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ANDROID APPLICATION FOR EARLY SCREENING OF ATRIAL FIBRILLATION USING DEMPSTER SHAFER METHOD

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Abstrak. Atrial Fibrillation (FA) is one of the most common heart rhythm disorders found in clinical practice in Indonesia. Atrial fibrillation can cause a 5-fold risk of stroke. Meanwhile, stroke cases tend to increase and become one of the leading causes of death yearly. The cause of high FA cases is the lack of knowledge and public awareness/sensitivity to the early symptoms of the disease. This research aims to design an android device for the initial screening of suspected FA by examining pulse rate, complaints/symptoms and disease risk factors. Dempster Shafer method is used as a decision-making tool for suspected FA or not FA. The detection system performance test results obtained a sensitivity of 93.5%, specificity of 89.7%, and accuracy of 91.7%. The results of the Android application design test, namely Visual Design and User Interaction, Functionality, Stability and Performance and Overall Satisfaction, showed a "good" response in all aspects.

INTRODUCTION

Atrial fibrillation is a heart rhythm disorder (arrhythmia) marked by disorganization of atrial depolarization resulting in disorders of atrial mechanical function (Dinarti et al., 2009). Atrial fibrillation is the most prevalent type of heart rhythm disorder in clinical practice compared to other heart rhythm disorders. According to data from an observational study (MONICA-multinational Monitoring of Trends and Determinants in cardiovascular disease) in an urban population in Jakarta, Indonesia, the prevalence of FA was reported to be 0.2% with a male-to-female ratio of 3:2. The elderly population has a significant increase of 7.74% in 2000-2005, and WHO estimates that it will increase to 28.68% in 2045-2059, so the incidence of atrial fibrillation is also expected to increase significantly. Although this disease is quite common, there is still a lack of knowledge and awareness of FA.

One of the most concerning complications of atrial fibrillation is stroke since patients with atrial fibrillation have a five times higher risk of stroke than those without atrial fibrillation. A FA stroke also results in twice the mortality and a care cost of 1.5 times (Y Yuniadi et al., 2014).

In the health sector, technological advancements have enabled computers to work like experts or doctors, called expert systems. Using an expert system can help find an answer or determine what conclusions can be drawn. An expert system is an artificial intelligence that exists in software built with the ability to approach an expert with high knowledge in a certain area. Hopefully, it can help solve a problem (D Touriano, 2014).

This study aims to design an android application for the initial screening of presumed FA by reading the pulse rate, symptoms, and risk factors. For FA detection, the system uses an artificial intelligence method based on an expert system,

the Dempster-Shafer method. Meanwhile, device evaluation is divided into two schemes: detection performance testing and interface design testing to ensure user comfort. This android application can provide practical knowledge and raise awareness of FA disease to minimize strokes. This will certainly increase work productivity because there is no physical interference/complaint.

Methodology

There are 3 phases carried out in this study: the detection system design phase, the application interface design phase, and the device testing phase. The FA detection system is designed with 19 input parameters (Table. 1) and two outputs (presumed FA or presumed not FA). The classification method used is Dempster Shafer. Data collected in this study used 60 data obtained from interviews and patient medical record data, each consisting of 31 patient data diagnosed with atrial fibrillation and 29 patient data not diagnosed with atrial fibrillation. The criteria used in this study are 19 risk factors and symptoms found in patients with the potential to suffer from atrial fibrillation.

At the knowledge base design phase, parameters are compiled, such as risk factors and symptoms of atrial fibrillation obtained from literature studies, and then discussed with experts, such as cardiologists. After determining the parameters, a process of giving weight or belief values from experts for each parameter is carried out. As shown in Table 1.

