

# Improving Knowledge of Line Follower Robots at SMP Muhammadiyah 1 Godean

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## ABSTRACT

Robotics is one of the fields of study that is closely related to several other subjects such as mathematics, science, and technology. Studying robotics will obviously be very beneficial for students. There is no exception for students of SMP Muhammadiyah 1 Godean who do not yet have a curriculum or extra-curricular about robotics. One of the efforts to increase knowledge about robotics, especially line follower robots, is a training on how to assemble and test the robot. In collaboration with the service team from the University of Muhammadiyah Yogyakarta, the training activities were carried out with 30 students from grade 7. In this training, 10 line follower kid robots were used and a track field for the arena to test the success of the assembly. In this activity, a pre-test was carried out with an average result of 43% of participants who answered correctly. At the end of the training, a post-test was conducted with the average result of participants who answered correctly as much as 90%. It can be concluded that there is an increase in knowledge about robotics by the participants by 47%.

## KEYWORDS

Robotics;  
line follower;  
SMP Muhammadiyah 1 Godean



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## 1. Introduction

Robotics is a branch of technology that deals with the design, construction, operation, structural disposition, manufacture and application of robots. By learning robotics, students can apply the knowledge learned in these subject areas. Robotics can be an effective way for teachers to teach science, IT, and mathematics. Robotics provides an opportunity for students to connect the lessons they have learned into a productive technology in the present and the future. Studying robotics will obviously be very beneficial for students, because it can increase their creativity and imagination which is then poured into a real work in the form of a robot. In addition, robotics also trains a structured way of thinking and solves a problem accurately. By introducing robotics to students, it is one way for us to create a better next generation. One of the robotics technologies that is widely used is the line tracer robot or more commonly called the line tracer robot or line follower. Several previous researchers have conducted research on autonomous robots that are used for this community service reference. Cameras, LiDAR, and Multi-modal SLAM Systems for Autonomous Ground Vehicles: A survey researched by Chghaf [1]. Testing based on an autonomous robot model using TestIt was researched by Kanter [2]. The use of UV-C disinfection robots in routine cleaning processes: a field study in an Academic hospital researched by Astrid [3]. Automatic identification and autonomous sorting of cylindrical sections in a cluttered scene based on 3D reconstruction of monocular vision was investigated by Wei [4]. CircuitBot: Learn to survive by drawing robot circuits researched by Tan [5].

Monitoring of the sea-ice-atmosphere interface near arctic tidal glaciers: A contribution to ocean robotics research by Bruzzone [6]. Short-range Lidar SLAM utilizing monocular localization data was investigated by Nakamura [7]. Stock visibility for retail using RFID robots was researched by Morenza-Cinos [8]. Sample-based integration of unmanned aerial vehicle air traffic, path planning, and collision avoidance was investigated by Sababha [9]. Robot Architecture for Outdoor Competitions was researched by de Oliveira [10]. A self-oscillating photonable system driven by a self-winding fiber actuator was investigated by Hu [11]. Automatic vector-based mapping of road structures using multibeam LiDAR was investigated by Zhao [12]. The flock deformation frequency response with

control barrier function was investigated by Origane [13]. Enhancing Autonomous Exploration Using Estimate-Reduced Common Voronoi Charts was researched by Li [14]. Remote management system for echinococcosis control and surveillance: design and implementation based on internet of things researched by Yang [15]. Untethered microgripper—a dexterous hand at the micro scale was studied by Yin [16]. Remote vascular interventional surgical robotics: A review of the literature researched by Zhao [17]. The TRIPLE/nanoAUV Initiative is a technology development initiative to support the astrobiological exploration of marine worlds studied by [18]. Active robotic technology for total knee arthroplasty was investigated by Stulberg [19]. Selective image registration for efficient visual SLAM on planar surface structures in underwater environments was investigated by Hong [20].

