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Implementation of the Knuth-Morris-Pratt Algorithm in a Web-Based Physiotherapy Service Search System

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Abstract. In today's digital age, text-based information retrieval has become an important feature in the development of web-based information systems, including health service search systems such as physiotherapy. This article aims to implement the Knuth-Morris-Pratt string matching algorithm in a physiotherapy service search system to improve the efficiency of searching for services that meet the needs of the general public. The KMP algorithm is known for its ability to avoid unnecessary repeated comparisons during pattern matching. The results of this study show that the implementation of Knuth-Morris-Pratt is capable of providing relevant solutions in web-based physiotherapy service searches. This study is expected to serve as a reference in the development of fast and efficient text search systems in the health sector.

Keywords: Implementation, Algorithm, Knuth-Morris-Pratt, Search System, Physiotherapy Services

1. INTRODUCTION

Information retrieval is an important aspect in the digital world, especially in the health sector, which is increasingly integrated with web-based information systems. One of the main needs of the community is to obtain information about health services, such as physiotherapy services, quickly and accurately.

However, text-based search processes are often hampered by the efficiency and relevance of the results displayed. Therefore, a string matching algorithm is needed that can optimize the search process with accurate results and fast response times.

The Knuth-Morris-Pratt algorithm is one of the string algorithms that has been proven to be efficient in searching for patterns in a text [1]. The main advantage of this algorithm is its ability to avoid unnecessary character comparisons, thereby speeding up the search process [2]. This study aims to implement the KMP algorithm in a web-based physiotherapy service search system to improve the quality and efficiency of healthcare service searches.

The selection of the Knuth-Morris-Pratt algorithm used in this study as a string matching algorithm to solve -Pratt used in this study as a string matching algorithm in solving web-based physiotherapy service search problems, is inseparable from the positive contribution of this algorithm to solving text-based information search problems that have been studied by previous researchers, such as research by Fenina Adline Twince Tobing, et al. (2022) on data search in SQL like operators [3], research by La Ode Abdurrahman, et al (2023) on language translation in the Muna language dictionary [4], research by Lipko Soliger, et al (2024) on medical record data search at a community health center [5], etc.

2. METHODOLOGY

2.1 Research Stages

In this study, the author used the research stages as described below

a. Problem Identification
   In the initial stage, we identified the problems faced by users in finding physiotherapy services quickly and accurately on web-based platforms. The main problem found was a slow and inaccurate search process when users entered certain keywords. Traditional search systems often only match simple substrings without considering the efficiency of the string search algorithm. Therefore, a solution is needed in the form of a more optimal search algorithm, one of which is the Knuth-Morris-Pratt algorithm.
b. Data Collection
   This stage involves collecting data related to physiotherapy services, which will be used as a search database.

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Data is collected from several sources, including:
1. Online and offline physiotherapy service directory
2. Official physiotherapy clinic website
3. Questionnaire or interview with users regarding service search needs

c. Implementation of Knuth-Morris-Pratt
After the data was collected, the KMP algorithm was implemented into the web-based search system. The KMP algorithm is used to efficiently match patterns (search keywords) with physiotherapy service data.

d. Analysis Results
After the system was successfully implemented, an analysis was conducted on the performance of the physiotherapy service search using the KMP algorithm in solving problems experienced by users.

e. Conclusions
Finally, at this stage, the researcher draws conclusions from the results of the analysis conducted on the implementation of the KMP algorithm into the web-based physiotherapy service search system that has been completed in this study.

2.2 String Matching

String matching is a process in computer science that aims to find the existence of a string pattern in a longer text [6]. This process involves matching the character sequence of the pattern to certain parts of the text to determine whether the pattern appears in its entirety in the text [7]. In addition to detecting the existence of patterns, string matching also aims to identify the position or index of the pattern's appearance in the text, whether once or repeatedly [8]. String matching methods are widely used in various fields of application such as information retrieval [9].

2.3 Knuth-Morris-Pratt

The Knuth-Morris-Pratt algorithm is one of the string matching algorithms known to be efficient and reliable in finding a pattern in a text [10]. Developed by Donald Knuth, Vaughan Pratt, and James H. Morris in 1977, this algorithm provides an optimal solution to the string matching problem with linear time complexity, namely O(n + m), where n is the length of the text and m is the length of the pattern [5].

The main advantage of the KMP algorithm lies in its ability to avoid unnecessary character comparisons, which often occur in conventional matching algorithms such as brute force. KMP achieves this through a preprocessing step on the pattern to be searched, by forming an array called the failure function or Longest Prefix Suffix. This array stores information about how many characters of the pattern can be skipped when a mismatch occurs, so that the search does not need to return to the beginning of the pattern, but can continue directly from the correct position [11], [12], [13].