TABLE 1. Risk Factor Confidence Score and Atrial Fibrillation Symptoms

Code	Parameter	Belief Value at Risk of Atrial Fibrillation (C1)	Belief Value Not at Risk of Atrial Fibrillation (C2)
G1	The pulse rate felt by the user:	0	0.9
	1. Normal pulse: The pulse has a basic and regular rhythm.		
	2. Abnormal pulse: The pulse has a basic rhythm, but there is a situation of missing one beat between the basic rhythms.	0	0.9
	3. Abnormal pulse rate: The pulse has a basic rhythm, but there is a situation of increasing one beat between the basic rhythms.	0	0.9
	4. Irregular pulse: The pulse has no basic rhythm and is irregular.	0.9	0
G2	Irregular pulse rhythm is caused by physical activity	0.655	0
G3	Rapid heartbeat (Palpitations)	0.9	0
G4	Acute fatigue	0.736	0.164
G5	Shortness of breath (dyspnea)	0.655	0.245
G6	Chest pain or chest pain	0.655	0.327
G7	Dizziness or mild headache	0.736	0.327
G8	Temporary loss of consciousness/fainting (syncope)	0.9	0.164
G9	Active smoker	0.655	0.327
G10	History of Hypertension	0.655	0.164
G11	History of Diabetes Mellitus	0.736	0.327
G12	History of Coronary Heart Disease	0.818	0.164
G13	History of Heart Failure	0.818	0.082
G14	History of Heart Valve Disease	0.9	0.082
G15	History of Stroke	0.818	0.164
G16	History of Chronic Pulmonary Disease	0.9	0.082
G17	Gender:	0.491	0.327
	1. Male		
	2. Female	0.409	0.327
G18	Age ≥ 75 years	0.655	0.327
G19	BMI ≥ 30	0.573	0.327

Second, the application of Dempster Shafer's Theory. Dempster Shafer's theory is representation, combination, and propagation of uncertainty, where this theory has several characteristics that instinctively match the way of thinking of an expert but a strong mathematical basis. In general, Dempster Shafer's theory is written in an interval: [Belief, Plausibility] (Sinaga and Sembiring, 2016). Belief (Bel) measures the evidence's strength in favor of a proposition set. A value of 0 indicates no evidence, and 1 indicates certainty. Plausibility (Pls) will reduce the certainty level of the evidence. Plausibility is 0 to 1. If sure for X', then it can be said that Bel(X') = 1, so the formula above the value of Pls(X) = 0.

There are three steps in the Dempster Shafer method calculation: determining the initial density value (m), the new density value (m), and the largest density value. The initial density value consisting of probabilities of potentially and not potentially suffering from atrial fibrillation is usually called the belief value, and the plausibility value of each parameter is based on the knowledge base. The plausibility value is obtained from the result of 1 - the belief value in the following equation.

$$Pls\ (X) = 1 - Bel\ (X) = 1 - \sum_{Y \subseteq X} m(X)$$

Dimana :
Bel (X) = *Belief* (X)
Pls (X) = *Plausability* (X)
m (X) = *mass function* (X)
m (Y) = *mass function* (Y)

The new density value (m) could be determined by creating a combination table and following the equation below..

$$m3(Z) = \frac{\sum_{X \cap Y=Z} m_1\ (X).m_2(Y)}{1 - \sum_{X \cap Y=\emptyset} m_1\ (X).m_2(Y)}$$

Where:
m3 (Z) = *mass function* from *evidence* (Z)
m1 (X) = *mass function* from *evidence* (X), which is calculated from the belief value of evidence multiplied by the disbelief value of the evidence
m2 (Y) = *mass function* from *evidence* (Y), which is calculated from the belief value of evidence multiplied by the disbelief value of the evidence.
$\sum_{X \cap Y=Z} m_1\ (X).m_2(Y)$ = It is the strength value of evidence Z obtained from the combination of the belief value of a group of evidence.

Detection results are obtained by calculating the Dempster Shafer method with the largest density value. When the density value of C1 is greater than C2, the system will provide detection results of potential atrial fibrillation. It will display the probability value of possible risk factors and symptoms experienced by the user. Still, when the density value of C2 is greater than C1, the system will provide detection results without potentially having atrial fibrillation and display the probability value.

The application interface is designed with three main menus: the info menu to share information about FA and the potential for stroke due to FA, the learning menu to recognize pulse abnormalities, and the detection menu. Furthermore, an expert system test is carried out on the detection results obtained from the calculation of the Dempster Shafer method and then analyzed with three tests, including sensitivity, specificity, and accuracy.

