

Development of Android-Based Smart System for Gingivitis Diagnosis Using Certainty Factor

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Abstract: Gingivitis is a gum disease that causes bleeding, swelling, redness, discharge, changes in normal contours, and although health authorities take this seriously, sometimes some patients consider it normal. This study aims to educate the public about the importance of understanding the condition of their bodies, especially the most vulnerable teeth. Lack of time to consult an expert leads to this disease being neglected. Therefore, it is necessary to develop a consultation application in the form of an expert system. The built system adopts the deterministic factor method. The certainty factor works by reading the entire data submitted by the expert and giving the result as a percentage of confidence that the patient has gingivitis. The experts used in this system are dental experts. Data obtained from direct experts and consultations resulted in new knowledge in the form of the percentage of trust patients suffering from gingivitis. The data collected are symptoms and solutions obtained from experts. This research provides a new service for patients suffering from gingivitis without the need to see a specialist directly. Based on the testing data provided to the patient and based on the patient's condition at that time, the test results of the system reached a confidence level of 98.74%. So that the results of consultation are obtained in the form of information about the disease and the solutions needed.

Keywords: Expert System; Gingivitis; Certainty Factor; Android

INTRODUCTION

Gums are one of the oral organs that require attention. Failure to do this can be fatal, leading to gum inflammation that requires proper treatment (Keumala, 2014). Gingiva/gingiva is an organ located in the mouth and consists of mucosal tissue that covers the alveolar bone (Yuliyana & Sinaga, 2019). Pink gums indicate the presence of blood vessels behind the gums. Therefore, gums / gingiva is often used as an indicator of whether there is a problem in the oral tissue (Salfiyadi et al., 2023). The gum / gingiva is divided into two parts, namely fixed gingiva and non-sticky gingiva (Akmal & Sonata, 2021).

Gingivitis is a common disease in both children and adults. The World Health Organization (WHO) notes that 80% of young children suffer from gingivitis / gingivitis (Arfajsyah et al., 2018). The gums are one of the few very influential oral organs, located just below the teeth and if something goes wrong it can disrupt the entire digestive process (Tuslaela & Permadi, 2018). Many factors contribute to the occurrence of gingivitis, including lack of understanding and information about gum health, causing a lack of enthusiasm to prevent gingivitis (Yuliza, 2022). Gingivitis is a form of periodontal disease accompanied by swelling of the gums/gum tissue. If not treated properly, swelling can spread to the supporting tissue underneath (Putra, 2022). There are 3 types of gingivitis/gingivitis, namely chronic marginal gingivitis, eruptive gingivitis, and artificial gingivitis. Lack of access and absence of dentists

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in determining the type of disease and treatment can cause the healing process to take a long time and if not treated properly can be fatal (Yansyah & Sumijan, 2021).

This is a major cause of difficulties in patient management and recovery. Limited dentist identification is an important issue (Dian et al., 2020), therefore one solution to this problem is to create an Android-based expert system for gingivitis/gingivitis diagnosis. Expert system, also called knowledge-based expert system, is a system that uses computer-based knowledge and uses facts and reasoning to solve problems that can only be solved by experts and experts in their fields (Fernando et al., 2022). Expert system is a form of system implementation that utilizes expert knowledge to be easily accessed and utilized by the community. The method in this system adopts the factor determination method. The certainty factor method is a method to prove the certainty of facts or rules of the problem faced by describing the level of expert confidence (Lubis & Gaol, 2022). Some of the problem formulations in this study are identifying the types of gingivitis/gingivitis based on the symptoms suffered by the patient, designing an expert system application to diagnose the types of gingivitis/gingivitis based on the symptoms suffered by the patient using the deterministic factor method, and the application of Building a deterministic factor approach implemented on an Android-based expert system to diagnose gingivitis/inflammation of the gingiva in the community broad.

The goal of this research is to create something new that can make it easier to diagnose gingivitis using an Android phone that does not require an internet connection, so that network outages are no longer a problem.

LITERATURE REVIEW

Gingivitis

Gingivitis is an inflammatory process in the supporting soft tissues of the tooth, where the unifying epithelium has not undergone a change in attachment. Gingivitis is caused by a buildup of bacteria present in the oral cavity (Wahyuni & Garjita, 2019). Inflammation that occurs in the gums without damaging the supporting tissue of the teeth is also called gingivitis (Rianti et al., 2021). Gingivitis can cause bleeding accompanied by swelling, redness, exudate, and changes in normal contours. Uncontrolled gingivitis can progress to irreversible periodontitis (Arfajsyah et al., 2018).

