Jurnal Teknologi Sistem Informasi dan Aplikasi **ISSN: 2654-3788**
Penerbit: Program Studi Teknik Informatika Universitas Pamulang **e-ISSN: 2654-4229**
Vol. 6, No. 4, Oktober 2023 (783-787) **DOI: 10.32493/jtsi.v6i3.34226**

Implementation of Finite State Automata to Simulation of Automatic Clothes-Folding

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Submitted Date: September 19th, 2023 Reviewed Date: September 22th, 2023
Revised Date: October 15th, 2023 Accepted Date: October 18th, 2023

Abstract

Inconsistencies and differences clothes-folding methods are often a major problem in the military. Everyone has thier method to fold and their method is still traditional. Besides, the neatness of the clothes in the military is emphasized. This method certainly took up their time and energy then the folding was different to each other. To solve this problem, a simulation machine is made to fold the clothes automatically. This system works using Finite State Automa type Non-Deterministic Finite Automata. Finite State Automata are used because they are simple and do not require storage space. The result of this research is a design of an automatic clothes-folding that can be implemented properly and correctly for UNHAN RI's students. This automatic clothes-folding has succeeded to create consistent folds even though user tried with different clothes.

Keywords: Finite State Automata; clothes-folding; Non-Deterministic Finite Automata

1. Introduction

The indicators of the standard of living of a human being include three aspects (Leonita & Sari, 2019). These three aspects are commonly called primary needs. The primary needs of every human being consist of clothing, food, and housing. As social beings, clothing is the most important thing for every human.

In the military, folding clothes is one thing that is considered. The neatness of the clothes in the military is emphasized. Almost every day, the coach checks the neatness and similarity of the folds of students's wardrobes. There are many methods used by soldiers to match the folds of clothes, but their method is still traditional. For example, folding clothes using cartons. This method certainly took up their time and energy, and it was not certain that each soldier had the same folds as another.

Nowadays, students of Indonesia's Defense University have been equipped with military activities. This military activity must be equipped with a uniform appearance, especially in uniforms. Now, students have been equipped as reserve components who have been trained both academically and militarily.

The procedure for displaying clothes is always emphasized. Before they officially became university students, they had passed basic military education for two months. The basics regarding dress code in the military are also taught here.

As Military University (UNHAN RI), time is very precious. To save time and equalize the folds, an automatic clothes-folding device was made. This clothes-folding tool uses the Finite State Automata concept for its application (Lediwara et al., 2022), (Han & Chen, 2018). Finite state automata are used because they are simple and do not require storage.

The main section consists of an introduction, methodology, experiment result, discussion, conclusions, and future work. The author can use other structures to adjust the topics of paper.

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2. Literature Review

Research on automatic machines was discussed (Agastya Nugraha et al., 2020). This research discusses vending machines. This vending machine is used to sell fruit salad. The type of automata used is a mealy machine. Based on the results of using this automatic machine, it is hoped that the sale of fruit salad can increase its selling power to consumers.

Automatic machines for selling medicines were also discussed (Supriyanto et al., 2021). This research uses an automatic sales machine, namely a vending machine. This vending machine uses an implementation of finite state automata with a non-deterministic automata type. It is hoped that with this automatic machine, buyers can buy medicine at any time. In this research, there is a suggestion that if this research wants to be developed further, it can be done by adding a change feature to this vending machine.

3. Theoretical Basis

Finite State Automata is an abstract machine of a mathematical model with input and output that can understand language at a simple level and can be implemented in real life (Hussain et al., 2019). It consists of several states accompanied by several inputs. Each input serves to represent a transition. It is a type of automata, this type of automata does not have storage (low memory).

According to the type of Finite State Automata, there are language engines that can accept, recognize, and reject, consisting of DFA (Deterministic Finite Automata) and NFA (Non-Deterministic Finite Automata). Finite State Automata has five tuples. The tuples can be seen in Table 1.

Table 1. Tuples Finite State Automata

Tuple	Definition
Q	The set of states
∑	Input symbol set
δ	Transition function
S	Initial State
F	Final state

In Deterministic Finite Automata, each state must receive all inputs (Zhang et al., 2020). Deterministic Finite Automata does not allow for empty input. Deterministic Finite Automata can be seen in Figure 1.

