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IMPLEMENTATION OF THE LEVENSHTEIN ALGORITHM IN ZAKAT RECIPIENT E-ARCHIVING

Nur Wafiqah Azizah Sitompul[-1], Ali Ikhwan[-2], Muhamad Alda[-3]

Information System
Faculty of Science and Technology
State Islamic University of North Sumatra, Indonesian
nurwafiqah25062003@gmail.com[-1], ali_ikhwan@uinsu.ac.id[-2], muhamadalda@uinsu.ac.id[-3]

Abstract

The advancement of information and communication technology is now increasingly being used by the community in all sectors of activities, one of which is archive data management. The importance of archive data management today, increasing awareness in agencies and organizations by utilizing information technology. The conventional management of archive data can result in possible errors that can be caused by several factors, namely, the age of archive data storage, the loss of archive data due to negligence and damage to archive data. So, there is a website-based information system that can be used by organizations that can minimize errors in managing archive data. The purpose of this study is to design and build an information system with the implementation of the Levenshtein algorithm in the archives of zakat recipients in BAZNAS Central Tapanuli Regency, where the development of the system uses a waterfall process and for the performance of the Levenshtein algorithm here functions to measure the difference or distance between two strings in order to be able to save time when searching for stored archive data.

Keywords: Algorithm Levenshtein; Archive; Zakat; Information System; E-Archive

Abstrak

Kemajuan Teknologi informasi dan komunikasi sekarang yang semakin pesat semakin banyak dimanfaatkan oleh masyakarat dalam semua sektor kegiatan salah satunya pengelolaan data arsip. Pentingnya pengelolaan data arsip dimasa kini, meningkatkan kesadaran pada instansi dan organisasi dengan memanfaatkan teknologi informasi. Adapun pengelolaan data arsip dengan konvensional bisa mengakibatkan kemungkinan kesalahan yang bisa disebabkan oleh beberapa faktor yaitu, usia penyimpanan data arsip, hilangnya data arsip akibat keteledoran kerja dan rusaknya data arsip. Maka, adanya sistem informasi berbasis website yang bisa digunakan oleh organisasi yang bisa meminimalisir kesalahan dalam pengelolaan data arsip. Tujuan penelitian ini untuk merancang bangun sebuah sistem informasi dengan implementasi algoritma Levenshtein pada arsip penerima zakat di BAZNAS Kabupaten Tapanuli Tengah, yang mana pengembangan sistem menggunakan proses waterfall dan untuk kinerja algoritma Levenshtein disini berfungsi untuk mengukur perbedaan atau jarak (distance) antara dua string agar bisa mengefisien waktu ketika mencari kembali data arsip yang tersimpan

Kata kunci: Algoritma Levenshtein; Arsip; Zakat ; Sistem Informasi; E-Arsip

INTRODUCTION

Information and communication technology is facing rapid development that can now be used by all activities in life, one of which includes the management of archival data (Ayu Andini Wijaya Garnish et al., 2023). Archives are important for an institution as a provider of information needed in formulating a policy and providing decisions so that later they produce accurate and complete information in accordance with the procedures that have been determined in its management, therefore, the importance of archives also has a wide reach, namely as a tool that helps human memory in the context of carrying out activities, both in the government and in the life of the nation and state (Putra & Marliana, 2021).

As for the problems behind this research, the management of archival data stored is still conventional which is a little less effective in the current era which is already technology-based, so the BAZNAS Institution needs a system that can help, especially in the efficient search time and reprinting of archive data, to minimize the