Expert system

An expert system is a system that provides a solution to a specific problem in a particular domain, the solution is executed in the capacity of an expert who is an expert in his field (Setiawan & Lubis, 2022). Expert systems impart knowledge based on expert competence. Knowledge embedded in expert systems can be obtained from various sources, such as books, magazines, and even experts in certain fields. Expert Systems are one part of artificial intelligence. A system is called intelligent if it can solve problems independently and efficiently. Such intelligence is found in computer systems (Irmansyah Lubis et al., 2023). Artificial Intelligence techniques have been used in the field of medicine to accurately identify diseases. Expert System is a system that implements knowledge from an expert into a computer program (Lubis & Gaol, 2022).

Certainty Factor

Certainty Factor is a method of proving whether a fact is certain or uncertain in the form of metrics commonly used in expert systems. The magnitude of the Certainty Factor ranges from -1 to 1, -1 indicates absolute distrust while the value of 1 indicates absolute trust. The Certainty Factor method is used. When faced with a problem the answer is uncertain. This uncertainty can be a probability. In the system, experts use the Certainty Factor method as a method to calculate the certainty value of symptoms given by patients and the value given by experts. One of the advantages of the Certainty Factor method is that this method is suitable for use in expert systems to measure whether something is certain or uncertain in diagnosing diseases as one example, because calculations using this method in one calculation can only process two data so that the accuracy of the data can be maintained (Mashaq et al., 2021).

$$CF[H, E] = MB[H, E] - MD[H, E] \quad (1)$$

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$$MB[H, E] = \frac{\max[P(H|E), P(H)] - P(H)}{\max[1, 0] - P(H)} \tag{2}$$

$$MD[H, E] = \frac{\min[P(H|E), P(H)] - P(H)}{\min[1, 0] - P(H)} \tag{3}$$

METHOD

This study used a quantitative approach to test the validity of hypotheses about the possibility of gingivitis based on symptoms experienced using certainty factor analysis methods. This research also uses research and development methodology with the aim of creating an android-based application that is able to diagnose gingivitis using the Certainty factor algorithm. In addition, there is a framework to follow to conduct this research. The following is an overview of the framework that will be carried out in this study:

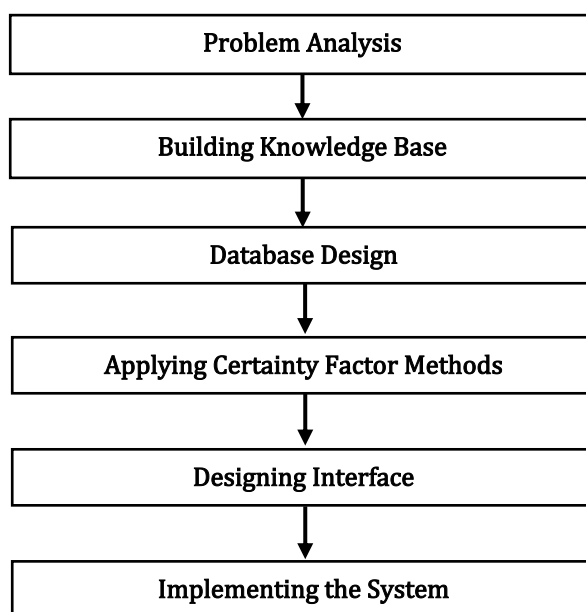


Fig 1. Framework of Research

Problem Analysis

This study notes the limitations of experts who specialize in dealing with Gingivitis disease, therefore it is necessary to create an android-based system that provides solutions for early management of Gingivitis.

Building Knowledge Base

The source of expert knowledge comes from the society's expert information on gingivitis. This study also uses references from several theoretical sources, such as articles published in national journals discussing gingivitis and the Certainty Factor method. Such information is presented below in the form of disease tables, symptom tables and database tables.

Database Design

Database creation using data sourced from Disease data, symptom data on Gingivitis disease. The data that has been collected will be used into the database on the Android-based application that will be built.

Applying Certainty Factor Methods

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Then apply the Certainty Factor method to identify the periodontal disease, and the test results will be implemented into an Android-based application.

Designing Interfaces

The system's user interface design was developed to facilitate the use of Android applications that will be integrated with the gingivitis diagnostic system for the wider community, so that the use displays attractive forms.

Implementing the System

Application of Android-based Systems / Applications, this system is easy to use for those who already have an Android phone. This system allows people to diagnose gingivitis independently without internet, so that network disruption problems do not affect system performance when the application/system is used.