The sensitivity value is used to see the likelihood of patients potentially affected by atrial fibrillation from the overall data of patients with the potential to have atrial fibrillation. The sensitivity value is obtained by matching the results of expert diagnosis on patients diagnosed with atrial fibrillation with the calculation results of the method used as the conclusion of the system output. This value also determines how well the method predicts the potential for atrial fibrillation. The calculation to determine the sensitivity value can be done using the following equation.

$$\text{Sensitivitas} = \frac{TP}{TP+FN} \text{ x } 100\%$$

Keterangan:
TP = *True Positive*
FN = *False Negative*

True Positive is a result where the Dempster-Shafer method correctly predicts data potentially having atrial fibrillation. False Negative is a result where the Dempster Shafer method incorrectly predicts data potentially having atrial fibrillation.

The specificity value is used to see the possibility of patients who do not have the potential to have atrial fibrillation from all patient data that does not have the potential to have atrial fibrillation. The specificity value is obtained by matching the expert diagnosis results in patients not diagnosed with atrial fibrillation with the calculation results of the

method used as the conclusion of the system output. This value is also used to determine how well the method is used in predicting not potentially having atrial fibrillation. The calculation to determine the sensitivity value can be done using the following equation.

$$\text{Specificity} = \frac{TN}{TN+FP} \text{ x } 100\%$$

Keterangan:
TN = *True Negative*
FP = *False Potitive*

True Negative is a result where the Dempster-Shafer method correctly predicts data that does not have the potential to have atrial fibrillation. False Positive is a result where the Dempster Shafer method incorrectly predicts data that does not have the potential to have atrial fibrillation.

The accuracy value is used to measure the accuracy of atrial fibrillation prediction by comparing the results of expert diagnosis. This value is obtained by using all the prediction results from the method used and compared with the results of the expert diagnosis. The higher the accuracy value, the more precise the method is in predicting the potential for atrial fibrillation. The calculation to determine the accuracy value can use the following equation..

$$Accuracy = \frac{\sum true\ data}{N} . 100\ \%$$

Keterangan :
∑ true data = Total number of matching data between expert diagnosis results and system output results
N = The number of trials conducted

In this study, the expert system used is implemented into an Android-based application so that an application test is needed, which aims to find out whether the application is good enough or not and eliminate any bugs and errors in the application that has been made. It is intended that the application can be used easily by all users.

According to Google Play Developer Guidelines, two tests must be carried out in an Android program: User Satisfaction Test and Software Testing. The User Satisfaction Test aims to determine the level of user satisfaction with the application that has been made. The application will be submitted to the user for testing and survey in this test. This test can also be used as a means of finding bugs and asking for suggestions so that the application can be better. Testing is done using a questionnaire that includes important aspects. Important aspects of the satisfaction test in Nuzul (2016) include ease of user interface, functionality, stability, performance, and overall satisfaction with a rating scale of 1-10.

Software Testing aims to perfect the application that has been made. Software testing methods are divided into two, namely, White Box Testing and Black Box Testing. White Box Testing is a testing method by looking at the program listing to examine the program code, which is then analyzed for errors and whether the desired output is appropriate or not based on the program code that has been created. At the same time, Black Box Testing is a method carried out by analyzing whether the application output follows the desired process and results. This test method sees whether the final result of the application process is built following the initial design of making the application, both in terms of functionality and internal structure.

RESULT AND DISCUSSION

This study used 60 patient data at Universitas Airlangga Hospital, with details of 31 patients diagnosed with atrial fibrillation and 29 patients not diagnosed with atrial fibrillation. After the parameters selected by the user are entered, and the system calculates the Dempster Shafer method, the results of the expert system prediction of the Dempster Shafer method are matched with the results of the expert diagnosis, as shown in Table 2.

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TABEL 2. Matching System Prediction Results with Expert Diagnosis

Data to-	Expert Diagnoses	*System Outputs*	Description
1	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
2	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
3	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
4	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
5	Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	non-conforming
6	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
7	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
8	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
9	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
10	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
11	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
12	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
13	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
14	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
15	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
16	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
17	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
18	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
19	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
20	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
21	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
22	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
23	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
24	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
25	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
26	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
27	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
28	Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	non-conforming
29	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
30	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
31	Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	Conforming
32	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
33	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
34	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
35	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
36	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	non-conforming
37	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
38	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
39	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
40	No Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	non-conforming
41	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
42	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
43	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
44	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
45	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
46	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
47	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
48	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
49	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
50	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
51	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
52	No Potential to have Atrial Fibrillation	Potential to have Atrial Fibrillation	non-conforming
53	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
54	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
55	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
56	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
57	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
58	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
59	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming
60	No Potential to have Atrial Fibrillation	No Potential to have Atrial Fibrillation	Conforming

Determination of the performance of the Dempster Shafer method can be determined by three testing methods,

namely sensitivity, specificity, and accuracy.