damage of files that are stored in hardcopy by applying the Levenshtein Algorithm in this archive system at BAZNAS, Central Tapanuli Regency It is hoped that it will improve the quality of storage and management of zakat recipient archive data. To help research using the levenshtein algorithm, there are several previous studies that use the levenshtein algorithm that have been carried out with the title "The Application of the Levenshtein String Algorithm in the E-Archive of Pagar Merbau District" resulting in a study that discusses the use of the Levenshtein string algorithm for string matching with the calculation of string distance in the E-Archive of correspondence system at the Pagar Merbau District Office (Rofiqih et al., 2022). Furthermore, there is this study with the title "Designing a Library Information System Application Using the Levenshtein Distance Algorithm at the Al-Mizan Islamic High School Library" the result of this research is the use of the Levenshtein algorithm in a website-based application for libraries which aims to facilitate the processing of data on borrowing and returning books, this application is also designed to be accessible by school library admins, all teachers, and students through the school's website facilities. Then in this study, we also discuss the design of the application for this library using the stages of the Rational Unified Process (RUP) method which consists of four phases: Inception (Determining the project vision, scope, and business feasibility.), Elaboration (Defining and perfecting the system architecture and reducing engineering risks), Construction (Developing and implementing software based on the design that has been created), and Transition (Distributing and implement the system to the end user) (Abdurahman & Deffy Susanti, 2023). Based on the description of the previous research above, archive management is very important and with the implementation of the levenshtein algorithm will help in the search for archives stored in the form of pdf files.

RESEARCH METHODS

Design research is considered a research paradigm that aims to develop a sequence of activities and understand an empirical understanding of how learning works. For a more directed research process, this research has stages as a guide from the research process to the design of the information system with the implementation of the levenshtein algorithm can run according to its function and purpose (R. Akbar et al., 2023). The following is the flow of this research process :

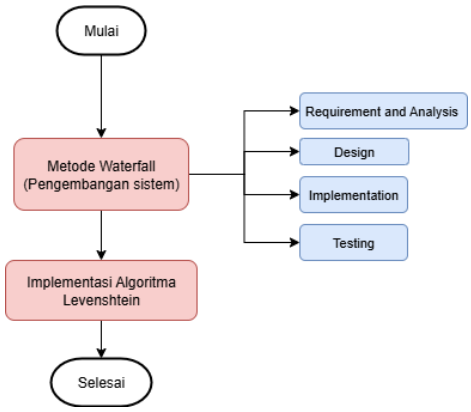

Figure 1. Research Framework

Based on the research flow above, the research was carried out starting from the following:

System Development Procedure

Waterfall Method, this system development method is a classic approach model in software development, which describes linear and sequential development methods (Martin & Nilawati, 2024) However, this study will use the requirement and design stages, implementation, and testing (Saputra & Dyah P.A, 2023) The purpose of this development is that the author will conduct an analysis to conclude the needs of the information system needed, then design to ensure the interface and software specifications are in accordance with the purpose, after which it will carry out the implementation stage of coding the Levenshtein algorithm, finally will carry out the testing stage to validate the system according to its purpose

Requirement Analysis

1. Problem Identification, at the stage of identifying this problem, research is carried out with a literature study, in order to get the problem and how to form a solution to solve the problem with the previous literature.
2. Data Collection, for the data collection stage needed in the system development process (Ikhwan & Khalilah, 2023), for data collection is carried out in several ways, namely:
   - Interview

Interviews are a method of data collection that requires communication with data sources, and communication is carried out directly or indirectly through oral dialogue or question and answer (Alda, Ulandari, et al., 2023). So, at the interview stage, the writer carried out with employees/implementing staff of the BAZNAS

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agency of Central Tapanuli Regency. The purpose of this interview process is to strengthen the reasons for the problems in the ongoing zakat recipient data archive at BAZNAS agencies in Central Tapanuli Regency, so that they can also get a form of evaluation that makes it easier to solve problems.

- Literature Study

At the literature study stage, it is an activity of collecting information and data whose information sources are selected from various research sources in the form of books, journals, manuscripts, reports and historical documents, including electronic research sources such as radio, television and other electronic media (Ikhwan & Lubis, 2023). In this study, using several journal sources and research reports to help this research.

- Observation

Observation is observation, observation is carried out in a static system that is carried out through a direct approach to the place/object of research (Suendri et al., 2024). The observation process was carried out directly with the author coming to the BAZNAS agency of Central Tapanuli Regency with the aim of paying direct attention to the way the archive is stored.