What if there is no return visit? Large-scale graphic-based SLAM with traffic sign detection on HD maps using LiDAR inertial odometry was investigated by Sung [21]. The realization of CUDA-based real-time multi-camera visual SLAM in embedded systems was investigated by J. Li [22]. Evolutionary Modular Robotics: Survey and Analysis was researched by Alattas [23]. When robots contribute to combating the spread of COVID-19 in the context of containment was investigated by Houacine [24]. Deep Reinforcement Learning for Humanoid Robot Behavior was researched by Muzio [25]. The Retribution Gap and the Locus of Responsibility Associated with Robots and Automated Technologies: Replies to Nyholm was researched by de Jong [26]. Fully Autonomous Aerial Robots for Search and Rescue Applications in Indoor Environments using Learning-Based Techniques was researched by Sampedro [27]. A new solution with fast Voronoi-based coverage path planning in disordered environment for robot cutting system was investigated by Huang [28]. Autonomous Curvilinear Motion Simulation of Robotic Towing System was studied by [29]. A hybrid model-based and data-based wind speed estimator for autonomous robotic aircraft was investigated by Marton [30]. Optimizing Robotic Pool Cleaning with Genetic Algorithm was researched by Batista [31]. Freshwater organisms potentially useful as biosensors and power generation mediators in biohybrid robotics were studied by Rajewicz [32].

A Visually Encoded Contact Inspection System for EMAT was researched by Yung [33]. Deep learning-based estimation of monocular placental poses: towards collaborative robotics in fetoscopy was investigated by Ahmad [34]. A particle swarm optimization approach using adaptive entropy-based fitness quantification of expert knowledge for high-level real-time cognitive robotic control was investigated by de Jager [35]. Valley of the Morals: A Robot's Appearance Moderates How His Decisions Are Judged was researched by Laakasuo [36]. Can Robotic AI Systems Be Virtuous and Why Is This Important? studied by Constantinescu [37]. Active asteroid-SLAM researched by Nakath [38]. A mind model for intelligent machine innovation using future thinking principles was researched by Botha [39]. Influencing leads and follows in a human-robot team was researched by Li [40].

SMP Muhammadiyah 1 Godean is a private educational institution based on religion. All students of SMP Muhammadiyah 1 Godean up to now total 520 students, consisting of 5 classes in 7th grade, 5 classes in 8th grade and 5 classes in 9th grade, and has 32 teachers. Currently, Muhammadiyah 1 Godean Middle School uses the 2013 Curriculum. There are no subjects related to robotics in the curriculum, nor are extracurriculars. This is because they do not yet have instructors in the field of robotics and are constrained by costs when applied as extra curriculars. While the knowledge of robotics itself is generally known by all students of this school, at SMP Muhammadiyah 1 Godean, it is very rare to get additional knowledge about robotics. Considering that in the industrial era 4.0, almost all industries have used robot technology as a work aid, students need to be introduced and given additional understanding so they are not left behind when entering the industrial world. In order to increase knowledge, especially knowledge of robotics, students of Muhammadiyah 1 Godean Middle School, it is necessary to hold robotics training. The training provided is specifically about analog line follower robots, namely robots with the ability to follow lines on a track. In order to realize this training activity, the UMY service team contributed facilities by presenting robotics practitioner resource persons, 10 line follower robot kids and a line follower robot trial arena. Robotics extracurricular activities have a positive impact on the creative thinking skills of elementary school age students. In addition, studying robotics is related to mathematics, physics, science and technology, and computers and programming. This robotics training activity can provide deeper learning opportunities regarding basic programming. Programming knowledge is an important skill for children who grow up in this technological age. The output of this activity is: the designed robot product.

## 2. Method

This section describes the methods used in implementing the community service program.

### 2.1. Proposed Planning

At this stage a service team was formed consisting of 3 lecturers from the Electrical Engineering Study Program and 2 electrical engineering students from the Faculty of Engineering, University of Muhammadiyah Yogyakarta (UMY). The service team then determines the service scheme and partners.