From the tests carried out according to Table 2, the number of true positive (TP) data is 29, and false negative (FN) data is 2. So that the sensitivity value of the Dempster-Shafer method in predicting the potential for atrial fibrillation is 93.7%. While the true negative (TN) is 26 data and the false positive (FP) is three, the specificity value of the Dempster-Shafer method in predicting the absence of the potential for atrial fibrillation is 89.7%. So that the accuracy of the Dempster-Shafer method in predicting the presence and absence of the potential to have atrial fibrillation is 91.7%.

The expert system in this research is implemented into an Android-based application. Interface design provides an overview of the application display that the user will use. The results of the interface design in this study consist of the main, learning, detection, info, and help windows.

The main display window is the initial display in a splash screen, and the main menu is shown in Figure 1. In the main menu, there are four menus, namely the learning menu, detection menu, info menu, and help menu.

The learning menu contains a video of how to feel the pulse because, in this study, the main parameter used is the pulse condition; it is necessary to learn in advance about how to handle the pulse and recognize various pulse conditions. The display of the learning menu is shown in Figure 2.

According to the knowledge base, the detection menu contains questions in the form of symptoms and risk factors for atrial fibrillation. On the initial page of the detection menu, the user will be presented with a video in the form of 4 pulse conditions (Figure 3). The first video is a description of a normal pulse condition, namely a pulse that has a primary and regular rhythm, the second is a description of a pulse condition that has a basic rhythm, but there is a loss of one beat between primary rhythms, The third is a description of the condition of the pulse having a basic rhythm but there is a state of increasing one beat between the primary rhythms, and the fourth is a description of the condition of the pulse not having a basic and irregular rhythm, the fourth pulse state is a description of the pulse state experienced by atrial fibrillation patients. Then the user chooses one of the pulse videos that best suits their feelings. Furthermore, the user will answer questions about symptoms and risk factors for atrial fibrillation by answering yes or no, choosing a history of illness experienced, and filling in height, weight and age, as shown in Figure 4. At the end of the question, there will be a detection button; Figure 5 is an example of the conclusion of the detection results generated by the application.

The Info menu is shown in Figure 6; in the info menu, there are three menus; the first is the atrial fibrillation information menu; this menu contains an understanding of potential dangers due to atrial fibrillation and symptoms and risk factors for atrial fibrillation. The second menu is the application information menu; this menu contains information about the application's purpose and the application's test results. The third menu is the programmer information menu; this menu includes information from the application creator.

The Help menu contains procedures for running the application, so it is expected to help users use it. The display of the help menu is shown in Figure 7.

(a) (b)

