Decision Support System, Medicinal Plant Learning.*

INTRODUCTION

Often the learning process is carried out through a face-to-face process between instructors and students that requires both to be present, as well as learning resources that are often used in the form of print such as books for example. This type of learning activity has a very significant shortcoming, namely the limitations of space and time and the type of learning resources that are less interactive. To overcome these problems practitioners in the field of education can utilize technology to improve the quality of learning, this is in line with the area of instructional technology or learning technology that examines the application of technology in learning activities (Smaldino, Lowther, & Russell, 2002).

Although technology can be a solution, but in overcoming various problems in learning activities it must still focus on humans as users or subjects who utilize the technology, the scientific field that focuses on building interactivity between humans and computers is IMK or HCI (Human Computer Interaction). HCI focuses on implementing a mechanism both in the form of software and hardware to support effective interaction between humans and computers, so that harmony between user characteristics and technological capabilities must be considered when developing a technology that will be used by humans (Thuseethan & Kuhaneesan, 2014).

Mobile learning is one solution that can be offered to solve problems such as interactivity of learning resources and limited space & time, because it is able to create its own learning environment that allows learning resources to be accessed anytime and anywhere and increases interactivity (Shyshkanova, Zaytseva, & Frydman, 2017). The 4th Industrial Revolution is able to make learning activities more interactive, intelligent, portable, virtual, and tailored to the needs of students, which are also supported by various technologies, one of which is Artificial Intelligence (AI) (Shahroom & Hussin, 2018). One application of artificial intelligence in the field of education which is a combination of mobile learning is the Mobile Intelligent Decision Support System or MIDSS (Liu, Diao, & Tu, 2010).

MIDSS is a system that has a purpose to assist students in making decisions. By using MIDSS users or students can be given various types of information that can take the form of increasing student knowledge, various alternative choices, the results of the analysis of a problem, as well as various other types of information that can help students make decisions. To carry out its functions MIDSS has five basic components namely the data base, model base, method base, man-machine interface, and intelligent components. Seeing this explanation, it is clear that the advantages of MIDSS compared to mobile learning are the capabilities that enable learning activities to be delivered more intelligently, in the sense of being able to facilitate learning activities thanks to the intelligence they have. By looking at these characteristics MIDSS can be applied in various learning activities that involve the decision making process, and one of them is the learning activities of medicinal plants.

Learning activities about medicinal plants are carried out in various departments both at the lecture level such as S1 and at the school level such as SMK. In introducing medicinal plants to students the sources used are usually like books, power points, or even field observations. For field observation activities usually only special places that can be visited, because there are not many locations that provide various types of medicinal plants in the same location. In Bandung alone there are three places that are often visited for field observations of medicinal plants namely Dago Herbal Herbs, Sari Herbal Medicine Plants, and Manoko Experimental Gardens. Each location has a variety of types of medicinal plants, but information related to each plant is incomplete, both in terms of species names to their properties and processing methods.

If visitors or students who come to the location want to know complete information about the plant, then they need another more complete source of information, such as a clerk or caretaker, or a book listing medicinal plants. The garden officer or caretaker is most likely to be able to provide accurate information regarding the information of each type of plant in the location, but the amount is certainly limited when compared to visitors or students who come to the location at the same time. If every visitor or student uses a book containing a list of medicinal plants, the process of identifying plants will take quite a long time, because they need to match the pictures in the book and the plants in front of them. That way both sources are considered less effective and efficient in helping students get to know a variety of medicinal plants, and we need a tool or technology that can help these learning activities.

MIDSS is able to help the learning activities of medicinal plants, but MIDSS itself has various types because the decision making process also varies according to what data or information is processed to be able to draw conclusions or make decisions. In helping the learning activities of medicinal plants, the right type of decision support system used is a computer vision based decision support system, which is considered suitable because of its ability to process, analyze, and understand images taken from the real world which are then processed into information to support the process of taking decision (Kaklauskas, 2015). MIDSS with this type of use computer vision as an intelligent component that allows it to process data, one example of technology or computer vision systems that are successful and suitable to be applied in mobile systems is MobileNetV2 (Sandler, 2018). Computer vision based decision support systems can be used in medicinal plants learning activities by visitors or students taking pictures or photographing medicinal plants that they have not yet identified, which will later be processed in such a way that the results of data processing will produce information in the form of plant species, its properties, processing methods, parts that can be utilized, and so forth.

