

Android Smartphone Damage Diagnosis Expert System by Web-Based Forward Chain Method

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Abstract: Android smartphones are commonly used smartphones. Smartphone damage often plagues smartphone users nowadays, and the user should bring the smartphone to his smartphone service provider to find out what kind of damage has happened to the device. The repair time consumed while the user's smartphone is at a service point can also consume the user's time, not to mention the cost of the repair and the distance traveled to the smartphone's service point can be significant. That's why we created an expert system for diagnosing damage to Android smartphones. When creating the system, the forward chain method was used to determine solutions to overcome smartphone damage and damage. The results of an expert system that uses a website-based forward-chain method to diagnose Android smartphone damage produces an expert confidence value that is processed before being used by the system. With this expert system, the researchers hope to help Android smartphone users deal with damage caused to their smartphones.

Keywords: Smartphones; Expert System; Forward Chaining.

1. Introduction

The development of technology and information in the smartphone sector has expanded and continues to grow. Not only used by adults, but also children and even toddlers and preschoolers [1]. However, along with the development of this technology, damage to smartphones is also increasingly common, both on hardware and software devices. Damage to a smartphone can annoy the user and takes time and money to fix, especially if you have to take it to a smartphone service location which may be very far away [2]. To overcome this problem, an effective and efficient solution is needed, namely by using an expert system [3]. An expert system is a computer program designed to imitate the thought processes and knowledge of an expert in solving a particular problem [4]. In this case, an Expert System for Diagnosing Android Smartphone Damage Using the Web-Based Forward Chaining Method was created, which aims to provide solutions and diagnose damage to smartphones quickly and accurately.

The Forward Chaining method is a method in an expert system that is used to determine the diagnosis of a problem by gathering information from the symptoms that occur in the problem. This method is suitable for expert systems for diagnosing damage to smartphones because damage to smartphones generally has clear symptoms. In addition, this expert system is designed to be web-based so that it can be accessed easily and quickly via the internet, without having to bring your smartphone to a service center. In this expert system, knowledge from experts is implemented in the form of a knowledge base, which contains rules and facts used to diagnose damage to smartphones. Users only need to enter symptoms or problems that occur on the smartphone, and the expert system will carry out an inference process to produce an accurate diagnosis and solutions to overcome the damage. This will make it easier for users to deal with damage to smartphones without having to take them to a service center, saving time and money. This research has a very big interest in providing solutions to overcome the problem of damage to smartphones that often occurs. With this expert system, it is hoped that it can reduce the time and costs incurred by smartphone users in repairing the damage that has occurred. In addition, this expert system can make it easy for smartphone users to find out the damage that has occurred to their device without having to bring the smartphone to a service location.

The main contribution of this research is the creation of an expert system that can diagnose damage to smartphones automatically using the forward chaining method. This expert system is able to provide solutions and recommendations to overcome damage that occurs to hardware or software devices. In addition, this expert system is also built on a web basis so that it can be accessed from anywhere and at any time by smartphone users who need help diagnosing damage

to their device. In terms of novelty findings, this research can be a reference in developing expert systems in the future, especially in the field of information and communication technology. In addition, this research can also contribute to the development of better technology in overcoming technical problems that occur in electronic devices, such as smartphones.

2. Research Method

In making this system there is a Forward Chaining method in which the method will start working with the available data and use inference rules to obtain other data until the target or conclusion is obtained. An inference engine that uses forward chaining looks for inference rules until it finds one of the antecedents (hypotheses or IF - THEN clauses) that is correct. When these rules are found, the decision-making engine can make conclusions, or consequences (THEN clauses), which generate new additional information from the data provided. The machine will repeat through this process until the target is found [5]. For data collection which is used as a reference in determining symptoms, damage and solutions carried out in the Android smartphone damage diagnosis expert system, the author collects data from experts or technicians. The data that has been collected is then arranged using a table of damage, symptoms and rules. The stages in this research are the steps used to build an expert system in order to achieve a desired goal. The steps used can be seen in Figure 1.

