MedLeaf: Mobile Application For Medicinal Plant Identification Based on Leaf Image

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MedLeaf: Mobile Application For Medicinal Plant Identification Based on Leaf Image

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Abstract*— This research proposes MedLeaf as a new mobile application for medicinal plants identification based on leaf image. The application runs on the Android operating system. MedLeaf has two main functionalities, i.e. medicinal plants identification and document searching of medicinal plant. We used Local Binary Pattern to extract leaf texture and Probabilistic Neural Network to classify the image. In this research, we used 30 species of Indonesian medicinal plants and each species consists of 48 digital leaf images. To evaluate user satisfaction of the application we used questionnaire based on heuristic evaluation. The evaluation result shows that MedLeaf is promising for medicinal plants identification. MedLeaf will help botanical garden or natural reserve park management to identify medicinal plant, discover new plant species, plant taxonomy and so on. Also, it will help individual, groups and communities to find unused and undeveloped their skill to optimize the potential of medicinal plants. As the results, MedLeaf will increase of their resources, capitals, and economic wealth.

Keywords*— Heuristic evaluation, medicinal plant, identification, Local Binary Patterns, Probabilistic Neural Network.

I. INTRODUCTION

Biodiversity is in crisis [1, 2, 3, 4]. Many plants are at the risk of extinction. With the predicted loss of genetic and species diversity as great as past mass extinction events [5], a pressing challenge in environmental sciences will be understand the factors causing this decline [6].

Indonesia is a country of mega biodiversity. Indonesian Science Board (Lembaga Ilmu Pengetahuan Indonesia/LIPI) states that Indonesia is home to 30,000 out of 40,000 medicinal herbal plants in the world. However, according to Groombridge and Jenkins (2002), the percentage of Indonesian medicinal plant used has only been 4.4% [7]. Researchers, students, and practitioners through the exploration of the various regions in Indonesia have documented some medicinal plants, either through surveys of potential plant diversity and ethno botany studies. However, dissemination of information, identification, and utilization of medicinal plants to the public is still not optimal. The most urgent situation is Indonesia does not have a complete inventory of medicinal plants and only a little of this information has been recorded in a systematic manner. It is one of our biggest responsibilities to save the plants from various threats, restore the diverseness of plant community and put everything back to balance.

In this research we propose a mobile application for medicinal plant identification automatically based on leaves image. Many methodologies have been proposed to analyze plant leaves in automated fashion [8, 9, 10].

In this research, develops a mobile application for medicinal plants identification based on leaves image that runs on Android operating system. Local Binary Pattern Variance (LBPV) is used to extract leaf texture and

Probabilistic Neural Network (PNN) is used for classification.

II. Local Binary Pattern

Local Binary Patterns (LBP) proposed by [11] for rotation invariant texture classification. To obtain LBP value, thresholding performed on the neighborhood circular pixels using the central pixel, then multiply by binary weighting.

LBP is formulated by:

$$LBP_{P,R}(x_c, y_c) = \sum_{p=0}^{P-1} s(g_p - g_c)2^p \qquad (1)$$

$$s(x) = \begin{cases} 1 & x \geq 0 \\ 0 & x < 0 \end{cases} \qquad (2)$$

where x_c and y_c are the coordinate of center pixel, p is circular sampling points, P is number of sampling points or neighborhood pixels, g_p is gray scale value of p, g_c is center pixel, and s or sign is threshold function. For classification purpose, the LBP values are represented as a histogram.

III. Rotation Invariant Uniform Patterns

Rotation Invariant Uniform Patterns are denoted $LBP_{P,R}^{riu2}$ is an operator that rotation invariant and uniform. A uniform LBP value detects basic texture properties such as line, edge, point, and corner. Uniform patterns can be expressed as follows:

$$U(LBP_{P,R}) = |s(g_{P-1} - g_c) - s(g_0 - g_c)| + \sum_{p=1}^{P-1} |s(g_p - g_c) - s(g_{p-1} - g_c)| \qquad (3)$$

Uniform patterns is characterized by the value of $U(LBP_{P,R})$ is less than 2. $LBP_{P,R}^{riu2}$ is formulated as:

$$LBP_{P,R}^{riu2} = \begin{cases} \sum_{p=0}^{P-1} s(g_p - g_c), & if\ U(LBP_{P,R}) \leq 2 \\ P+1, & otherwise \end{cases} \qquad (4)$$

If the patterns is uniform patterns, $LBP_{P,R}^{riu2}$ value obtained by counting the number of bits of the patterns that determines the location of uniform patterns bin. If P or the number of sampling points equal to eight, $LBP_{P,R}^{riu2}$ values are in range zero to nine. LBP patterns that are not uniform are grouped under bin 9th [12].