- Documentation

At the documentation stage, it involves collecting data from documents, archives, or other written materials (Ardiansyah et al., 2023), so to complete the development of this information system, archival data used by the author is needed, namely BAZNAS archive data in 2024.

Design

The process of developing this information system uses the waterfall method, the waterfall method is a model that provides a sequential programming lifeflow approach or starting from inspection, planning, coding to testing (Alda, Nazar, et al., 2023). The design stage, aims to provide a complete picture of what needs to be done and how the desired system will look. So that it helps to specify hardware and system needs, as well as define the system architecture that will be made as a whole (Supiyandi et al., 2022). The design process is carried out starting from designing the process with UML to the appearance of the system interface with vigma.

Implementation

This process is the process of translating the system design into program code using the relevant programming language (Apriliana et al., 2025). This process functions so that it can display the interface and the system process can be used according to its purpose.

Testing

Blackbox, is a test that is carried out to monitor the input and output of software without knowing the software code structure. This test is carried out at the end of software creation to ensure that the software functions according to its purpose (Asyilah & Dedi Irawan, 2022). The categories that are the criteria for testing this system are:

1. System login process
2. Input Data
3. Edit Data
4. Data search
5. System logout

User Experience is the process of assessing user satisfaction from the use of products, systems, or services (Fernando, 2020). In this study, there will be several categories of user experience assessment, namely, there is a system display, and system usage.

Data Processing technique

The implementation of the Levenshtein Distance Algorithm is one of the algorithms that can be used for decision-making. This algorithm is often used to measure the distance between words or to determine the degree of similarity between two words and can also be used as an auto-correction feature that also uses the Levenshtein algorithm (Marhalim et al., 2022). This algorithm is often seen on search engines on the internet. For example, when an internet user wants to type a word like "journal", even though the typing is still on "jour", the search engine will suggest "journal", "journal", or "journalist" as the word to search for (Putera Utama Siahaan et al., 2023). After all the processes are carried out, it will proceed to the implementation stage of the Levenshtein Algorithm, with the aim of producing a more efficient information system for zakat recipient data archives in re-searching with string matching. The formula of the levenshtein algorithm The formula of the equation is used as a reference in editing the string to be changed. The way it works is to create a matrix sized according to the initial string pair, and the target string. Then each row of the matrix that is filled in will be calculated using the equation formula :

$$lev_{a,b}(i,j) = \begin{cases} \max(i,j) \; if \; \min(i,j) = 0 \\ \min \begin{cases} lev_{a,b}(i-1,j)+1 \\ lev_{a,b}(i,j-1)+1 \\ lev_{a,b}(i-1,j-1)+1_{(ai \neq bj)} \end{cases} \end{cases} \quad (1)$$

Formula description :
a = Initial string
b = String target
lev = Levenshtein distance value
i = Initial string character value
j = Target string character value

The formula of the equation above is used as a reference in editing the string to be changed. The way it works is to create a matrix sized according to the initial string pair, and the target string. Then each row of the matrix that is filled will be calculated using the equation formula. Where there are some adjustments needed to do so, here is the operation of the matrix that is performed:

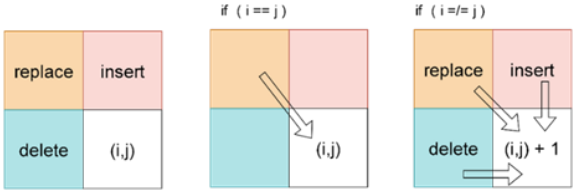

Figure 2. Operation Matrix Algorithm Levenshtein

Where if the string i (initial) is the same as the string j (target) then there is no need to perform any operation, just move the value from the box above it to the next box. If the string i (initial) is not the same as j (target), then to fill in the calculation of the next matrix is added to 1 to fill in the advanced matrix in the box string (i,j) (I. F. Akbar et al., 2024)

RESULTS AND DISCUSSION

After conducting all stages of research, the completion of the implementation of the Levenshtein algorithm is described as follows:

Design Process Planning

In this study, the author uses a business process flow with Unified Modeling Language (UML). Unified Modeling Language (UML) is one of the widely used standard languages in the industry with the aim of defining requirements, analyzing and designing, and describing architectures in object-oriented programming. UML is also a visualization language for modeling and communication systems using diagrams and text (Ikhwan & Fahrian, 2022).