Based on the problems that arise in the study of medicinal plants in the field and the development of adequate technology, it becomes a separate opportunity to be able to make an MIDSS in the form of applications that are able to assist students in recognizing medicinal plants while in the field. The development of MIDSS in the form of applications to identify medicinal plants is the focus of this study, which is expected to be able to facilitate students or the general public in recognizing medicinal plants as well as understanding the efficacy and processing procedures so that they can broaden students or the general public's knowledge about medicinal plants.

METHODOLOGY

This research focuses on making applications and knowing the responses of users to the resulting application. Seeing these reasons, the research model used in this study is the Design and Development (D&D) model, the D&D research model also has a prescriptive nature, which means trying to find the best solution where the solution or model or product has certainly been validated beforehand (Rusdi, 2018, p. 8).

In the D&D research model there are various types of research procedures to choose from, in this study the research procedure used is the research procedure proposed by Johannesson and Perjons (in Rusdi, 2018, pp. 73-74) which consists of five steps of the design research procedure and development ie Analysis of Problems, Determine Requirements, Design and develop products, Demonstrate products, and Evaluate products.

The problem that is the basis of application development in this study is the lack of information contained in medicinal plant gardens, where in three locations of medicinal plant gardens namely Dago Herbal Herbs, Sari Alam Medicinal Plantations, and Manoko Experimental Gardens. This lack of information becomes an obstacle for visitors or students who come to learn medicinal plants that are there. So we need a tool that is able to help users identify and study medicinal plants in the field at a moment's notice.

Based on the problems that have been analyzed previously, then the requirements regarding what things need to be owned by the application that will be developed. Because the purpose of developing this application is to help users identify medicinal plants in the field, this application needs to emulate the ability of an expert and a system that has this capability is also called an expert system. In addition to identifying, this application also needs to have extensive information about the medicinal plants listed there because it requires a knowledge management technique to help manage that information.

While in general the application is tasked with helping the user make decisions about what medicinal plants he is looking for or in determining information on a type of plant, a system that can help users make a decision is also called a decision support system or DSS. By looking at the three requirements that have been explained previously, in this study the application to be developed is a decision support system developed from expert systems which is also combined with artificial intelligence and knowledge management techniques or also called intelligent decision support systems (Kaklauskas, 2015). Because this application will be used in the field, the application developed must be in the form of mobile, thus the application to be developed in this study is the Mobile Intelligent Decision Support System or abbreviated as MIDSS, which is also supported by Liu, Diao, & Tu (2010) that MIDSS is one type of combination between artificial intelligence and mobile learning. This is in line with the goal of developing this application which is to help the learning activities of medicinal plants to be more independent and can be carried out anywhere and at any time in order to overcome the problems that have been described previously, where the solution is mobile learning. From the aspect of artificial intelligence itself, it elaborates on the technology created, which is an intelligent decision support system.

After the requirements have been determined, the next step is to design and develop the application. Based on the needs of the problems that have been analyzed and the requirements that have been described previously determined that this application will have three features or menus. The three features or menus are the "Gallery" which will list the medicinal plants in the application along with information about the plants, "Plant Identification" which allows the user to take pictures of a plant and will later try to be predicted by the application including what type of plant it is, and "Usage Instructions" which contain instructions for using the application.

These three features will be designed and developed in stages in accordance with the Waterfall software development model that researchers use. The steps taken in designing this application consist of making SKPL documents that contain the needs in making future applications, a flowchart containing the system running flow, and a storyboard that illustrates the application workflow containing the system flow and the appearance of the application later. While this application development step consists of gathering & preparing data that is collecting data and information needed by the application, namely photos and information of each medicinal plant that wants to be loaded in it, building intelligent models, namely developing a medicinal plant identification algorithm through photos, and developing an Android app that is developing applications Android that will load the intelligent model and contain information - medicinal plants.

After the application is successfully developed the next step is to demonstrate the application through trials to experts and users. This application will be demonstrated to experts in the form of expert review, which is an assessment of the application of the system aspects by the system expert and material aspects of the material expert. Besides this application will also be tested on 32 students majoring in Pharmacy 2018 class in the Poltekkes Negeri Bandung. This group was chosen because Pharmacy students are one of the potential users of the application to be developed. After these students try to use this application they will be asked to fill in an open questionnaire to provide responses regarding this application. The results of the system expert and material expert assessment along with the responses of the users namely Pharmacy students will be the basis of the evaluation of this application.

RESULTS AND DISCUSSION

Based on the results of interviews with system experts and observations to three locations of medicinal plantations namely Dago Herbal Herbs, Sari Sari Medicinal Plantations, and Manoko Experimental Gardens, it was determined that the application design of the MELANI (Medicinal Plant Identifier) Mobile Intelligent Decision Support System must prioritize application accuracy in conveying medicinal plants information both types and other details such as habitat, benefits, species, and so forth. The design process is divided into three steps in more detail, namely the creation of a Software Requirements Specification document or SKPL, Flowchart, and Storyboard.