IV. Local Binary Patterns Variance (LBPV)

By definition VAR describes local contrast properties, and $LBP_{P,R}^{riu2}$ describes texture patter properties, so that the two operators are complements. Ojala *et al.* perform joint distribution of local contrast pattern with LBP as a texture descriptor called LBPV [12, 13, 14]. LBPV intended to be a texture descriptor that can inform local patterns of texture and contrast. LBPV histogram is calculated as:

$$LBPV_{P,R}(k) = \sum_{i=1}^{N} \sum_{j=1}^{M} w(LBP_{P,R}(i,j), k), \quad k \in [0.K] \qquad (5)$$

with

$$w(LBP_{P,R}(i,j), k) = \begin{cases} VAR_{P,R}(i,j), & LBP_{P,R}(i,j) = k \\ 0, & otherwise \end{cases} \qquad (6)$$

V. Probabilistic Neural Network (PNN)

Probabilistic Neural Network (PNN) proposed by Donald Specht in 1990 as an alternative back-propagation neural network. PNN has several advantages i.e. training requires only one iteration, and general solution is obtained by using a Bayesian approach. PNN is a neural network that uses radial basis function (RBF). RBF is a function that is shaped like a bell that scales a nonlinear variable [15].

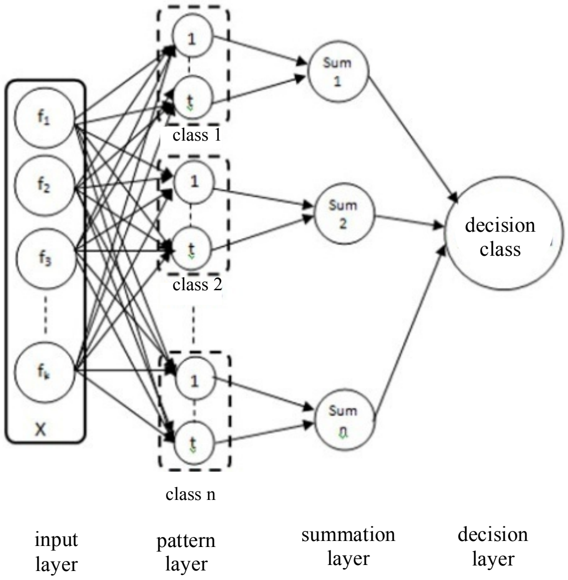

Fig. 1 Structure of PNN

PNN consists of four layers, input layer, pattern layer, summation layer and output layer. PNN structure is shown in Figure 1. The layers that make up the PNN is as:

1. Input layer

   Input layer is input x consisting of k value to be classified in one class of n classes.

2. Pattern layer

   Pattern layer performs dot product between input x and weight x_{ij}, or $Z_i = x \,.x_{ij}$, Z_i then divided by a certain bias σ then inserted into the radial basis functions, that is $radbas(n) = exp\,(-n)$. Thus, the equation used in pattern layer is computed as:

$$f(x) = exp\left(-\frac{(x-x_{ij})^T(x-x_{ij})}{2\sigma^2}\right) \tag{7}$$

   where x_{ij} express training vector class i order j.

3. Summation layer

   In this layer, each pattern in each class is summed to produce a population density function for each class. The equation used at this layer is:

$$p(x) = \frac{1}{(2\pi)^{\frac{k}{2}}\,\sigma^k\, t} \sum_{i=1}^{t} \exp\left(-\frac{(x-x_{ij})^T(x-x_{ij})}{2\sigma^2}\right) \tag{8}$$

4. Output layer

At the decision layer input x will be classified into class I if the value $p_I(x)$ is larger than any other class.

VI. EXPERIMENTAL RESULT

A. Data Collections

Medicinal leaf plant are collected from Ex-situ conservation area of medicinal plant in Biofarmaka IPB, Cikabayan IPB, Ex-situ Conservation Center of Plant Medicinal Tropical Forests Indonesia, Faculty of Forestry IPB and the Bogor Botanical Gardens, West Java, Indonesia. The number of data is 1,440 leaf images, which consist of 30 medicinal plant species. Each species consists of 48 digital leaf images. The image sizes are all 270 by 240 pixels. RGB image captured using a camera phone and then RGB images are converted into gray scale images and resized to 240x270 pixels.

B. Results

The experiment result show that the accuracy of medicinal plant identification is 56.33%. The low accuracy is caused by the image quality is not good because the images was taken using camera smartphone. The images have different illumination. Also, some species of medicinal leaf plants have similar texture. We have been developed automatically medicinal plant using combination of leaf features such as shape, color and texture [16].