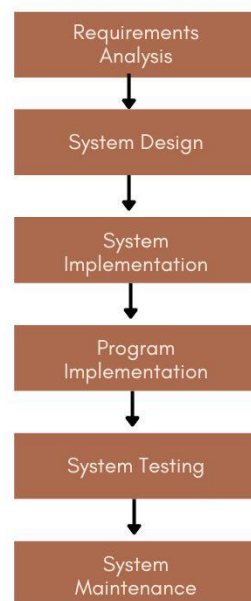


Figure 1. Research Stage

- 1) **Requirements Analysis**
This stage is to analyze the requirements needed for research and system development. Such as writing needs, data collection, to the need for software development. The importance of analyzing needs to anticipate data shortages or unprepared systems due to needs that were not analyzed before. This stage is very important to maximize the application development process [6].
- 2) **System Design**
System design as the stage after the analysis of the system development cycle defining functional requirements and preparation for implementation design, describes a system formed [7].
- 3) **System Implementation**
The implementation stage of the system results is the stage of exposing the results of the implementation of the program code that has been created using the PHP language. At this stage it also describes the results of the expert system website for diagnosing android smartphone damage using the web-based forward chaining method. the results or output in the form of an interface page resulting from expert system website design. This stage contains evidence that this expert system has been well designed as expected [6].
- 4) **Program Implementation**
In making an expert system for diagnosing damage to an Android smartphone, a program code is needed to run the system. The program code used in making this expert system is using the programming language PHP, JavaScript, which is combined using CodeIgniter 3. CodeIgniter is a PHP framework that can help speed up developers in developing PHP-based web applications compared to writing all program code from scratch [8].

5) System Testing

System testing is done by carrying out functional testing using the black box method to find errors in the system that has been built. Tests are carried out to test system functions, especially testing rules (adding, editing, and deleting) and testing the results of expert system diagnoses based on the facts given [9].

6) System Maintenance

In maintenance, it is carried out by making repairs if there are errors or bugs in the system as well as design weaknesses that are not known during the testing phase and backing up data to anticipate if unwanted things happen later.

This research requires data on Android smartphone symptoms for the application of the forward chaining method. The following is a symptom table of the expert system that will be created:

Table 1. Symptom Data

Symptom Code	Symptom Name
G01	The screen on the smartphone is cracked
G02	The LCD on the smartphone is not sensitive
G04	There is flickering (moving lines)
G05	The LCD light on the smartphone is off
G06	There are black dots or dead pixels in certain parts
G07	It often happens that the touchscreen misses
G08	The smartphone screen cannot be touched at all
G09	The screen on the smartphone moves on its own
G10	The power button doesn't work at all
G11	There is a bug or error in the smartphone system
G12	There is a power button line that is broken or not connected
G13	The smartphone is exposed to liquids such as oil or water
G14	Short circuit or short circuit occurs on the smartphone
G15	The smartphone screen turns on by itself and later turns itself off without any command
G16	The smartphone cannot be charged at all
G17	The smartphone battery does not charge at all when it is charging
G18	When the charger cable is plugged in, there is no sign of charging on the smartphone screen
G19	The charger cable on the smartphone is easily separated
G20	Smartphone battery is slow to full when charging
G21	When the camera menu on a smartphone is opened, a black or white blank image appears
G22	When the camera menu on the smartphone is opened, there is a striped display
G23	When the camera menu is opened, the message "camera failed" appears
G24	When the camera menu is opened on the smartphone, the smartphone restarts
G25	When the camera menu on the smartphone is opened, the smartphone is blank or stuck
G26	When the camera on a smartphone is used to take pictures, it cannot save the images
G27	The sound of the speaker on your smartphone is broken
G28	There is no sound at all on your smartphone
G29	Often use too loud or maximum volume
G47	Smartphone batteries don't last long when used
G48	The microphone on the smartphone cannot record sound
G49	The microphone on the smartphone cannot function or even turns off
G50	There is a lot of dust on the smartphone microphone
G51	The caller's voice is not heard on the telephone receiver
G52	The brass memory card on the smartphone is broken
G53	The memory card is not read at all on the smartphone
G54	The memory card on the smartphone is full
G55	The memory card on the smartphone has a lot of viruses
G56	The application on the smartphone is not compatible
G57	Cache files on the smartphone are piling up