FIGURE 1. Main Window (a) Initial View (b) Main View

FIGURE 2. Learning Menu

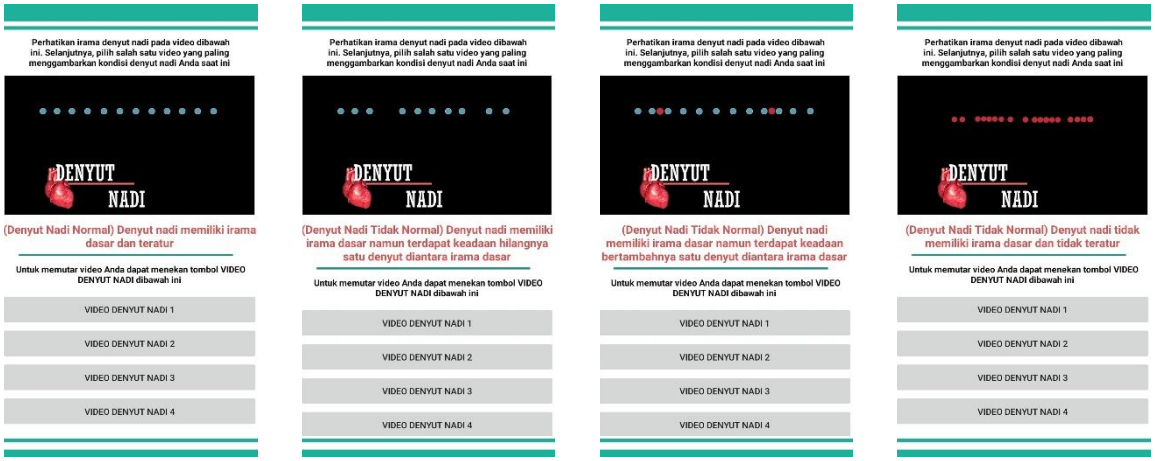


FIGURE 3. Pulse condition detection menu (a) Normal pulse, (b) Pulse with one beat missing at basic rhythm, (c) Pulse with one beat added at basic rhythm, (d) Irregular pulse and no basic rhythm.

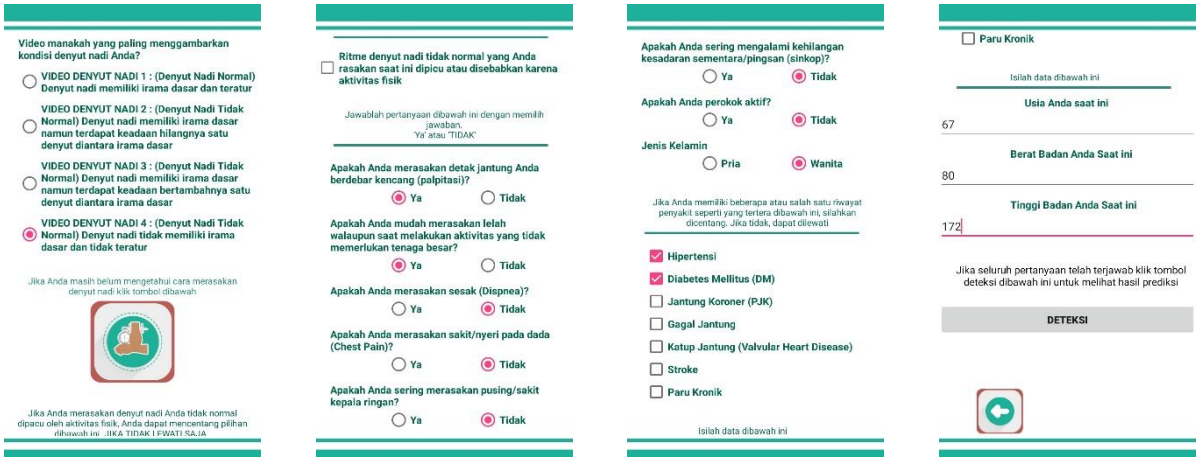


FIGURE 4. Detection menu (a) Menu matching pulse rate with video, (b) Detection with history, (c) Disease history, (d) Patient data

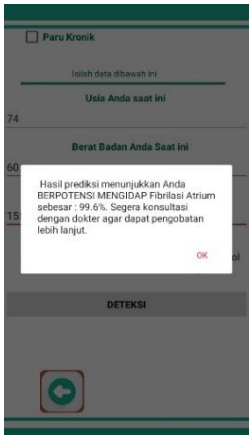
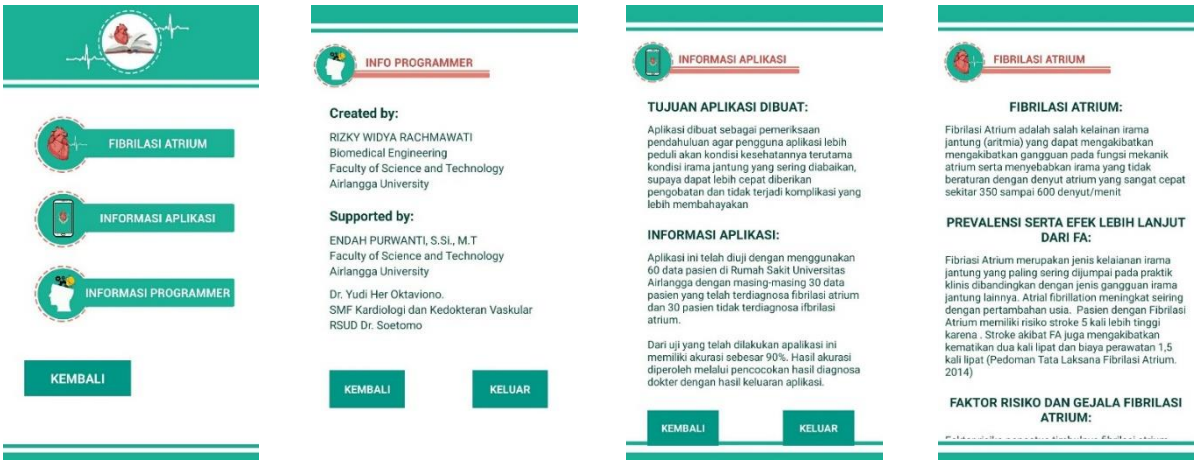