1. Use Case Diagram

The image of the use case diagram on this system is as follows:

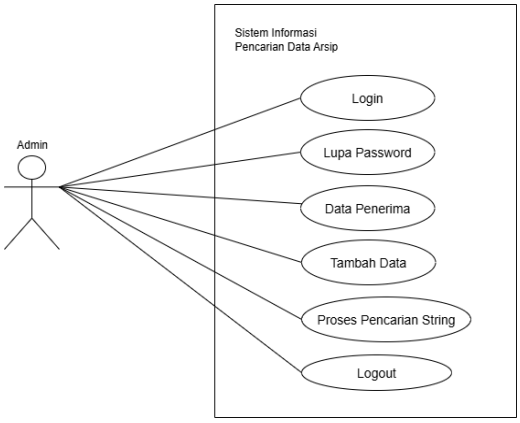

Figure 3. Use case Diagram

A use case diagram is a diagram that can be used as a scenario to represent the functionality of the system to be built (Febrian et al., 2025). The use case diagram in this system is built with the features of login, forgot password, recipient data, add data, string search process, and Logout.

Implementation Levenshtein Algorithm

The implementation stage is a phase to prove the function of the algorithm's work in the system in accordance with the objectives (Febrian et al., 2025). In this study, the author uses the levenshtein algorithm to check the spelling of zakat assistance recipients at the BAZNAS agency of Central Tapanuli Regency, with the aim that the Levenshtein algorithm is able to provide output in the form of correction or checking the strings input by the user with the strings in the database.

The levenshtein algorithm works when the search is being used by the user, as an implementation if the initial string is "Ahmad Shahroni" and the string data stored in the database is "Ahmad Muhaidin", then it then calculates the value of the initial string with the target string, with the note that there are three operations in this algorithm, including insert, edit, and delete. All three operations are determined based on the closest distance. So to do a manual calculation with the equation formula that has been explained earlier. Given :
string i : Ahmad Shahroni
string j : Ahmad Muhaidin
The solution: By visualizing the matrix
Line 1 (The word "A" with "Ahmad Muhaidin")
(A,A) → equal → min (1, 1, 0+0) = 0
(A,H) → difference → min (2, 1, 0+1) = 1
(A,M) → difference → min (3, 2, 1+1) = 2

(A,A) → equal → min (2, 4, 3+0) = 3
(A,D) → difference → min (5, 4, 3+1) = 4
(A,) → difference → min (6, 5, 4+1) = 5
(A,M) → difference → min (7, 6, 5+1) = 6
(A,U) → difference → min (8, 7, 6+1) = 7
(A,H) → equal → min (9, 7, 8+0) = 8
(A,A) → equal → min (10, 9, 8+1) = 9
(A,I) → difference → min (11, 10, 9+1) = 10
(A,D) → difference→ min (12, 11, 10+1)= 11
(A,I) → difference→ min (13, 12, 11+1)= 12
(A,N) → difference→ min (14, 13, 12+1)= 13

The calculation using this equation is done repeatedly until it is completed by adjusting if the string i and string j are the same, then it is added by 0 (zero), but if string i and string j are different, then it is added by 1.