RESULT

System analysis that will be made using Certainty Factor by collecting a knowledge base in the form of disease data, symptom data and disease solution data. All knowledge bases are used to make conclusions regarding the diagnosis of gingivitis. In designing a Detection System, the most important thing to do is to determine the knowledge base. A knowledge base is a collection of facts. The knowledge base approach is carried out using rules because there are necessary steps to achieve goals. Some of the knowledge bases in this study are presented in Tables 1 and 2.

Table 1. Gingivitis Disease Data

No.	Code	Disease	Definition
1	P001	Acute Gingivitis	The pain arises suddenly and in a short period of time
2	P002	Sub-Acute Gingivitis	Greater or more severe stages of acute gingivitis
3	P003	Recurrent Gingivitis	Inflammation of the gums that can recur after cleaning with treatment or disappear spontaneously and then recur
4	P004	Chronic Gingivitis	The most common gum inflammation is found to occur slowly over a long time, and does not hurt if there are no complications from acute and subacute gingivitis that get worse

Then in Table 2 below, are the symptom data in gingivitis used to diagnose gingivitis in sufferers, which are as follows:

Table 2. Indications Data

No	Code	Indications
1.	G001	Gums bleed easily
2.	G002	There is pain and pain in the teeth that appear suddenly without being touched.
3.	G003	The occurrence of swelling of the gums is quite severe.
4.	G004	The presence of sockets or gum pockets.
5.	G005	The presence of an unpleasant smell or odor in the mouth.
6.	G006	If pierced with a sonde device, bleeding occurs with a score of 1-3.
7.	G007	The pink color of the gums undergoes a slight discoloration to become concentrated reddish (different from blackish).
8.	G008	The gums will become soft on the surrounding tissue, so it can cause shaking in the gums.
9.	G009	Changes in gum color from healthy pink to pale blackish.
10.	G010	There is pain and pain in the missing teeth arise.
11.	G011	The occurrence of slight swelling of the gums that disappears on its own when the pain begins to decrease.
12.	G012	The presence of sockets or gum pockets with a small amount The presence of sockets

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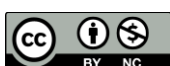
		or gum pockets with a small amount.
13.	G013	The occurrence of bleeding when pierced with a sonde device, bleeding occurs with a score of 0-1.
14.	G014	The shape of the gums is slightly rounded (unstippling).
15.	G015	The occurrence of shrinkage in the gums, so that the size of the teeth is higher than usual.
16.	G016	The distance between one tooth and another began to feel tenuous.
17.	G017	There is pain and pain in the gums when touched.
18.	G018	There is pus between the gum cavity and the teeth.
19.	G019	Teeth or gums are easily loose without realizing it.
20.	G020	Teeth undergo changes when biting.

Then in Table 3 below, is an identification table between symptoms and types of disease for the diagnosis of gingivitis along with the Certainty Factor value determined by the expert, which is as follows:

Table 3. Identification of Gingivitis Disease

Code Disease	Name Disease	Code Indications	Indications Name	CF
P001	Acute Gingivitis	G001	Gums bleed easily	0.8
		G002	There is pain and pain in the teeth that appear suddenly without being touched.	0.6
		G003	The occurrence of swelling of the gums is quite severe.	0.4
		G004	The presence of sockets or gum pockets.	0.4
		G005	The presence of an unpleasant smell or odor in the mouth.	0.8
P002	Sub-Acute Gingivitis	G006	If pierced with a sonde device, bleeding occurs with a score of 1-3.	0.6
		G007	The pink color of the gums undergoes a slight discoloration to become concentrated reddish (different from blackish).	0.2
		G008	The gums will become soft on the surrounding tissue, so it can cause shaking in the gums.	0.6
		G009	Changes in gum color from healthy pink to pale blackish.	0.6
		G010	There is pain and pain in the missing teeth arise.	0.4
P003	Recurrent Gingivitis	G011	The occurrence of slight swelling of the gums that disappears on its own when the pain begins to decrease.	0.6
		G012	The presence of sockets or gum pockets with a small amount The presence of sockets or gum pockets with a small amount.	0.8
		G013	The occurrence of bleeding when pierced with a sonde device, bleeding occurs with a score of 0-1.	0.8
		G014	The shape of the gums is slightly rounded (unstippling).	0.5
		G015	The occurrence of shrinkage in the gums, so that the size of the teeth is higher than usual.	0.8
P004	Chronic Gingivitis	G016	The distance between one tooth and another began to feel tenuous.	0.5
		G017	There is pain and pain in the gums when touched.	0.4
		G018	There is pus between the gum cavity and the teeth.	0.8
		G019	Teeth or gums are easily loose without realizing it.	0.8
		G020	Teeth undergo changes when biting.	0.4

