



Application Of The Finite State Automata Concept In Applications Fruit Vending Machine Simulation

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ABSTRACT

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Fruit as a traditional food has become a global food, but its sales are still traditionally in markets, minimarkets, and currently there are still using mobile carts. Fruit sales that can be developed in a more modern way are fruit vending machines. To deepen the understanding of one of the most basic computational models, the fruit vending machine design will use the finite state automata method of the mealy machine model. With the finite state automata design, this research has resulted in an automatic fruit vending machine design that can accept input and select a combination of several types of fruit as desired, then will produce the expected output. There is also a choice of payment methods for ease of purchase transactions. Fruit products sold with vending machines are automatically expected to increase added value in the form of automation to facilitate purchasing, packaging and product hygiene that can attract consumers widely.

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1. Introduction

The agricultural sector plays an important role in meeting the food needs of the Indonesian people. Along with the rapid development of the Indonesian population, the variety of food needed by the community to maintain and improve their quality of life is increasing (Hidayatullah, 2018), one of which is fruit farming. Fruit-producing plants are plants that are deliberately planted that produce fruit to be consumed in a fresh state, contain sources of vitamins and protein, are used as food, and complement other needs. From this description, it can be concluded that fruit trees are plants that are intentionally planted and are a primary human need that has many benefits in everyday life. Fruits are one of the horticultural commodities that play an important role for all Indonesian people (Ziraluo & Duha, 2020).

Fruit as a traditional food has become a global food, but its sales are still traditionally in markets, minimarkets, and currently there are still using mobile carts. The development of information technology has changed most people's lifestyles, especially in Indonesia, which was originally traditional to modern. Various innovations that lead to the use of tools that make work more efficient, practical, safe, fast, and comfortable. The use of technology in the industrial sector, namely automatic machines that aim to change manual activities into automatic ones, especially to accelerate the production of quality products (Fergie Joanda Kaunang, 2019). The breadth of the field in information technology cannot be separated from the clear and written according to the application of language theory and automata which underlies the development of computing technology. Finite State Automata (FSA) is the simplest computational model with only very limited memory (Nugraha et al., 2020).

Finite State Automata is a component of informatics that has the functions of a digital computer. Receives input, produces output, can have temporary storage, and is also able to make decisions in converting input to output. Automata itself is a system consisting of a finite number of states, where each state represents information about the previous input, and can be considered as machine memory. While the



automata theory is a theory about abstract machines, and is closely related to a formal language theory (Erni et al., 2020; Ma'arif & Fauziah, 2018).

Automata are abstract machines that can recognize, accept, or generate a sentence in a particular language (Maulana, Ahmad Saufi; Azizah, Nur Hanifah; Kirana, 2020). The input on the automata machine is considered a language that the machine must recognize. Furthermore, the automata machine makes a decision that indicates whether the input is accepted or not, so that the automata machine can be used to produce a language whose rules are determined by that language (Suharsih & Atqiya, 2019). FSA is a mathematical model that can accept input and output. FSA has a finite number of states and can move from one state to another based on input and transition functions. FSA does not have storage or memory, it can only remember the current state (W. et al., 2016). FSA is a mathematical modeling with input in the form of a finite number of sets. FSA also has a finite set of states, an initial state, and a transition function to switch states, as well as a subset of states to accept the results as output (Yohanes et al., 2017). Finite Automata or called NFA is one of the machines in Language Theory and Automata, chosen because it is easy to apply and in accordance with human logic, it is also a very useful tool for recognizing and capturing patterns in data and a directed graph that serves to describe the workings of an object. FSA, FSA is also interpreted as a mathematical model that can accept input and output an output that has a finite number of states and can move from one state to another based on input and transition functions (Wirasbawa et al., 2019)(Maulana, Ahmad Saufi; Azizah, Nur Hanifah; Kirana, 2020).