The following is a table of damage and solutions from the expert system that will be made:

Table 2. Damage and Solutions

Crash Code	Damage Name	Solution
K01	Damage to the LCD	Solutions or ways to deal with damage problems like this are: Activate the anti-flickering feature on another smartphone, then enter the camera, select

		settings, select the anti-flickering or anti-banding feature, set the 60 hertz scale, aim at the flickering smartphone LCD and then the lines on The LCD will automatically disappear. then avoid high temperature room. Place the smartphone in a place with low light intensity and use a quality smartphone LCD protector. If the methods above are not effective, then replace your LCD before it gets even worse.
K02	Damage to the Touchscreen on the Touchscreen	Solutions or ways to overcome damage problems like this are: When the touchscreen does not work or only partially functions, the cause can be from the software or hardware side (usually the touchscreen itself is damaged). For that, try applying the hard reset or flash method on your smartphone. If this method doesn't work, replace the touchscreen on your smartphone.
K03	Damage to the Power Button	Solutions or ways to deal with damage problems like this are: One way to deal with a power button that doesn't work is to check it first, maybe there is a small hard object like a rock or other dirt that has settled between the power button so that the button has interference. You should also check the frame of your smartphone, maybe it is shifted so that the power button is disturbed. Apart from that, you can also activate Assistive Touch on your smartphone or use the Assistive Touch application.
K04	Damage to the Charging Port	The solution or way to deal with damage problems like this is: Clean your smartphone's charging port and replace your smartphone's connector with another. If the two methods above have been done and it turns out that your smartphone's charger port is still having problems, then you have to replace the charge IC with a new one. This component is what functions to conduct electricity from the charger cable to the battery on the smartphone. It is recommended that you do not try to replace it alone. Apart from being difficult, the tools to fix it will not work if you disassemble the smartphone unofficially. You can replace it at the service center.
K05	Damage to Camera	The solution or how to deal with damage problems like this is: Restart your smartphone first or reset the smartphone to factory settings (Factory Reset) then Update the Firmware. If that doesn't work, another way is to use an application from a third party and it usually has features that are superior to the default camera application from the smartphone that you have.
K06	Damage to the Speakers	The solution or how to deal with damage problems like this is: First, clean your speakers first. Then enter the sound menu to set speaker sound options. Then, try setting the smartphone speaker volume at the highest or maximum level. Try playing a song or another sound source to test the sound. If you hear an unpleasant sound or it is distorted and static, turn down the volume. Do the opposite if you don't hear a sound which indicates the speaker is broken and you have to fix it at a smartphone service place to prevent further damage.
K07	Damage to Antenna Switch	Solutions or ways to overcome damage problems like this are: The first step that must be taken is to repair the software by tuning the signal. If after tuning the signal you still have problems, then the last step is to replace the antenna switch component that is related to the weak cellphone signal. A weak antenna switch doesn't mean you have to replace it. If indeed the funds we have are very limited, then we can jumper switch the antenna without having to replace the PA IC.
K08	Damage to the SIM Card	The solution or how to deal with damage problems like this is: Clean your sim card first. Perform a network reset on the smartphone. If there is no change then replace the existing sim card with a new one it could be that your sim card has been blocked.
K09	Battery Damage	The solution or how to deal with damage problems like this is: Do a calibration on your smartphone's battery first, but if the battery calibration can't fix your smartphone's battery, it's possible that your battery has a leak. We recommend that you replace the battery on your smartphone.
K10	Damage to the Microphone	Solutions or ways to deal with damage problems like this are: If the problem is with the system, the most effective solution is to try doing a factory reset on your smartphone. Then clean the microphone hole on your