FIGURE 5. Detection Results



(a) (b) (c) (d)

FIGURE 6. Info menu (a) Info menu list, (b) Programmer info, (c) Application Information, (d) Atrial Fibrillation

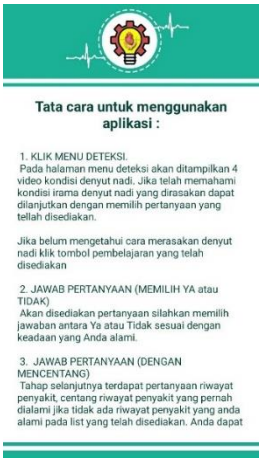


FIGURE 7. The Help menu

Next, the User Satisfaction Test. In this test, the atrial fibrillation detection application is handed over to the user to try and then test and survey user satisfaction when using the application. The test was carried out by filling out a questionnaire conducted by 20 randomly selected people, and then the average value of the assessment results was calculated. This test has essential aspects, namely visual design and user interaction, functionality, stability, performance, and overall satisfaction, with a rating scale of 1-10. The number 1 indicates very bad, cannot function, and has errors. While the number 10 shows very good, can function properly and has no errors. The test results of the user satisfaction test can be seen in Table 3 to Table 6.

TABLE 3. Survey Results of Visual Design and Program User Interaction

No	Subject	Average Value
1	Icon display on the Android menu screen	8,4
2	Initial splash screen display	8,4
3	Detection window display	8,1
4	Learning window display	8
5	Info window display	8,1
6	Help window display	7,9
7	Ease of finding the Detection icon on the main menu screen	8,7
8	Ease of doing the parameter filling process in the detection window	8
9	Ease of displaying detection results	8,4
10	Ease of returning to the main page of the application	8,4
11	The level of convenience and appearance of the application as a whole	8,3

The average value obtained from the survey results is above 8 in visual design and user interaction. But only the appearance of the help window only got a value of 7.9. In visual design and user interaction, it is expected that the application has been made has met the standards of the Android Design Guidelines. These standards include the use of the icon system should not deviate far from the function of the application, support the back button feature and so on.

TABLE 4. Program Functionality Survey Results

No	Subject	Average Value
1	Response to the opening of the atrial fibrillation detection application when you press the icon on the menu screen	8,8
2	The learning button on the main page can function properly	8,9
3	The detection button on the main page can function properly	9
4	The info button on the main page works well	9
5	The help button on the main page works well	8,9
6	The atrial fibrillation information button on the info page works well	8,9
7	The application information button on the info page works well	8,9
8	The programmer information button on the info page works well	8,7
9	The detection process runs properly	8,7
10	Ease of understanding the contents of the learning window	8,2
11	Ease of understanding the contents of the atrial fibrillation info window	8,2
12	Ease of understanding the contents of the programmer info window	8,2
13	Ease of understanding the contents of the application info window	8,2
14	Ease of understanding the contents of the help window	8,4
15	Ease of understanding the detection results provided	8,5
16	The learning button on the detection window can function properly	8,7
17	The video play button on the detection window can function properly	8,8
18	The video play button on the learning window can function properly	8,9
19	The next button on the learning window can function properly	8,9
20	The exit button on the main page can function properly	8,9
21	The level of functionality of the components contained in the application	8,7

The average value obtained from the survey results is above 8 in program functionality. In program functionality, it is expected that the application that has been made can at least run and function properly and correctly on the targeted device.