The SKPL document created discusses the requirements needed to make this MELANI application both technically and non-technically. Technical requirements cover the necessary data, references in algorithm development, system flow, development operating environment, and interfaces. The data needed in this MELANI application is information on medicinal plants in the form of text, a database of photos and videos of medicinal plants, as well as an algorithm for identifying medicinal plants through photographs or which can also be called intelligent models in which all three are static data that is permanent. For dynamic data in the MELANI application this is a photo that will be taken by the user to be identified so that it will change the data.

For references used in developing intelligent models are two articles entitled "An Overview of Convolutional Neural Network Architectures for Deep Learning" by John Murphy and "MobileNetV2 (2016) : Inverted Residuals and Linear Bottlenecks" by Mark Sandler, Andrew Howard, Menglong Zhu, Andrey Zhmoginov, & Liang-Chieh Chen. The intelligent model for the MELANI application utilizes the MobileNetV2 algorithm which is discussed in one of the articles used as a reference, which is then developed again based on information about the Convolutional Neural Network algorithm in the article by John Murphy which is used as a reference. Non-technical requirements include the availability, memory usage, portability, response time, and reliability of the application.

The MELANI application consists of two main components namely the intelligent model and the Android application which are developed separately and then integrated. The intelligence model was developed using the Google Collaboratory service, which is a service for programming in the cloud with the Python programming language, this service is usually used to create machine learning models or algorithms for artificial intelligence. The Android application itself was developed using the Android Studio IDE with the Java programming language for logic and XML for how it looks.

This MELANI application can later be installed on all Android smartphones with Android OS 5.1 Lollipop API 22 and above. In addition to the smartphone OS it is necessary to have a camera as an image capture interface to be identified later, and RAM with a minimum capacity of 2 GB.

After SKPL is completed, then the MELANI application system flow is made in the form of a Flowchart and Storyboard which consists of three menus namely Gallery, Plant Identification, and Instructions for Use. When the user opens the Gallery menu there will be a list of medicinal plants registered in the application in the form of a photo and the name of the plant. If one photo of the plant is selected it will open a list of information about the medicinal plant along with a photo and a button which if pressed will open a video of the plant to give a more complete picture of the medicinal plant. This applies to every type of medicinal plant in the gallery.

Furthermore, the Plant Identification menu if selected will open the default smartphone camera, with the camera the user can take pictures of the plant that you want to identify, when the photo is deemed clear enough the user can immediately process the photo by pressing the button with the checklist icon, after it has been processed by the results system Identification prediction will appear by displaying the photos taken, prediction of plant name, and accuracy of identification prediction according to the system. The last menu is the Usage Guide which if selected by the user will display information on how to use the MELANI application.

The first MELANI application development process starts from collecting data in the form of photos and information - 12 types of medicinal plants, namely Cepentu, Glass Plate, Yellowing, Cat Whisker, Pare, Gotu Kola, Pepermint, Connecting Lives, Celery, Spoon, Betel, and Tread Dara. The photos were taken and collected from several locations, namely Bumi Herbal Dago, Manoko Experimental Garden, and Parongpong. While the information of these plants is obtained from the Reference Guide to Herbal Products Edition 1 Volume 2 - 7. The photos that have been collected are then resized to size 224 x 224 pixels because the intelligent model to be created requires image input to be processed to size 224 x 224 pixels.

The process of developing an intelligent model uses a service called Google Collaboratory as explained earlier, so the first thing to do is to make a new notebook that must be made every time you start a project. Because in developing intelligent models researchers use the Tensorflow library it is necessary to install the library in a notebook that has been made, the two types of libraries that are installed are the Tensorflow Hub and the Tensorflow Nightly GPU.

After that, the thing to do is to prepare a photo dataset in advance by uploading a previously zipped dataset to a notebook that has been created in Google Collaboratory. After the dataset is uploaded, it must be extracted, then augmented by increasing the amount of photo data by using photos that already exist but edited in such a way that they have several versions. An example is if the original photo is a photo of a Cepentu leaf, then the photos resulting from the augmentation can be a photo of the Cepentu leaf that has been rotated, enlarged the photo, and other changes to increase the number of datasets and variations in their distortions. After completing the augmentation process, all plant photos were entered into two variables, namely training data used to train intelligent models and test data to test intelligent models that were created later. From the dataset that researchers collected there were 20 photos for each type of medicinal plant. Of the 20 photos 16 of them were included in the training data to train the intelligent model, and 4 of them were included in the test data to evaluate the intelligent model later.