		smartphone. If the problem isn't in the system, then it's possible that the microphone component on your smartphone is damaged. There are various causes for the damage. It could be because of the flexible cable, or because the microphone component is already damaged.
K11	Damage to the Memory Card	Solutions or ways to overcome damage problems like this are: Actually it's very easy. There are several ways you can try, such as deleting application data, updating applications, restarting the smartphone, upgrading the OS and others. Because it's possible that your memory card is too full and there are viruses and you should replace your memory card with a new one so it doesn't damage other systems.

3. Result and Discussion

3.1 Results

To describe more clearly the flow of research using the Forward Chaining method. Based on the data that has been compiled, a decision tree is given to facilitate researchers in compiling their research [10]. The following is a decision tree in this study:

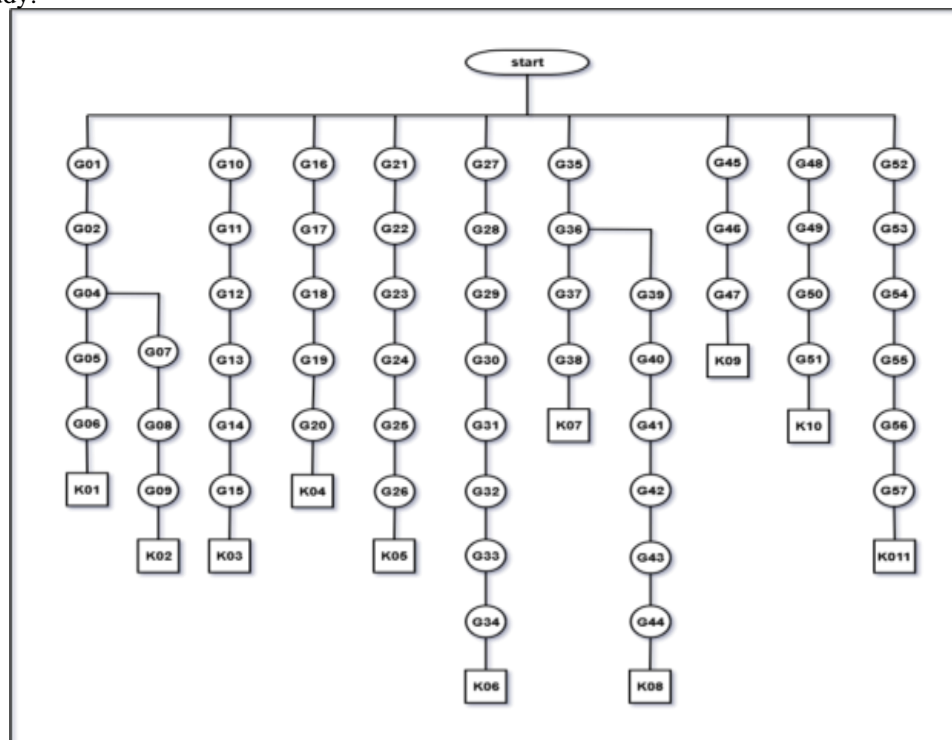


Figure 2. Decision Tree

Rule is a knowledge structure that connects some information that is already known to other information so that it can be concluded. A rule is a procedural form of knowledge. Thus, what is meant by a rule-based expert system is a computer program to process problems from specific information contained in active memory with a set of rules in the knowledge base, using an inference engine to generate new information [8]. The following are the rules for determining the damage that occurs to an Android smartphone based on the symptoms of the damage that has occurred. K01 : Damage and G01 : Symptoms of Damage.

