



# Algorithm Analysis of Massage Robot Technology: The Use of Techniques and Their Movements on the User's Bodyi

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## ABSTRACT

Technology is now very advanced, many people are competing to create a renewable innovation, one of which is in the field of robotics. Robot is a technology whose main focus is to help ease the work of humans or maybe help in other things that can increase the efficiency of a job and can make human work more comfortable because it is assisted by robots. This time it will focus on massage robots or massage robots, robots that perform reflexology or therapy to human limbs. This article will make an analysis of the robot's work, how it works, the results of the algorithm, a discussion of the results, as well as other supporting materials that will be presented. What needs to be emphasized is how this massage robot has instructions or algorithms that can be executed so that he can complete the work, there are several massage robots that have continuous repetition, so that they end up being inefficient in their work, for that it is necessary to pay attention to the algorithm on the massage robot.

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## 1. INTRODUCTION

Technology in industry, transportation, information and other sectors is growing very rapidly. The Industrial Revolution has gone through several phases from 1978 as the first Industrial Revolution, to now the fourth Industrial Revolution (Luo & Hsieh, 2018; Hus et al., 2021). The Industrial Revolution has more or less affected various sectors of human life, as well as the Indonesian people.

Among the various sectors impacted by the fourth Industrial Revolution, health is one sector that has benefited from the merging of physical, digital and biological systems. This is reinforced by the results of a survey of 622 business leaders from various industries around the world by The Economist Intelligence Unit. This poll of business leaders shows that a significant majority of executives believe that healthcare is the sector that will benefit most from the impact of the fourth Industrial Revolution (Liu et al., 2019; Chen et al., 2019).

Research related to the implementation of technology in the health sector is generally still focused on overcoming dangerous diseases such as: cancer, diabetes, cholesterol and so on (Man et al., 2021; Jia et al., 2021). Meanwhile, the implementation of technology for handling other diseases that are not too dangerous such as aches and massages is still very limited. So that the implementation of technology related to massagers is one of the interesting things to research. One that is being developed in the health sector is the use of robots in various variations (Zhou et al., 2022; Su et al., 2021; Du et al., 2020).

Based on the way of controlling, robots are divided into 2 types, namely Controlled Robots and Autonomous Robots. Automatic robots usually operate in an environment with a certain boundary condition. One example of an automated robot is a soccer robot that is able to detect the ball and bring the ball to the goal automatically (Ticllacuri et al., 2020; Liu et al., 2020). In contrast to automatic robots, controlled robots have a simpler system because the system is more open and there is not much feedback information that must be processed. Controlled robots have a fairly wide variety.

The development of robots for medical purposes is indeed a challenge. Considering, procedures for medical purposes are stricter and more difficult than for other purposes (Jeong et al., 2021; Golgouneh et al., 2020). Several studies related to health care robots, among others, are related to the design of health care robot systems, analysis of the stability of the robot while moving, to the design of robots to monitor elderly patients with dementia. Robots for medical purposes are basically expected to play a role in improving the quality of health services for patients (Chen et al., 2018; Arezoo et al., 2021). This of course makes the challenge of developing robots for health purposes more difficult and complex

Technology is currently very developed, especially in the digital field such as social media, don't forget there is also a physical part such as robotics. Robotics that will be presented here are massage robots or massage robots. Massage robots are currently recommended for people who do heavy work or maybe for people who often sit for long periods in the office, thus requiring massage on achy limbs. There are various methods for the massage, such as hit mode (back and forth), there is also a walking mode such as using a wheel or other smooth movable tool (Fang et al., 2020).

The main purpose of this review paper, one of which is to find out several techniques for working on massage robots along with the algorithms that exist in automatic massage robots. When compared to the manual one, which is a massage tool that must go through human hands, then of course the automatic massage robot is superior because it is more flexible to use anywhere. However, it should also be noted that, apart from the fact that this massage robot is easier to use, the price is not cheap or quite expensive, especially with an All-in-one robot or one that can do everything, compared to a manual one by human hands. cheaper than automatic (Tanaka et al., 2020).

The algorithm of the automatic massage robot also needs to be considered, whether the robot has a complex algorithm that requires a long process or time or it can be shorter. The algorithm created can be in the form of a flowchart or in the form of other analyzes that involve time and space for working on an automatic massage robot.

## 2. RESEARCH METHOD

The method used is a qualitative method called Grounded theory, in which researchers can draw generalizations of what is observed/analyzed inductively, abstract theories about processes, actions or interactions based on the views of the participants being studied. This is because we need someone as an examiner as well as an assessor, whether what the massage robot does is appropriate or there is still something that needs to be corrected. Then from there a sample will be taken to be taken into consideration whether there is a need for modifications to the design or an existing system needs to be added. Of the several massage robot techniques carried out, the algorithms related to time and

space (space and time) will be compared where time can be effective and efficient, as well as space, namely memory or storage of instructions carried out.