Vending Machine Vending Machine (VM) is a sales machine that will issue the results of goods or a product after the buyer puts a certain amount of money into the available machine box (Sujana et al., 2019). VM is a food or beverage sales machine that works on a standalone basis. VM is an application of the field of Language Theory and Automata that can sell goods or human needs automatically. The sales system with VM does not require an operator, the buyer can choose the desired item himself (Wicaksono et al., 2019). VM is also a marketing tool to market a product in it (Sujana et al., 2019). A VM or vending machine is a machine that can dispense items such as snacks, drinks, cigarettes, tickets, consumer products, and even gold. The way a vending machine works is like a real seller, the machine will issue the item we want after we pay for it by entering a certain amount of paper money or other means of payment according to the vending machine's request (Sujana et al., 2018). The development of vending machines in Indonesia is still very young. Vending machines that can accept electronic money payment systems, for example e-money, flash, and other electronic cards will be increasingly popular and increasingly accepted in the community. The existence of Vending Machines will certainly continue to grow again with many variations or choices of types of goods provided and various nominal terms, both banknotes and coins. A vending machine must be able to process appropriate sales transactions based on the choices given by the user and can overcome problems in the VM, then the application of the FSA concept to the VM will be used to model the transaction process automatically (Suharsih & Atqiya, 2019).

This research is made a VM simulation application that can process fruit sales transactions for ten thousand rupiah each. This application requires input in the form of a choice of payment methods with the output being 2 (cash and non-cash), and input for selecting the type of fruit selected, with the output being ten kinds of fruit (Apple, Watermelon, Mango, Banana, Orange, Dragon, Pears, Grapes, Strawberries, and melons) according to the user's choice along with, receipt and change (if any). The money used can be seen in the VM already listed. This application also provides payment options with 2 methods (cash and non-cash) to make it easier for users to pay and can also provide change if the nominal money is greater than the price of the fruit purchased.

The purpose of this research is to apply the FSA concept to the fruit VM simulation application. The application of the FSA concept was chosen because finite automata are simpler machines, which were originally proposed to model human brain function (Ezhilarasu & Krishnaraj, 2015). To describe the flow of VM activities, Unified Modeling Language (UML) is used, which consists of use case diagrams and Activity diagrams. UML is a language used to describe requirements, make analysis, and design and describe architecture (Maezar et al., 2018). Use case diagrams explain between the user and the system created, while the activity diagram describes the activities of a designed system (Wijaya & Sari, 2015).

2. Research Methods

In a study, it is necessary to have well-structured stages so that the implementation of the research can



achieve the expected goals. The steps taken by the author are shown in Figure 1.

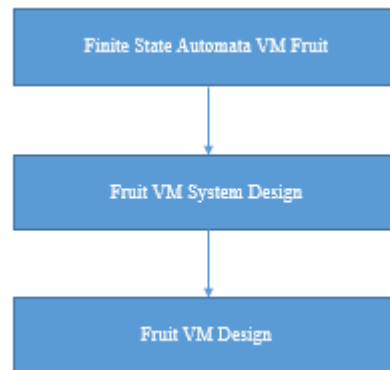


Figure 1. Stages of Research Methods

- a. Finite State Automata
In the finite state automata stage, the author describes the design of the DFA diagram transition diagram.
- b. Fruit VM System Design
The next stage of system design, the authors design the system using UML (Unified Modeling Language) which consists of use case diagrams and activity diagrams.
- c. Fruit VM Design
The last stage is the VM design, here the author describes the interface design on the fruit VM simulation application.

3. Results and Discussion

3.1 Finite State Automata

FSA is a model that can accept input and issue output that has a finite number of states and can move from one state to another based on input and transition functions (Aziz, Faruq; Said, Fadillah; Sudrajat, 2021). The state diagram used is the FSA with the concept of Non-Deterministic Finite Automata (NFA) because it can go to several states if a state is given input. NFA is defined by five tuples, with the formula: $M = (Q, \Sigma, \delta, S, F)$, with the description:

Q: set state

Σ : input symbol set

δ : transition function

S: initial state

Δ : output symbol set

F: final state

So it can be defined as follows:

$Q : \{Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13\}$

$\Sigma : \{a,b,c,d,e,f, g, h, I, j, k, l, m\}$

$S : \{Q0\}$

$F : \{Q13\}$

With the following information:

0 : None

1: Releasing Fruit

Q0 : Initial State

Q1 : Apples

Q2 : Smell of Watermelon

Q3 : Mango smell

Q4 : Banana Fruit

Q5 : Citrus Fruit

Q6 : Dragon Fruit

Q7 : Pears Q8 : Grapes
 Q9 : Strawberry smell
 Q10 : Melon Fruit
 Q11 :Cash Payment
 Q12 : Non-cash payment (e-money)
 Q13 : Exit Receipt (Final state)
 a : Choose apples
 b : Choose Watermelon
 c : Choose Mango fruit
 d : Choose Banana fruit
 e : Choose oranges
 f : Choose Dragon fruit
 g : Choose Pears
 h : Choosing grapes
 I : Choose Strawberry fruit
 j : Choose melon
 k : Choose cash payment
 l : Choose non-cash payment (e-money)
 m : Confirmation complete

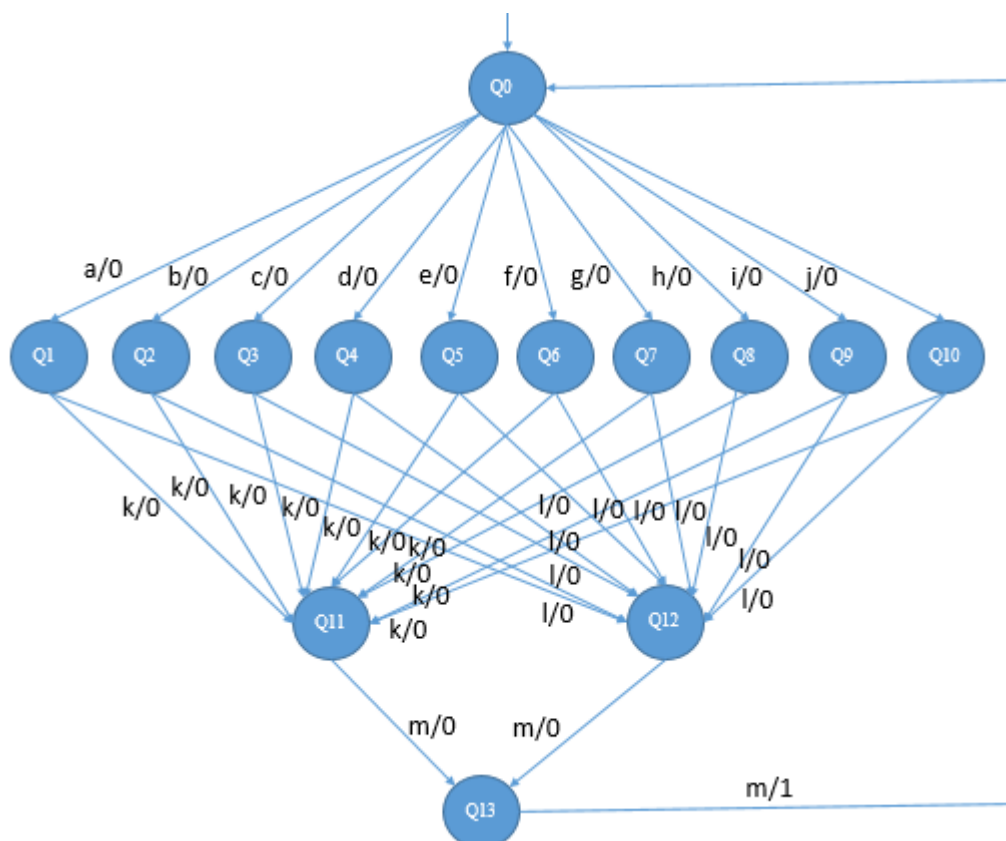


Figure 2. The Design of The Transition Diagram of the Finite State Automata Diagram