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Then, based on the identification table in Table 3 earlier, three rules were formed in diagnosing gingivitis, namely:

Table 4. Testing Scenarios with CFExpert

No.	Rules
1	<i>IF G001 AND G002 AND G003 AND G004 AND G005 THEN P001</i>
2	<i>IF G006 AND G007 AND G008 AND G009 AND G010 THEN P002</i>
3	<i>IF G011 AND G012 AND G013 AND G014 AND G015 THEN P003</i>
4	<i>IF G016 AND G017 AND G018 AND G019 AND G020 THEN P004</i>

In first-line testing, scenario trials were carried out to identify diseases from symptoms of gingivitis between experts and users. The scenarios in Table 5 and Table 6 are below:

Table 5. Testing Scenarios with CFExpert

No.	Rule	Indications	CF Expert
CF1	<i>IF</i>	Gums bleed easily	0.8
CF2	<i>AND</i>	The presence of an unpleasant smell or odor in the mouth	0.8
CF3	<i>AND</i>	The presence of sockets or gum pockets with a small amount.	0.8
CF4	<i>AND</i>	There is pus between the gum cavity and the teeth.	0.8
CF5	<i>AND</i>	Teeth or gums are easily loose without realizing it.	0.8

Table 6. Value of Trust from Users

Indications Code	Value of CF Expert	Value of CF User
CF1	0.8	0.6
CF2	0.8	0.8
CF3	0.8	0.6
CF4	0.8	0.8
CF5	0.8	0.8

Then calculate the value of the Certainty Factor between CF Expert and CF User. The calculation is as follows:

Table 7. Value of Trust from Users

Indications Code	CF Expert	CF User	Result
CF1	0.8	0.6	0.48
CF2	0.8	0.8	0.64
CF3	0.8	0.6	0.48
CF4	0.8	0.8	0.64
CF5	0.8	0.8	0.64

Next, find the certainty value of the combination of CF Expert and CF User trust values. And here is the calculation of the combination obtained:

Table 8. Value of Trust from Users

Iteration / Results	CFcombine = $CF1 + CF2 \times (1 - CF1)$
1	$0.48 + 0.64 * (1 - 0.48) = 0.8128$
2	$0.8128 + 0.48 * (1 - 0.8128) = 0.9027$
3	$0.9027 + 0.64 * (1 - 0.9027) = 0.9649$
4	$0.9649 + 0.64 * (1 - 0.9649) = 0.9874$
Result	$0.9874 * 100\% = 98.74\%$

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The last CF combine result is the result of a diagnosis that determines the type of gingivitis using the calculation of Certainty factor. And because the first rule is fulfilled, the diagnosis results from data no. 1 state that users are identified with chronic gingivitis with a confidence level of 98.74%.

DISCUSSION

Based on the tests that have been carried out in this study, that can be concluded from the advantages and disadvantages that still exist in the system, which are as follows:

Advantages:

- a. Users can choose the type of diagnosis according to the symptoms experienced by them.
- b. Each symptom found during the diagnosis process has a solution that can help the user in diagnosing gingivitis.

Disadvantages:

- a. The presentation of disease information is very simple because it is not accompanied by pictures or photos related to the disease.
- b. The determination of the value of CF Experts is limited to the source of an expert

CONCLUSION

Based on the results of the design and discussion of the design of the dental gingivitis diagnostic detection system, it can be concluded that the dental gingivitis diagnostic system is designed to be a system that can be used as a means of patient consultation. Diagnosis of their disease. Can help patients diagnose dental gingivitis and get information about the treatment of conditions suffered by gingivitis sufferers. The system correctly identifies the disease and gives results in percentage form. Based on the case of gingivitis, after the test data was provided directly to the user, it was found that the system worked best in the form of a confidence value of very sure with a percentage value of 98.74%.