TABLE 5. Stability and Performance Survey Results

No	Subject	Average Value
1	No lag, crash, force close, freeze when running the application	8,1
2	The response rate of application usage	8,2
3	No errors during the detection process	8,2
4	Application performance and stability level	8,5

The average value obtained from the survey results is above 8 in the stability and performance program. In the stability and performance program, it is expected that the application that has been made is at least able to run and function properly and correctly on the targeted device.

TABLE 6. Overall Satisfaction Testing Results

No	Subject	Average Value
1	Your assessment when using the app	8.5
2	Level of ease when performing the pulse learning process on the application	8.6
3	Level of ease when performing the detection process	8.6
4	The level of benefit from using the application	8.7
5	How much do you want the development of the atrial fibrillation detection application to continue	9,4

In overall satisfaction, the average value obtained from the survey results is above 8. In overall satisfaction, it is expected to know the general level of satisfaction with the application that has been made.

TABLE 7. Overall Average of Survey Results

No	Subject	Average Value
1	Visual Design and User Interaction	8,2
2	Functionality	8,7
3	Stability and Performance	8,3
4	Overall Satisfaction	8,7

Table 7 shows that the average value of the aspects surveyed to 20 randomly selected users is above 8. In Visual Design and User Interaction, the average value is 8.2. This shows the level of user satisfaction with the design and interaction of the application is quite good. On functionality, an average value of 8.7 is obtained. This shows that the application that has been made can function correctly. On stability and performance, an average value of 8.3 is obtained. This indicates that the application can run well with minimal potential for interference, such as lag, force close, errors, and so on. In overall satisfaction, an average value of 8.7 is obtained. This shows that the level of user satisfaction is relatively high overall in the application that has been made.

The software testing results with the White Box Texting testing method are carried out by looking at the program listing to examine each program code and analyze whether or not there are errors and whether the desired output follows the program code that has been made. The Black Box Testing method is done by running the application and then analyzing whether the final result of the application process is built following the initial design of making the application or not. The results of testing the application with the Black Box Texting method can be seen in Table 8

TABLE 8. Application Testing Results with Black Box Texting Method

No	Testing Procedure	Expected Output
1	Click the application icon	Display Splashscreen
2	Click the learning menu button	Display the learning page
3	Click the detection menu button	Displays a page containing questions to detect atrial fibrillation
4	Click the info menu button	Displays a page containing three options in the form of info buttons, including Atrial fibrillation info, application info, and programmer info
5	Click the atrial fibrillation info menu button	Displays a page containing information about atrial fibrillation
6	Click the application info menu button	Displays a page containing information about the application
7	Click the programmer info menu button	Displays a page containing information about the programmer
8	Click the help menu button	Displays a page containing help on how to use the application
9	Click pulse video button 1	Plays pulse video 1
10	Click the pulse video button 2	Playing the pulse video 2
11	Click the pulse video button 3	Playing the pulse video 3
12	Click the pulse video button 4	Playing the pulse video 4
13	Click the "Yes" or "No" Radiobutton	You can choose one of the answers by pressing the "Yes" or "No" button
14	Click the checkbox or not	You can choose by pressing or not pressing the checkbox following the selected parameters
15	Filling Edit Text	You can fill in the edit text field
16	Click the detection button	Displays detection output along with probability value and suggestions.
17	Click the back button	Displays the previous page
18	Click the Continue button	Displays the next page
19	Click the exit button	Displays a question to close the application
20	Click the "Yes" button on the exit menu	Close the application
21	Click the "No" button on the exit menu	Does not close the application

From the results of Black Box Testing in Table 5. This shows that the expert system application designed in this study can run well according to its functions.

CONCLUSIONS

Atrial fibrillation detection application as an effort to reduce the potential for stroke with the Dempster Shafer method has been successfully developed. The application is made with android-based and can detect the presence or absence of the potential to have atrial fibrillation based on 19 parameters in the form of risk factors and symptoms of atrial fibrillation. From the test results that have been carried out in this study using 60 test data consisting of 31 patient data that has been diagnosed with atrial fibrillation and 29 patients who were not diagnosed with atrial fibrillation, the sensitivity, specificity, and accuracy values of the Dempster Shafer method are 93.5%, 89.7%, and 91.7%.

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