2.4 Physiotherapy Services

Physical therapy services are health services that help restore and improve patients' physical function and quality of life through physical therapy. These services are provided by physical therapists and aim to reduce pain, restore movement, and prevent injury. Methods used include physical exercise, manual therapy, electrotherapy, and heat/cold therapy. These services are beneficial for various conditions such as injuries, post-surgery, stroke, and child growth and development disorders [14], [15].

3. RESULTS AND DISCUSSION

3.1 Sample Data

The data sample for solving web-based physiotherapy service search problems using the Knuth-Morris-Pratt algorithm in this study is “FISIOTERAPI STROKE” as the text and “STROKE” as the pattern.

3.2 Implementation of the Knuth-Morris-Pratt Algorithm

The results of implementing the KMP algorithm for string matching in solving the problem under study are as follows:

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a. First Stage String Matching

Table 1. Stage 1

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern	S	T	R	O	K	E												

In stage 1, Table 1 shows that matching begins at the start of the string in Text, where string pattern S is matched with string text F. However, no match is found between string S and F. Therefore, the process shifts one step to the right to perform stage 2 matching.

b. Second Stage String Matching

Table 2. Stage 2

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern		S	T	R	O	K	E											

In stage 2, no match was found between string pattern S and string text I. Therefore, the process shifted one step to the right to perform stage 3 matching.

c. Third Stage String Matching

Table 3. Stage 3

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern			S	T	R	O	K	E										

In stage 3, a match was found between string pattern S and string text S. Therefore, the matching process continued for string pattern T and string text I. However, no match was found between string pattern T and string text I. Therefore, the process shifted one step to the right to perform the matching for stage 4.

d. 4th String Matching Stage

Table 4. Stage 4

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern				S	T	R	O	K	E									

In stage 4, no match was found between string pattern S and string text I. Therefore, the process shifted one step to the right to perform stage 5 matching.

e. 5th String Matching Stage

Table 5. Stage 5

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern					S	T	R	O	K	E								

In stage 5, no match was found between string pattern S and string text O. Therefore, the process shifted one step to the right to perform stage 6 matching.

f. 6th String Matching Stage

Table 6. Stage 6

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern						S	T	R	O	K	E							

In stage 6, no match was found between string pattern S and string text T. Therefore, the process shifted one step to the right to perform stage 7 matching.

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g. 7th String Matching Stage

Table 7. Stage 7

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern							S	T	R	O	K	E						

In stage 7, no match was found between string pattern S and string text E. Therefore, the process shifted one step to the right to perform stage 8 matching.

h. 8th Stage String Matching

Table 8. Stage 8

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern								S	T	R	O	K	E					

In stage 8, no match was found between string pattern S and string text R. Therefore, the process shifted one step to the right to perform stage 9 matching.

i. 9th Stage String Matching

Table 9. Stage 9

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern									S	T	R	O	K	E				

In stage 9, no match was found between string pattern S and string text A. Therefore, the process shifted one step to the right to perform stage 10 matching.

j. 10th Stage String Matching

Table 10. Stage 10

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern										S	T	R	O	K	E			

In stage 10, no match was found between string pattern S and string text P. Therefore, the process shifted one step to the right to perform stage 11 matching.

k. 11th Stage String Matching

Table 11. Stage 11

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern											S	T	R	O	K	E		

In stage 11, no match was found between string pattern S and string text I. Therefore, the process shifted one step to the right to perform stage 12 matching.

l. 12th Stage String Matching

Table 12. Stage 12

Text	F	I	S	I	O	T	E	R	A	P	I		S	T	R	O	K	E
Pattern												S	T	R	O	K	E	

In stage 12, no match was found between the string pattern S and the string text (Space). Therefore, the process shifted one step to the right to perform the matching in stage 13.

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m. 13th Stage String Matching

Table 13. Stage 13

Text	F	I	S	I	O	T	E	R	A	P	I	S	T	R	O	K	E
Pattern												S	T	R	O	K	E

In stage 13, a match was found between string pattern S and string text S. Therefore, the matching process continued for string T with string T up to string E with string E, and in all of these matches, it was found that the string in the pattern matched the string in the text. Therefore, the automatic string matching process stopped.

4. CONCLUSION

Based on the implementation of the Knuth-Morris-Pratt algorithm in matching the string between the text "FISIOTERAPI STROKE" and the pattern "STROKE," it can be concluded that this algorithm is capable of performing pattern searches efficiently. The matching process is carried out gradually from the beginning to the end of the string, and a perfect match between the pattern and the text is found in the 13th stage, where all characters in the pattern "STROKE" are successfully matched sequentially with parts of the text. The use of the Knuth-Morris-Pratt algorithm has proven to be effective in solving string matching problems because this algorithm reduces the number of unnecessary comparisons, making it suitable for application in web-based search applications such as searching for physiotherapy services based on specific keywords.

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