After doing the calculation above, based on the calculation of String i "Ahmad Shahroni" with string j "Ahmad Muhaidin" above, the matrix table is produced as follows :

#NULL		A	H	M	A	D		M	U	H	A	I	D	I	N
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13
H	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12
M	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11
A	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10
D	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9
	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8
S	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8
H	8	7	6	5	4	3	2	2	2	2	3	4	5	6	7
A	9	8	7	6	5	4	3	3	3	3	2	3	4	5	6
H	10	9	8	7	6	5	4	4	4	3	3	3	4	5	6
R	11	10	9	8	7	6	5	5	5	4	4	4	4	5	6
O	12	11	10	9	8	7	6	6	6	5	5	5	5	5	6
N	13	12	11	10	9	8	7	7	7	6	6	6	6	6	5
I	14	13	12	11	10	9	8	8	8	7	7	6	7	6	6

Figure 4. Distance Calculation Matrix

From the results of the calculation of the previous matrix, it was found that the distance obtained was 6. Which means that it is necessary to perform 6 operations to change the i string (Ahmad Shahroni), to the j string (Ahmad Muhaidin). The following is the overall flow of operations that the system will perform

1. For words that are in a string (i = 1... 5) it doesn't need to be replaced because it has similarities with words that are in the string (j = 1... 5), i.e. "Ahmad". With current results : ahmad shahroni
2. For strings (i=6), and (j=6) do not need to be changed because they both contain zero values or contain spaces only. Current result : ahmad shahroni
3. The first operation is performed on strings (i = 6), and (j = 7) where the operation used is insert, by inserting the letter m before the letter s. Meanwhile, the letter s itself will be pushed to the index (j = 8) because the previous position has been filled by a new word. Current result : ahmad mshahroni
4. The second operation is performed on the strings (i = 7), and (j = 8) where the operation used is replace, by replacing the letter s with the letter u. Current result : ahmad muhahroni
5. For words that are in the string (i = 8... 10) No need to be replaced. Current result : ahmad muhahroni
6. The third operation is performed on the strings (i = 10), and (j = 11) where the operation used is replace, by replacing the letter h with the letter i. Current result : ahmad muhaironi
7. The fourth operation is performed on the strings (i = 11), and (j = 12) where the operation used is replace, by replacing the letter r with the letter d. So, for the current result: ahmad muhaidoni
8. The fifth operation is performed on the strings (i = 12), and (j = 13) where the operation used is replace, by replacing the letter o with the letter i. Current result : ahmad muhaidini
9. For words that are in the string (i = 13), and (j = 14) do not need to be replaced, where the string has a word that suits the need. Current result : ahmad muhaidini
10. The sixth operation is performed on the strings (i = 14), and (j = 14) where the operation used is delete, by deleting the letter i. The final result becomes: "Ahmad Muhaidin"

From the results of the above operation, it was found that for the string "Ahamd Shahroni" to "Ahmad Muhaidin" it required 6 operations to change it to the same. The following is the formula for calculating similarity distance and the result:

$$Similarity = \left(1 - \frac{\text{Distance}}{\max(\text{len}(S)), (\text{len}(T))}\right) \times 100\ \% \quad (2)$$

Given:
String i (initial): Ahmad Shahroni, String j (target): Ahmad Muhaidin, with the result of a distance matrix of 6, then Max Length/. Word length : 14, then :

$$Similarity = \left(1 - \frac{6}{14}\right) \times 100\ \% = 57{,}14\% \quad (3)$$

Implementation System

At the stage of system implementation, it must refer to the design of the system that has been made beforehand. This stage is the stage of a process of realizing a system in real conditions (Wakhidah & Febriani, 2024).

1. Login Page

At the beginning of starting the system as usual, users will log in with the appropriate username and password to be able to continue to manage the system.

Figure 5. Login page view

2. Dashboard Page

After passing the system login process, you will enter a dashboard page that displays the main information and the latest activities of the user.

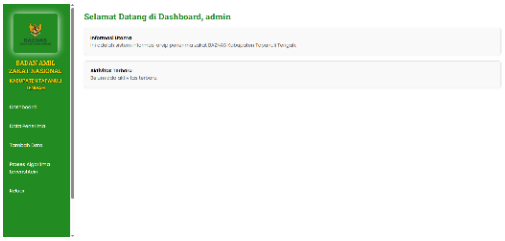

Figure 6. Dashboard Page View

3. Data Category Page

On the recipient data page, the system will display all the data of zakat recipients that are input from the data addition process. On this page, data is available for zakat recipients, for example, the category of a convert and the recipient of zakat for the poor category. On this page there are two actions for each data you can edit the data to update the data and if there is an error, then you can delete the data if it is no longer needed.