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REFERENCES

- Akmal, Z., & Sonata, F. (2021). *SISTEM PAKAR MENDIAGNOSA PENYAKIT RESESI GINGIVA MNGGUNAKAN METODE CASE BASE REASONING*.
- Arfajsyah, H. S., Permana, I., & Salisah, F. N. (2018). Sistem Pakar Berbasis Android Untuk Diagnosa Penyakit Gigi Dan Mulut. *Jurnal Ilmiah Rekayasa Dan Manajemen Sistem Informasi*, 4(2), 110. <https://doi.org/10.24014/rmsi.v4i2.5678>
- Dian, R., Sumijan, S., & Yuhandri, Y. (2020). Sistem Pakar dalam Identifikasi Kerusakan Gigi pada Anak dengan Menggunakan Metode Forward Chaining dan Certainty Factor. *Jurnal Sistim Informasi Dan Teknologi*, 2, 65–70. <https://doi.org/10.37034/jsisfotek.v2i3.24>
- Fernando, R., Suranti, D., & Suryana, E. (2022). *Application of the Naive Bayes Method in Expert Systems for Diagnosing Gingivitis Penerapan Metode Naive Bayes Pada Sistem Pakar Mendiagnosa Penyakit Gingivitis*. 1(2), 93–100.
- Irmansyah Lubis, A., Sartikha, S., & Ardi, N. (2023). Penerapan Teknologi Sistem Pakar Dengan Metode Teorema Bayes Untuk Deteksi Dini Penyakit Parkinson. *Jurnal Minfo Polgan*, 12(1), 311–320. <https://doi.org/10.33395/jmp.v12i1.12396>
- Keumala, C. R. (2014). FAKTOR-FAKTOR YANG BERHUBUNGAN DENGAN GINGIVITIS

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PADA IBU HAMIL YANG BERKUNJUNG KE POLI KIA PUSKESMAS BEBESAN. *Jurnal Online Keperawatan Indonesia*, 2(1).

- Lubis, A. I., & Gaol, N. Y. L. (2022). Application of Certainty Factor Method in Intelligent System for Diagnosis of Periodontal Disease Based on Android. *Sinkron : Jurnal Dan Penelitian Teknik Informatika*, 7(4), 2272–2279. <https://doi.org/10.33395/sinkron.v7i4.11695>
- Mashaq, F., Sari, H. L., & Prahasti, P. (2021). Expert System To Diagnose Periodontal Disease Using Certainty Factor Method. *Jurnal Komputer, Informasi Dan Teknologi (JKOMITEK)*, 1(1), 134–140. <https://doi.org/10.53697/jkomitek.v1i1.149>
- Putra, W. (2022). Rancang Bangun Sistem Pakar Untuk Mendiagnosa Penyakit Mulut Pada Manusia. *Teknologipintar.Org*, 2(12), 2022–2023.
- Rianti, E., Yenila, F., & Marfalino, H. (2021). System Deteksi Gingivitis Gigi Menggunakan Certainty Factor. *Jurnal Teknologi*, 11, 50–56. <https://doi.org/10.35134/jitekin.v11i2.51>
- Salfiyadi, T., Mardiah, A., Faisal, T. I., & Abdurrahman. (2023). The Role of Dental Nurses in Community Health Centers in Supporting Health Transformation. *Jurnal Pengabdian Kepada Masyarakat*, 2(1), 2964–6731.
- Setiawan, F., & Lubis, A. I. (2022). Sistem Pakar Dalam Penentuan Mustahiq Zakat Menggunakan Dempster Shafer. *Building of Informatics, Technology and Science (BITS)*, 4(2), 1146–1152. <https://doi.org/10.47065/bits.v4i2.2240>
- Tuslaela, & Permadi, D. (2018). Sistem Pakar Diagnosa Penyakit Gigi Dan Mulut. *Jurnal PROSISKO Vol.*, 5(1), 17–26.
- Wahyuni, S. N., & Garjita, L. (2019). Perancangan Sistem Pakar Diagnosa Penyakit Gigi Menggunakan Algoritma Bayes. *Indonesian Journal of Business Intelligence (IJUBI)*, 2(1), 9. <https://doi.org/10.21927/ijubi.v2i1.1020>
- Yansyah, I. R., & Sumijan, S. (2021). Sistem Pakar Metode Forward Chaining untuk Mengukur Keparahan Penyakit Gigi dan Mulut. *Jurnal Sistim Informasi Dan Teknologi*, 3, 41–47. <https://doi.org/10.37034/jsisfotek.v3i2.42>
- Yuliyana, Y., & Sinaga, A. S. R. M. (2019). Sistem Pakar Diagnosa Penyakit Gigi Menggunakan Metode Naive Bayes. *Fountain of Informatics Journal*, 4(1), 19. <https://doi.org/10.21111/fij.v4i1.3019>
- Yuliza, R. (2022). Sistem Pakar Akurasi dalam Mengidentifikasi Penyakit Gingivitis pada Gigi Manusia dengan Metode Naive Bayes. *Jurnal Sistim Informasi Dan Teknologi*, 5, 27–32. <https://doi.org/10.37034/jsisfotek.v5i1.157>