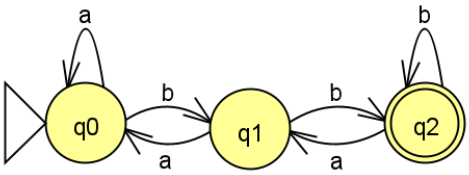

Figure 1. Deterministic Finite Automata

The Contrast between Deterministic Finite Automata, Non-Deterministic Finite Automata not always every input is in a state (Abdulnabi & Ahmad, 2019). Empty input is allowed for this machine (Pferscher & Aichernig, 2020). Pictures of Non-deterministic Finite Automata can be seen in Figure 2.

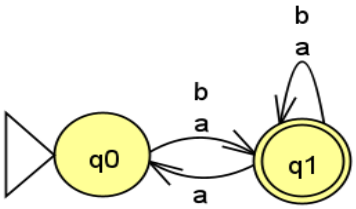

Figure 2. Non-Deterministic Finite Automata

The control mechanism of an elevator is an example of implementing automata. The lift performs a movement up and down. The mechanism does not remember previous requests but only the position of the elevator on the floor visited (Ghaleb & Oommen, 2021). Other examples of implementing Finite State Automata include examples of vending machines, text editors, and other automated tools (Kumar & Krishna Kumar, 2021), (Mavridou & Laszka, 2018), (Ulyantsev et al., 2018).

Other research on Finite State Automata has also been done to write Balinese scripts (Nyoman Crisnapati et al., 2019). In this study, Finite State automata are robots that can write Balinese script with a design resembling a human arm using open source Python. Robot is given input from Balinese in Latin form. Furthermore, the robot will translate the language into a .png file format.

4. Research Method

This research was conducted in several stages. These stages include system design. The system design used flow charts and UML diagrams (Koç et al., 2021).

In the early stages of the flowchart. The flowchart will make it easier for users to know the workflow of the system. This workflow description helps the user to be able to carry out the design stage in the next process. The user must enter the clothes to be folded. At this stage, there is a validation of whether the clothing is the type of uniform or not. If it is not, the automatic system will finish this step. If the clothes are right, the machine will process the folding of these clothes. The stages of the machine workflow can be seen in Figure 3.

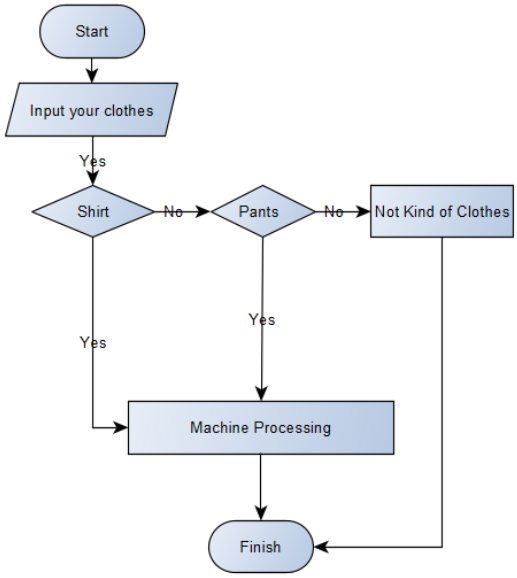

Figure 3. Flowchart System

The next stage is design UML Diagram. Use case diagrams can show how the machine mechanism works (Dabre et al., 2020). Especially if there are several options. Then this use case diagram is very helpfulI this research, we used Use Case Diagram. On Use Case Diagram user can find that there is two options to process of clothes-folding. User have to choose shirt or pants. Next of stage is validation. Validation can be processed based on the user's options. The appearance of Use Case Diagram can be seen on Figure 4.