Table 1. State of the art

Technique	Movement to the body	Algorithm Analysis	References
Hammer	Hammerhead on robot head	Best case : $O(1)$ Worst case : $O(n)$	Chen, H., Wu, X., Feng, W., Xu, T., & He, Y. (2016, August). Design and path planning of Massagebot: one massaging robot climbing along the acupuncture points. IEEE.
Pinching	Pinch on the robot's head	Best case : $O(1)$ Worst case : $O(-)$	Wang, W., He, L., Jiang, Q., Zhang, P., & Shi, Y. (2016, October). Path planning algorithm of a novel massage robot. IEEE.
Twirling	On the seated massage robot, vibrate	Best case : $O(n)$ Worst case : $O(n)$	Liu, Y., Zhou, P., Ma, B., Deng, D., & Wang, W. (2019, November). The Improvement in Design and Control of a Massage Robot on Human Back. IEEE.
Screwing	Human head	Best case : $O(1)$ Worst case : $O(n)$	Obokawa, Y., Solis, J., Ishii, H., Koga, H., Takanishi, A., & Katsumata, A. (2009, November). Clinical massage therapy with the oral-rehabilitation robot in patients with temporomandibular joint disorders. IEEE.
Pushing	Human back	Best case : $O(1)$ Worst case : $O(-)$	Zhu, W., & Wang, S. (2021, June). Design and realization of acupoint tapping massage system with three degrees of freedom based on STM32. IEEE.

a. Hammer

Hammer is a technique intended to affect the vegetative nerves in the tissues under the skin and look for or detect tissue abnormalities. The goal is to relax the tissue so that blood circulation and exchange of substances become good.

b. Pinching

Pinching is a pinching technique on a robot for the human back, in a massage manipulation technique in the form of a series of pinches on the superficial parts of the body tissue.

c. Twirling

A technique that performs small circular movements with a deeper emphasis. This movement is used in certain areas of the body such as calves, trapezium and others, with the aim of healing muscle tension and aches in the joints. To release the tense muscle can use a circular motion (small rotation).

d. Screwing

A technique that is like stabbing into the back, usually for people who often experience interference with people who often sit and stand for a long time.

e. Pushing

Massage manipulation technique by pressing small and deep on body tissues, to prevent and eliminate thickening and adhesion

### 3. RESULTS AND DISCUSSIONS

From the results studied, the next step is to look at the overall results whether the results given are in accordance with what is expected or there are still things that need to be developed again. For this reason, what distinguishes one technique from another is in

the instructions or algorithms carried out. How the robot works depends on the algorithm and also from the user for instructions, if the user does it many times without stopping then it can be said that the algorithm has  $O(\sim)$ , because it does not know when it will stop, as well as if the user is always in the wrong position the body that should be done, but because it continues to fail, it can't be determined when it will stop. For the case that has the best case and worst case equal to  $O(n)$ , it can be concluded that the work carried out by the robot cannot be done again after finishing the massage, but it is possible if it will be done again.

### 3.2 Discussion

The discussion obtained from the previous results, we can break down as below:

#### a. Hammer

For the first in the journal [1] page 972 with a flowchart algorithm drawing, what needs to be considered is the repetition part, this repetition can be completed, has a best case  $O(1)$  if it directly matches an input without going into iteration, then in the worst case is  $O(n)$ , because depending on the input it will repeat  $n$  times.

#### b. Pinching

For the second in the journal [2] page 1672 with a flowchart algorithm image, what needs to be noted is that it is more or less the same as the previous one, which has a best case  $O(1)$  algorithm because it could just go straight to branching without needing repetition, for worst case i.e.  $O(\sim)$  because on the flowchart it appears that there is no value that will break the repetition or rather just a question whether it has or not, so it cannot be determined when it will stop.

#### c. Twirling

For the third in the journal [3] page 479 with a flowchart algorithm image, what needs to be considered is the repetition, this repetition can be completed, has a best case  $O(n)$  because it must repeat and cannot be completed without repetition, then in the worst case it is  $O(n)$  too, because depending on the input it will repeat  $n$  times.

#### d. Screwing

For the fourth in the journal [4], the 3rd sheet with a flowchart algorithm drawing, has a best case algorithm  $O(1)$  because it could just go straight to the branch without the need for repetition, for the worst case it is  $O(\sim)$  because the flowchart looks not there is a value that will break the loop or rather just a question whether it has or not, so it can't be determined when it will stop.

#### e. Pushing

For the fifth in the journal [5] page 521 with a flowchart algorithm image, which has a best case algorithm  $O(1)$  because it could just go straight to the branch without the need for repetition, for the worst case it is  $O(\sim)$  because on the flowchart it looks like there is no a value that will break the loop or rather just a question whether it has or not, so it can't be determined when it will stop and when it will exit.

## 4. CONCLUSION

In this section, we will explain why algorithmic complexity is important. As is known, in a program or a technology it usually uses an algorithm or instructions, in this case the massage robot of course has an algorithm to do or execute commands to perform a massage. From these massages, this massage robot has different techniques, in each paper it will be shown whether each robot made has the appropriate algorithm or instructions or at least has a good enough best case, one of which can at least stop the massage robot, because the massage robot may move continuously or perform a loop or repetition which results in inefficient work on the massage robot, for that it is necessary to have a counter or value that will create a repetition or loop to exit or stop because of the counter.

The massage techniques performed by a robot are nothing more or less, that is, more or less the same as what humans do in general, the difference being that one is from a machine and one from a human. Humans have a time limit on when to stop a massage, when to change massage techniques. For robots, there are those that are as expected, there are also those that can't be said to be good enough in the process, for the good ones, namely at least the robot can stop, no repetition occurs or can complete the work, for the less good part, there are also papers. which does not make the robot stop or rather will be done repeatedly until finally it becomes inefficient in carrying out an instruction. In the flowchart presented by the existing papers, it is indeed necessary for programmers or ordinary people to know what the instructions are on the massage robot, of course this is very important considering that not everyone immediately knows how this robot works, and it is possible that lay people may need professional help to run this robot, for that it is necessary to have additional manuals or instructions to provide assistance or direction to lay people for how to run this massage robot.

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