- 1) Rule K01 = if G01 and G02 and G04 and G05 and G06 then K01
- 2) Rule K02 = if G01 and G02 and G07 and G08 and G09 then K02
- 3) Rule K03 = if G10 and G11 and G012 and G13 and G14 and G15 then K03
- 4) Rule K04 = if G16 and G17 and G18 and G19 and G20 then K04
- 5) Rule K05 = if G21 and G22 and G23 and G24 and G25 then K05
- 6) Rule K06 = if G27 and G28 and G29 and G30 and G31 and G32 and G33 and G34 then K06
- 7) Rule K07 = if G35 and G36 and G37 and G38 then K07
- 8) Rule K08 = if G35 and G39 and G40 and G41 and G42 and G31 and G44 then K08
- 9) Rule K09 = if G45 and G46 and G47 then K09
- 10) Rule K10 = if G48 and G49 and G50 and G51 then K10

11) *Rule K11 = if G52 and G53 and G54 and G55 and G56 and 57 then K11.*

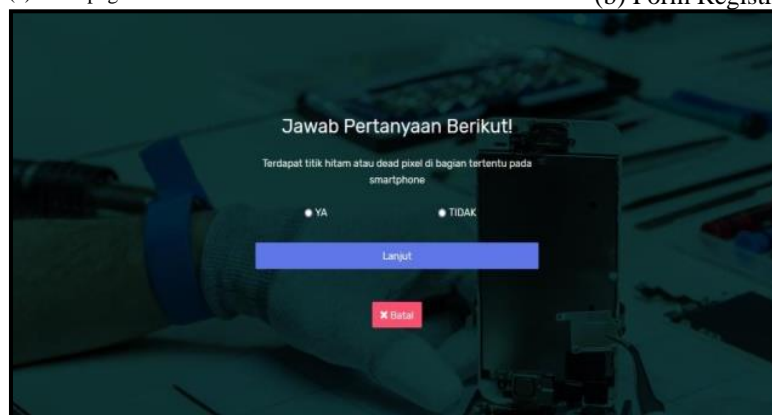
The results of this study are also in the form of an application, which can be seen in Figure 3 below.



(a) Main page



(b) Form Registration



(c) Consultation Page

Figure 3. Application Display

In Figure 3.a, is the main page on the system when users access the system. In Figure 3.b, the form page is used to enter the full name and email before the user consults. In Figure 3.c, is a consultation page where later the user will answer questions about symptoms of damage to an Android smartphone. This research uses the Forward Chaining method, and to facilitate researchers in compiling their research, a decision tree is provided. The decision tree consists of 11 rules, each of which determines the damage that occurs to an Android smartphone based on the symptoms of the damage that has occurred. The result of this study is an application that users can access to consult about their Android smartphone damage. The application has a main page, a form page to enter the user's full name and email, and a consultation page where the user will answer questions about symptoms of damage to their smartphone. The application uses the rules in the knowledge base, and an inference engine to generate new information.

3.2 Discussion

Based on the research results, it can be seen that the Forward Chaining method can be used to facilitate researchers in compiling their research. In this study, a decision tree is used to clearly visualize the research flow and provide guidance for researchers to understand the relationship between damage symptoms and types of damage to Android smartphones. In addition, this study also succeeded in finding a number of rules or rules in determining the type of damage to an Android smartphone based on the symptoms that occur. By using a rule-based expert system, researchers have succeeded in producing a computer program that is capable of processing problems from specific information contained in active memory and providing new information to the user. Furthermore, this research also produces an application that can be used to conduct consultations regarding symptoms of damage to Android smartphones. The application consists of three pages, namely the main page, forms, and the consultation page. Users can fill out a form with their full name and email before conducting a consultation, and then directed to the consultation page where the user will answer questions about symptoms of damage to an Android smartphone. Thus, this research has a significant contribution to the development of a rule-based expert system in determining the type of damage to an Android smartphone based on the symptoms that occur. The resulting application can also provide benefits for users who want to consult about damage to Android smartphones. However, this research still has limitations on the number of rules or rules found, so further research is needed to develop a more complex and effective expert system.