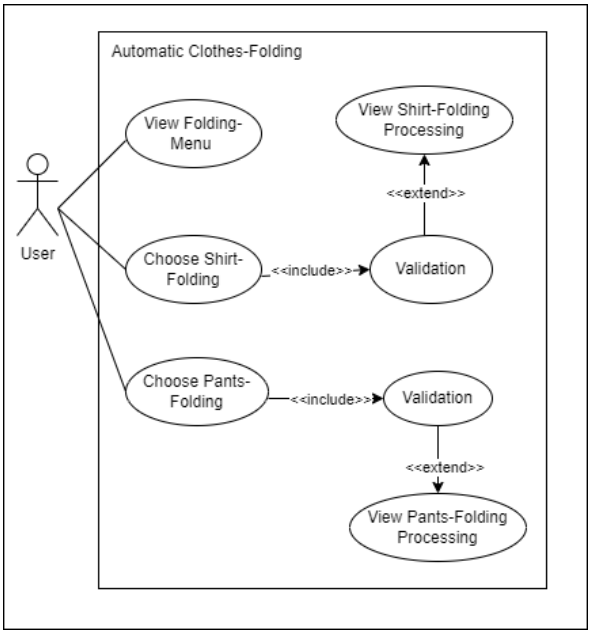

Figure 4. Use Case Diagram

5. Discussion Result

The result of the design of the flowchart and Use Case Diagram is the implementation using JFLAP (Wang & Chen, 2021). JFLAP is used for the working mechanism of the machine.

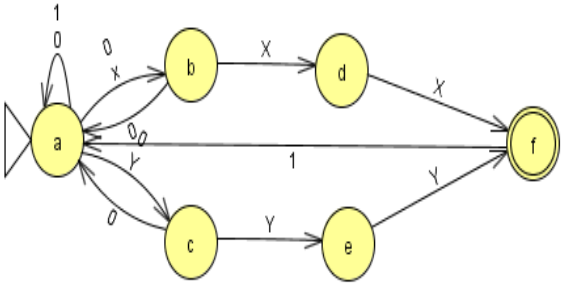

Figure 5. Clothes Folding Mechanism

Figure 5 explains how the Finite State Automata machine works. The initial stage is preceded by "a" symbol. From this initial state, the user can choose what input he wants. In this case, the type of automata used is Non-Deterministic Finite Automata (Pferscher & Aichernig, 2020), (Devi et al., 2020).

If the initial state is given input 0 then this state will return to the initial state. From this initial state, there are two choices, named "X" to receive input clothes and "Y" to receive input pants.

If the user selects the input to "b" then the next process will be processed to receive shirt

input. This process is the process for shirt folding and will be forwarded to process "d".

If the user chooses input to "c" then the next process will process it to receive pants input. From the process of receiving the input of these pants, it will be forwarded to process to "e".

Based on the input that has been given by the user, the next process is the processing process by the machine. When the user from state "b" inputs "X" to state "d" then in this step the machine works to fold the shirt.

If the user provides input "Y" from state "c" then the next step goes to state "e". In state "e", this is the process of folding the selection of pants folding.

If the folding process by the machine for both pants and shirts is complete, the machine's work will end. In this step, from either state "d" or "e" with each input "X" and "Y". It will go to the final state.

Complete information regarding the set of states can be displayed in Table 2. There are six states that used clothes folding machine.

Table 2. State Step

Tuple	Definition
a	Initial State
b	Acceptor shirt input
c	Acceptor pants input
d	Shirt folding processing
e	Pants folding processing
f	Final state

A collection of inputs can be seen in Table 3. In this clothes-folding machine there are 4 types of inputs.

Table 3. Input Symbol

Tuple	Definition
0	Unfit Clothes
1	Failed Folding
X	Shirt Input
Y	Pants Input

The following is a design of a simulation of a clothes-folding device. From this design, we can see that there is a place to put clothes, a container for processed clothes, and a container for clothes that are not processed. An overview of this machine can be seen in Figure 6.

Figure 6. Machine Of Clothes Folding

6. Conclusion

The design of a simulation of an automatic clothes-folding device for UNHAN RI's students can use FSA or Finite State Automata concept. An automatic machine can recognize and read input symbols into a language that can be recognized through the Finite State Automata concept. High accuracy is also one of the advantages of Finite State Automata in realizing input and output according to plan. Therefore, the application of Finite State Automata in a clothes-folding machine has succeeded in interpreting the functions that are made in detail and with high accuracy, so that the simulations can be carried out properly and correctly.

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