In figure 2 the state diagram accepts input in the form of the state to be addressed as well as zeros and ones. Zero, which means the state diagram continues to the next state, while receiving input, which is one, means the machine has completed its task (issued receipt and fruit) and will return to the initial state. The state diagram also has several special inputs for cash and non-cash payments, while, for the destination state, the

input is symbolized by the lower-case letters of the state to be addressed. The machine will run if the intended input matches the state to be addressed. In the initial state, the user will be asked to choose what type of fruit he wants, for example the user chooses an apple, then the initial state of Q0 will go to state Q1. After the fruit is selected then the total payment and payment method options appear, if the user chooses the cash payment method, state Q1 will go to state Q11, if you choose non-cash payment then state Q1 will go to state Q12, after that the rice purchase receipt will come out coincides with the release of fruit in Q13.

3.2 Fruit VM System Design

The system is designed using UML (Unified Modeling Language) which consists of use case diagrams and activity diagrams.

3.2.1 Use Case Diagram

Use case diagrams are used to describe system actions from the user's point of view, as a functional description of the system and its main processes, visually explaining who uses the system and how they interact. The vending machine simulation application in this study is used by the user or users. Use case diagrams for users can be seen in Figure 3.

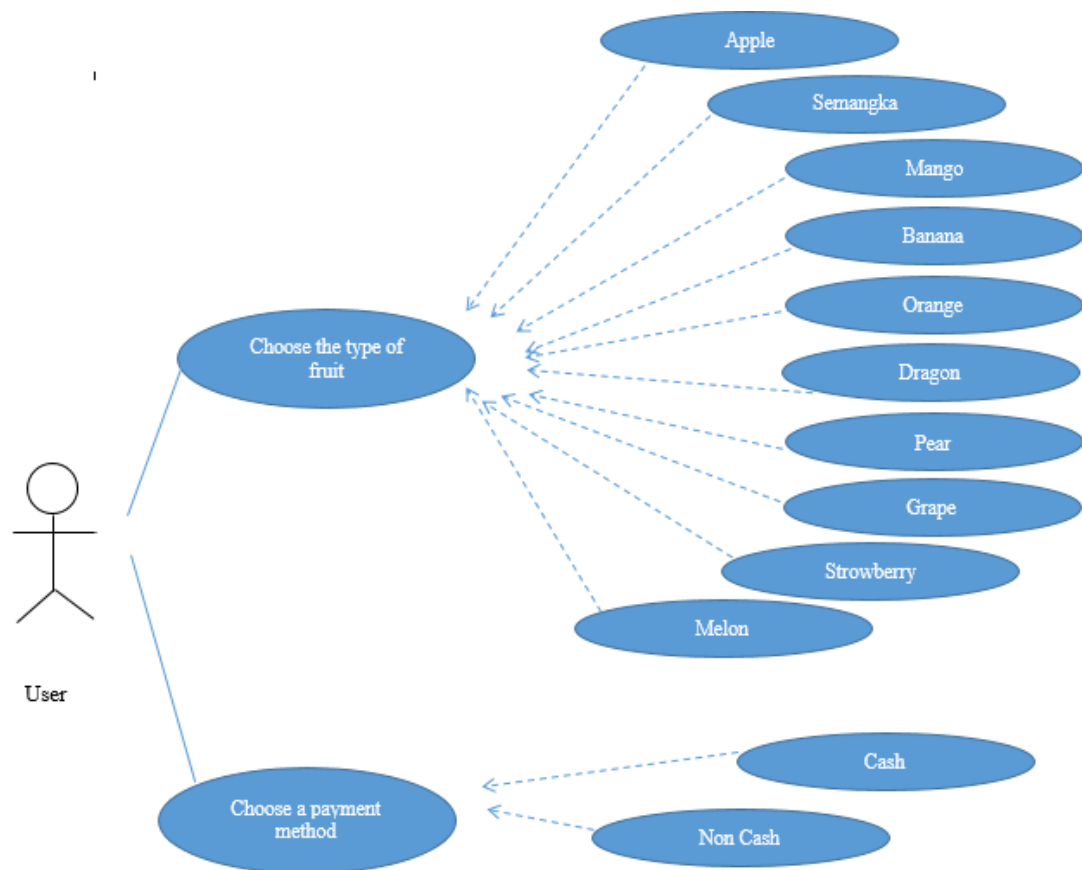


Figure 3. Use Case Diagram for Users

In Figure 3, the user can select the type of fruit and choose the payment method in cash or non-cash.