4. Related Work

Previous research conducted by Arifin and Witanti, 2021. This research has the goal of building an expert system for detecting damage to fiber optic networks using the forward chaining method. The results of the accuracy test concluded that the accuracy of the system based on the 36 data tested was 33 data (91%) which indicated that the system was functioning properly according to the expert's diagnosis. System inaccuracies are 3 data (9%) including errors in providing answers in diagnosing damage to fiber optic networks [11]. Previous research conducted by Qhustolani, 2020 raised the issue of designing a PC hardware repair service application supported by an expert system using the web-based forward chaining method in the MDT department of PT. Dirgantara Indonesia (Persero) which can be used to record requests for computerized PC hardware repair services and diagnoses PC hardware failure. This study uses the forward chaining method. The results of the expert system research carried out can diagnose PC hardware damage in the scope of boot failure problems and can calculate the duration of repairs for Key Performance Indicator (KPI) requirements [8].

Previous research conducted by Yudano, *et al* (2019), The application of the forward chaining method to an expert system for identifying damage to an Apple-based smartphone web is intended to simplify smartphone users, especially the Apple-based iOS operating system, in identifying earlier if damage occurs to the smartphone they are using. With this expert system, users are expected to get information about the types of damage symptoms that occur when a smartphone is damaged and can easily identify what damage it might experience [3]. Previous research conducted by Oktapianai, 2017. This research aims to help users to deal with damage and initial maintenance that often occurs on computers in their daily activities. We can understand the location of the damage if we know the characteristics of the known damage. repair damage that often occurs on the PC itself, with this problem how expert systems trace computer damage using the Forward Chaining method. The expert system was successfully implemented using the Visual Basic 6.0 object-oriented programming language [12]. Previous research conducted by Sugiharni and Divayana, 2017. This study aims to present a solution in detecting and providing detailed information about defects in color TV. This expert system provides consulting facilities that are used to facilitate question-and-answer interactions between the system and the user. The solution search method used in this system is forward chaining. The results of this study are a desktop-based expert system using the Visual Basic 6.0 programming language [13].

Expert systems have become a popular solution for diagnosing hardware problems in a variety of devices, including smartphones, computers and televisions. In this review, we summarize the findings from several previous studies of expert systems for diagnosing hardware problems. Several previous studies have been carried out regarding the use of the forward chaining method in expert systems for fault diagnosis, both on fiber optic networks, PC hardware, smartphones, and color TVs. This research succeeded in developing an expert system that is capable of diagnosing with fairly high accuracy, as well as making it easy for users to identify the types of damage that has occurred. The use of a web-based expert system also provides convenience in recording requests for repair services and calculating the duration of repairs. All of this research shows that expert systems can be an effective tool for diagnosing hardware problems on various devices. The use of the forward chaining method is a popular choice for identifying hardware problems, as shown in several studies. However, there is still room for improvement in the accuracy and efficiency of this system, especially in dealing with complex hardware issues. Overall, expert systems offer a promising solution for diagnosing hardware problems and increasing the efficiency of the repair process.

5. Conclusion

Based on the results of the research that has been done, it can be concluded that the website-based expert system for diagnosing damage to Android smartphones using the forward chaining method has been successfully built. This system has the ability to diagnose damage to an Android smartphone which has 57 symptoms and provides 11 possible solutions. The forward chaining method used in this expert system allows users to make diagnoses more easily and quickly and provides solutions that are accurate and in accordance with the symptoms that occur on Android smartphones. Previous research has also shown that the use of the forward chaining method in a damage diagnostic expert system is not only limited to android smartphones but can also be applied to various other types of devices such as fiber optic networks, PC hardware, and color TVs. In these studies, expert systems built using the forward chaining method are able to provide accurate diagnoses and solutions and help make it easier for users to determine damage to the device used. In developing this website-based expert system for diagnosing damage to Android smartphones, it is necessary to increase the symptom data and solutions provided so that it can accommodate more types of damage to Android smartphones. In addition, it is necessary to carry out further testing to evaluate the accuracy and performance of this expert system on a larger scale and with more complex variations of damage types.

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