An intelligent model consists of three parts or structures, the first is a feature extractor that will extract pixel data from images into a group of numbers, then a hidden layer that looks for correlations of each data pixel, then an output layer that determines the final result of image identification. The intelligent model built for MELANI uses the MobileNetV2 algorithm as a feature extractor with the required input image of 224 x 224 pixels. The MobileNetV2 algorithm can be used by referring the following link "https://tfhub.dev/google/tf2-preview/mobilenet_v2/feature_vector/3".

The MobileNetV2 algorithm that has been prepared and entered into a variable is then compiled into an intelligent model structure, with a hidden layer with 128 nodes using reLu activation functions, and an output layer with 12 nodes according to the number of plants contained in the MELANI application with Softmax activation functions. Besides this intelligent model also uses Adam optimizer with a learning rate of 0.001 and epsilon 0.0001 to further improve accuracy.

After the dataset and intelligent model are ready the next process is to train the intelligent model in order to understand the photos in the dataset, the training process is carried out 10 times where the intelligent model will process all photos in the dataset 10 times repeatedly. Understanding here is an intelligent model algorithm that will process each photo in a dataset one by one by extracting the pixel data in each photo, then the algorithm will look for an equation according to its category. An example is that every photo of Ceplukan need in the training data will be extracted pixels into a form of data and look for similarities, so that later it can be concluded if there is an image extracted from pixels similar to a collection of photos of Ceplukan, then it can be concluded that there is a percent chance that the photo is also a photo of Ceplukan require .

When the process of training the intelligent model has been completed, an evaluation is carried out to see the accuracy of the model in identifying medicinal plants through photographs. The first simple evaluation that can be done is to look at the level of "Accuracy" that shows the accuracy of the model in identifying medicinal plants through photographs and "Loss" which shows the misclassification done by the model, each time the intelligent model training process that takes place 10 times. By looking at the graphs of ups and downs of accuracy and loss, the researcher can conclude that the model that has been made is good enough and can identify photos of medicinal plants in general.

The next evaluation is to make a Confusion Matrix. It is known that there are 4 photos for each type of medicinal plant in the test data variable, intelligent models that have been made will try to identify 4 photos for each type of medicinal plant and the results can be true or not. By using the Confusion Matrix researchers can see from a total of 4 photos on each type of medicinal plant, how many photos were able to be correctly identified by intelligent models made and how many were wrong. The results were quite satisfying where 5 types of medicinal plants 3 out of 4 photographs were correctly identified, and 7 other types of medicinal plants all of the photos were correctly identified. That way overall 43 of the 48 photos in the test data were identified correctly.

The last evaluation is to look at an example of the results of identification carried out by an intelligent model of the first 30 photographs in the test data by juxtaking between the identified photo and the name of the medicinal plant prediction identified. This is done to see if there are certain trends in misidentification by intelligent models, such as Peppermint leaves which are often considered to be Cepatible leaves. After going through several stages of evaluation and it is sufficient that the intelligent model will be saved in the form of .tflite file format and will be integrated with the MELANI Android application to be made.

The next process is the development of the MELANI Android application which was developed in the Android Studio IDE using the Java programming language. Display of each activity is adjusted to what has been designed in the storyboard, with a total of 24 activities for information and videos of each plant type - 2 each, 1 main menu activity, 1 activity gallery, 1 activity usage manual, and 1 activity to display the identification results. Programming for each activity is almost the same, in the form of a button to open the other activity to the destination, what is different is the code or programming for the activity when the user has taken a picture through the Plant Identification feature, and then is processed to identify the type of plant.

In this section the code or programming is much more complicated where the system must first prepare an intelligent model and list the 12 types of medicinal plants listed in the intelligent model. This is done by taking a .tflite intelligent model file that has been made before then stored into a variable, as well as a label list of 12 types of medicinal plants that are stored into a variable. After the successful process, the next step is to prepare a new variable to store images or photos that the user will take into the ByteBuffer format.

Before the image can be changed in format, the image is first accepted by the system, after that the image will be converted into the ByteBuffer format and saved into the variable that was prepared. Furthermore, the photo data that has been stored in the ByteBuffer format will be processed by an intelligent model while juxtaposed with a list of 12 types of medicinal plants to find a similarity presentation of the photo with each photo on each type of medicinal plant. The results of this process produce a list of similarity photographs with each type of medicinal plants, to get the highest types of medicinal plants the percentage of similarity, then the list of percentages is sorted and then the largest percentage is taken. The data taken is a prediction of the type of medicinal plant and the percentage of similarity, which will then be displayed or shown to the user. In addition to the different programming or code section, there is a complete information page on one of the medicinal plants, where there is a button which if pressed will create a new activity that directly plays the plant video.