3.2.2 Activity Diagram

An activity diagram is a flow of activities in a system that is being designed, how each flow begins, what decisions occur, and how these activities end. Activity diagrams can be seen in Figure 4.

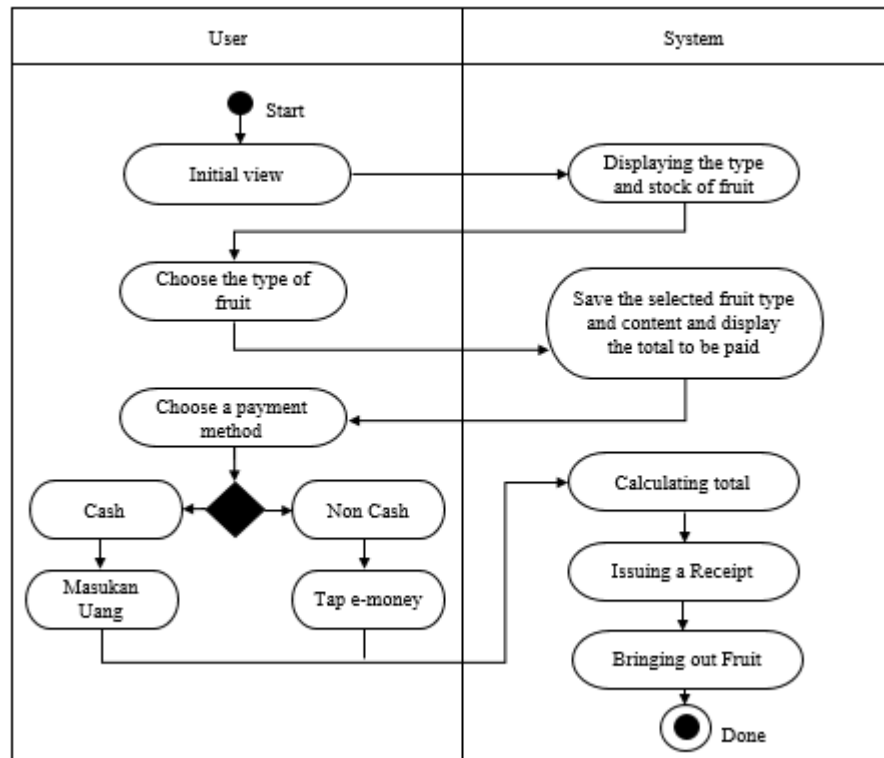


Figure 4. Activity Diagram

Figure 4 describes the Activity in the fruit VM. The first step taken by the VM pad user shows the initial display of fruit types and fruit stocks, namely by selecting the desired fruit type, then the VM will display a selection of fruit types and the total to be paid will appear on the screen.

Users can also choose the desired payment method, cash, or non-cash. If the user chooses cash, then the user can enter cash, if the amount of money entered does not match the amount to be paid, then the user must choose cash payment again and enter the money again, and if the money entered is more than the system will issue change and receipts will come out, then the user can take the fruit.

Meanwhile, when the user selects a non-cash payment method, the VM system will activate the e-money tap and the user can paste the e-money card in the space provided, then the system will read the automatic payment from the e-money and the truck will come out, then user can pick up fruit.

3.3 Vending Machine Desain

The interface design for the fruit VN simulation application to be made is as shown in Figure 5.