Figure 7. Data Category Page

4. Algorithm Levenshtein Process Page

In the display process for the Levenshtein algorithm in this system is in the table for data search, where in this system if the user with the target string "Ahmad Muhaidin", but with the source string "Ahmad Shahroni", the system will help by still displaying according to the string stored by the database, i.e. the target string because the closest string in the database is "Ahmad Muhaidin". The system with the levenshtein algorithm will work to estimate strings with similar distances at the time of operation (Adawiyah & Saragih, 2022).

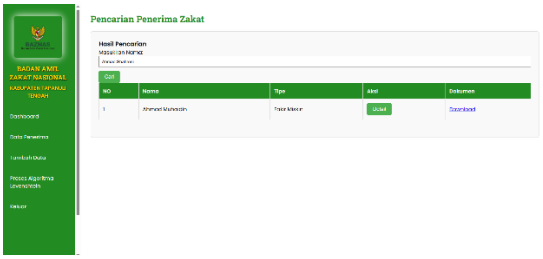

Figure 8. Algorithm Levenshtein Page

Testing Results

1. Testing System

In testing this system, a system blackbox is used that is focused on the software of this system. Here are the results:

No	FITUR YANG DIUJI	INPUT	OUTPUT	Ket
1.	Login Sistem	Username admin dan password	Benar, Masuk ke tampilan dashboard sistem	VALID
2.	Tambah Data	Mengisi form data	Daftar tabel data	VALID
3.	Edit Data	Mengisi Form edit data, menyesuaikan dengan data yang ingin diganti.	Menampilkan data yang berhasil di edit	VALID
4.	Pencarian Data Penerima	String yang ingin dicari	Menampilkan string yang ingin dicari	VALID
5.	Logout	Mengklik fitur logout	Kembali ke tampilan login	VALID

Figure 9. Blackbox System

2. User Experience

To prove how efficient this system is to help search archives at BAZNAS Central Tapanuli Regency survey user experience was conducted by 2 staff related to the

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management of archives in the agency. Some of the categories from this assessment are:

1. Simple and easy-to-understand login interface
2. Fast login process without any problems
3. The dashboard display is attractive and comfortable to see
4. Easy-to-use category data add-on feature
5. Data validation (e.g. mandatory inputs) is working well
6. The algorithm process runs as expected
7. The results provided by the algorithm are accurate
8. This system helps make my job easier
9. Overall, I am satisfied with using this system

The results of the user experience survey of this system are:

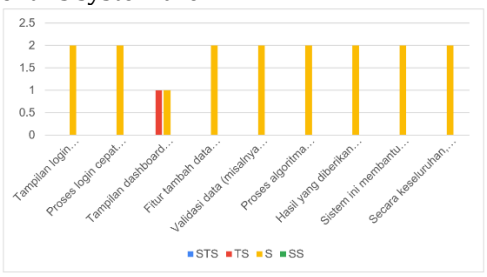

Figure 10. Survey User Experience

CONCLUSIONS AND SUGGESTIONS

Conclusion

This research successfully designed and built a web-based e-archive information system for zakat recipients at BAZNAS Central Tapanuli Regency by implementing the Levenshtein algorithm. This system simplifies the process of searching the archives of zakat recipients because it is able to measure the distance between the similarities of strings so that data can still be found even if there are differences in writing. In addition, this system improves time efficiency, reduces dependence on hardcopy archives by scanning hardcopies to create files in pdf format using a printer scanner so that they can be uploaded to the system, and assists staff in managing archive data in a more structured, modern, and accurate manner.

Suggestion

Suggestions for the development of advanced systems, systems can be developed by adding data security features (e.g. archive encryption and automatic backups) so that the data of zakat recipients is more protected.

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