We have been developed the mobile applications for medicinal plant identification. The application runs on Android operating system. The application is divided into two main functionalities, i.e., medicinal plant identification and document searching of medicinal plants. Also, we developed medicinal plant database (Figure 1).

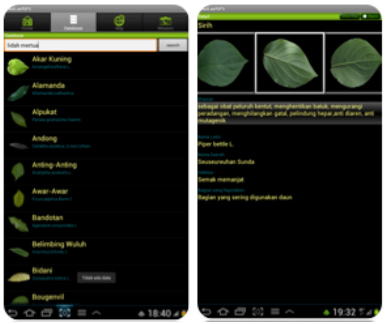

Fig. 1. Medicinal plant database

For medicinal leaf identification, the leaf image can be captured from the gallery or camera phone. The image will be displayed on the mobile screen. To identify the leaf, user press the identification button and **MedLeaf** will identify the medicinal plant automatically. Figure 2 show the interface of identification.

Fig. 2 User interface of medicinal plant identification

For document searching of medicinal plant, user input keyword and press search button. Figure 3 show interface of document searching of medicinal plant.

Fig. 3 User interface of document searching

We evaluated performance of the application using a questionnaire. There are 20 users who evaluate the application. They are students from different department in Bogor Agricultural University (IPB). We used heuristic evaluation in questionnaire that consists of [17]:

1. *Visibility of system status*
2. *Match between system and the real world*
3. *User control and freedom*
4. *Consistency and standards*
5. *Error prevention*
6. *Recognition rather than recall*
7. *Flexibililty and efficiency of use*
8. *Aesthetic and minimalist design*
9. *Help users recognize, diagnose, and recover from errors*
10. *Help and documentation*

The questionnaire is used to evaluate user satisfaction in medicinal plant identification and document searching. The questionnaires show that 35% of user satisfied with the results of identification, 50% of user quite satisfied, and 15% of user not satisfied with the results of medicinal plant identification (Figure 4).

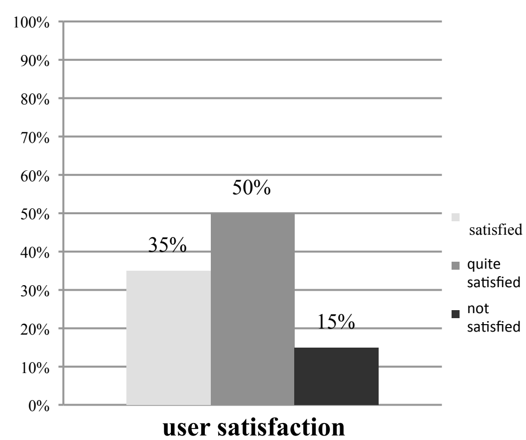

Fig. 4 User satisfaction for medicinal plant identification

Figure 5 shows user satisfaction for document searching. User satisfaction evaluation for document searching show that 40% of user satisfied, 60% of user quite satisfied and 0% of user not satisfied. This indicated that the application gives the relevant document to user.

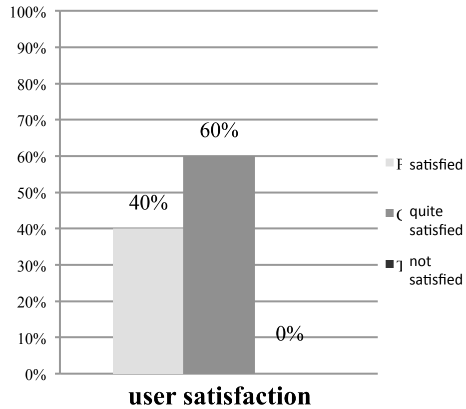

Fig. 5 User satisfaction for document searching

VII. CONCLUSIONS

We have been developed MedLeaf - a mobile application for medicinal plant identification based on leaf image. The application consists of two main functionalities, i.e. medicinal plant identification and document searching of medicinal plant. MedLeaf is computer-aided medicinal plant recognition system that use technology of image processing, computer vision and intelligent information processing techniques. We used Local Binary Pattern to extract leaf texture and Probabilistic Neural Network to classify the image. The medicinal plant identification is done only based on leaf texture. The accuracy of medicinal plant identification based on leaf texture is 56.33%. Now, we have been developed MedLeaf using combinations of leaf features such as shape, color and texture. MedLeaf will help botanical garden or natural reserve park management to discover new plant species, plant taxonomy, exotic plant detection, edible/poisonous plant identification and so on. Also, it will help individual, groups and communities to find unused and undeveloped their skill to optimize the potential of medicinal plants. As the results, it will increase of their resources, capitals, and economic wealth.

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