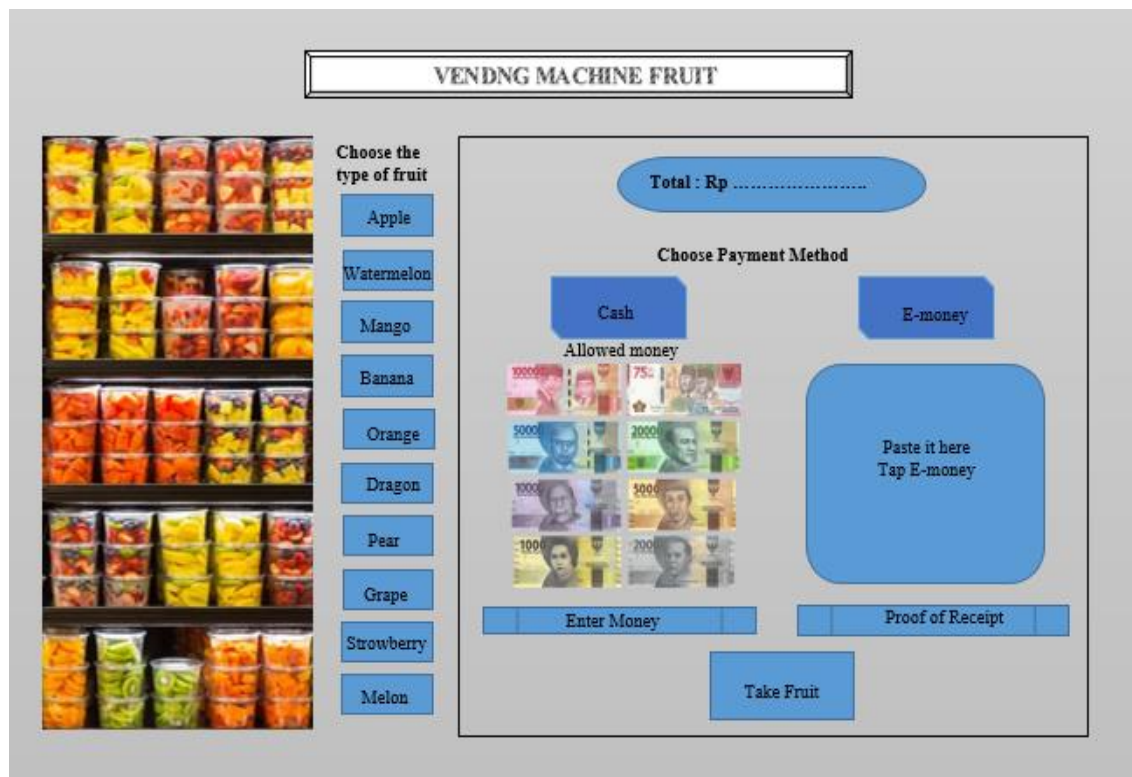


Figure 5. Vending Machine Interface Design

The first process carried out by the fruit VN shown in Figure 5 is to display the various types of fruit available in the VM with an average price of 10 thousand per fruit. Users can directly choose what type of fruit they want to buy, then the total price to be paid will appear, then the payment method will appear.

If the user chooses the cash payment method, the place to enter the money will be active with a light sign where the money is on, and the user can directly enter the type of money the machine receives. However, if the money entered is less than the total to be paid, then the user must enter the money back until the amount is appropriate, and if the payment exceeds the total, then the Machine will automatically return the change and proof of the fruit purchase receipt, then the machine will issue the fruit in its place.

Furthermore, if the user chooses a non-cash payment method, the e-money tap will light up so the user can paste the e-money card in its place and the machine will automatically read the total payment then the receipt will come out and remove the fruit in its place.

4. Conclusion

Based on the results of the FSA design made, it can be concluded that the use of non-deterministic finite state automata in the fruit vending machine design can be useful for users to maximize shopping time, especially fruit shopping, and can also be a factor in the lack of virus spread because it can avoid crowds. like in a traditional market. This fruit VM uses two cash and non-cash payment methods with e-money to make it easier for users to make payments as desired. Suggestions for future research are the development of VM, the addition of other non-cash payment features and e-money balance features.

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