After the application of MELANI is fully completed, the application is then tested on system experts and material experts in the form of expert review. The aspects assessed by system experts are Functionality which consists of evaluating the completeness of features and responsiveness of each feature, Performance consisting of assessing accuracy of predictions and interactivity levels, Usability consisting of ease of use of applications and clarity of instructions for use, & Portability consisting of assessments ease of installation of applications on other devices and variations in the location of application use.

The aspects assessed by material experts are Applications, Content and Materials. Application aspects consist of assessing the application of working well, ease of use of the application, and completeness of features for drug learning. The Content aspect consists of aligning information in the Plant Identification and Gallery features & validity and reliability of the information conveyed by the application. Material aspects consist of an assessment of the readability of the text and images in the application, the clarity of the information provided, and the suitability of the information submitted with the lecture material

From the evaluation of the system expert, it was found that there was a revision of the level of interactivity that was considered lacking, instructions for use that were not neat, and plant identification algorithms that had not been tested. Based on that, a revision was made to the MELANI application in the form of adding video features to increase interactivity, re-use instructions, and testing and enhancing image identification algorithms. From the material experts themselves, the assessment of MELANI application is included in the Good category, it's just that there are suggestions in the form of developing similar applications but specifically for use in certain locations such as the Manoko Experimental Garden.

The MELANI application was also tested on users, namely students of the Pharmacy class of 2018 at the Poltekkes Negeri Bandung. The trial was conducted in a way that every student tried to use the MELANI application completely, then they were given an open questionnaire to then answer the questions in the questionnaire. This was done to gather responses from users of Pharmacy students towards the MELANI application. The aspects asked in the questionnaire are the attractiveness level of the application, the accuracy of the features in meeting the needs of Pharmacy students, the clarity of the content ie images and text, the ease of use of the application, the compatibility of the information provided with lecture material, the validity of the information, helping whether or not the application in studying medicinal plants in field, constraints when using the application, and suggestions for improvement or application development.

Almost all students' responses to this application were positive as the application was considered interesting, suitable with lectures, very helpful in the field, and so on. It's just that there are various kinds of constraints experienced by students and also the suggestions given are varied, which if concluded refers to two things that must be corrected or improved from the application of MELANI, namely the number of plants that are considered lacking and the accuracy rate of the medicinal plant identification algorithm that is considered necessary improved. Based on this the researchers revised the application of MELANI by adding the number of medicinal plants from 10 to 12 by adding celery and kemuning medicinal plants, while the accuracy of the medicinal plant identification algorithm or intelligent model was improved from the previous 90% to 91%.

CONCLUSION

In general, the conclusions of this study resulted in the design and development of the MELANI (Medicinal Plant Identifier) Mobile Intelligent Decision Support System application in the form of design and application manufacturing processes that are able to help users identify and study medicinal plants in the field, which are made into Android application forms combined with artificial technology intelligence whose research procedures are based on Johannesson and Perjons. The results of the assessment of experts on the application MELANI also get the category of "Good" and the user's response was positive towards this application with a few inputs for the improvement and development of the application MELANI going forward.

The design of the MIDSS MELANI (Medicinal Plant Identifier) application prioritizes application accuracy in providing information on the right type of plant. This design is poured into the form of a Software Requirements Specification or SKPL document, a system flow that is a Flowchart, and making the overall application display in the form of a Storyboard.

The process of developing the MIDSS MELANI (Medicinal Plant Identifier) application starts with collecting photos of 12 types of medicinal plants with a total of 240 photos taken at the Manoko Experimental Garden, Bumi Herbal Dago, and Parongpong, and information on 12 types of medicinal plants from the ebook Reference to Herbal Supplies Edition 1 Volume 2 - 7. Continue to the Building stage of developing a medicinal plant identification algorithm using Google Collaboratory services by redeveloping the MobileNetV2 model. Continue to the process of developing the MELANI Android application using the Android Studio IDE in accordance with the storyboard design that was created.

The expert's assessment of the material and system aspects of the MIDSS MELANI (Medicinal Plant Identifier) application received the "Good" category. There are several revisions to the application obtained from experts, namely the addition of video media for each plant, rearranging the instructions for use, and re-developing the plant identification algorithm.

The response of users to the MIDSS MELANI (Medicinal Plant Identifier) application was very positive accompanied by several suggestions from users which were made revisions to the application. The revision is to increase the number of medicinal plants in the application to 12, and increase the accuracy of the plant identification algorithm to 91%.

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