### 2.2. Analysis of Partner Needs and Preparation of Proposals

After the team is formed, it starts with discussions with potential partners related to the problems faced, the solutions offered include the preparation of activity schedules, and agreements that are willing to become partners in this community service program. The next step is to prepare a service proposal for the Yogyakarta Muhammadiyah University through the Community Service Institute with the Muhammadiyah Service scheme

### 2.3. Program Implementation Stage

The preparatory stage is in the form of FGDs with partners to discuss the time, place, facilities and infrastructure needed in community service activities. The next stage is the preparation of training materials, namely material (ppt), LF robot module/kid, robot arena/track, assembly and operation guide.

### 2.4. Program Evaluation

The service party evaluates the service activities that have been carried out through input obtained from partners through the pre test and post test, to measure the level of student understanding regarding the material provided. Apart from that, it is also to find out the deficiencies in this activity that can be corrected and can be used as material for consideration in carrying out the next service activity.

## 3. Results and Discussion

The community service activities carried out by the team with SMP Muhammadiyah 1 Godean partners were carried out on Saturday, March 19 2022 with the following stages.

### 1. Preparation

#### a. Forum Group Discussion (FGD)

Preparation begins with FGD activities to coordinate with partners, namely the Principal and academic staff who are in charge of training activities. This FGD (Forum Group Discussion) took place at the office of the principal of SMP Muhammadiyah 1 Godean and took place on March 11, 2022. In the forum discussed material, budget, time, implementation techniques, location, infrastructure, consumption, and others. The partners provide the place, infrastructure, and training participants, while the Community Service Team prepares the rest. The FGD activities are shown in Figure 1. The figure shows that the service team is discussing with representatives from the school



**Fig. 1.** FGD with the Principal

## b. Preparation of Training Materials

In preparation for the implementation of community service activities, materials are prepared including training material, assembly and operation guides, kid robot line follower and robot arena/track. The line follower robot is shown in Figure 2. The figure shows that there are 10 line follower robots.



**Fig. 2.** Line follower robots

## 2. Implementation of Training

The community service activity was held on Saturday, March 19, 2022 in the Godean 1 Muhammadiyah Middle School Building with 30 students as participants shown in Figure 3. The figure shows that the participants are grade 7 students who rank 1-5 in each class. The activity took place from 08.00 to 13.30 while still implementing the health protocol. The activity was opened by the Principal, Mrs. Ovayagori Rahman, S.Pd.



**Fig. 3.** Partner's Remarks

The welcome from the Service Team is represented by the Team Leader, shown in Figure 4. The figure shows that the participants are paying serious attention



**Fig. 4.** Speech by the Leader of the Service Team

The activity begins with giving the pre-test to the training participants as shown in Figure 5. The pre-test questions consist of knowledge about robotics and its supporting components. The next activity is delivering material about line follower robots.



**Fig. 5.** Submission of material

After delivering the training material, the activity continued with the practice of assembling the line follower robot that had been prepared by the team as shown in Figure 6. From the figure, it can be seen that before the practice was carried out, the participants were first given instructions on how to assemble the robot. There are 10 kids provided, each kid is done by a group of 3 people. In this practical assembly activity, students can ask the team if there are any problems. Practice assembling a line follower robot



**Fig. 6.** Practice assembling robots

After all the robots have been collected, the next activity is testing the line follower robot on the track, shown in Figure 7.



**Fig. 7.** Testing the Robot on the track

At the end of the activity, a handover ceremony was held in the form of 10 kid robot line followers and their trajectories are shown in Figure 8. The handover was carried out by the head of the service team and was received by the Principal of SMP Muhammadiyah 1 Godean, witnessed by all participants. Goods handover process.



**Fig. 8.** Handover of Kid Robot LF

The service activity ends with a joint photo session between the service team and partners, shown in Figure 9.



**Fig. 9.** Group photo of Team and Partners

### Identify the Headings

#### Evaluation

In this service activity to find out the increase in knowledge about robotics, especially the line follower, a pre-test and post-test were carried out. The pre-test results are shown in table 1. The table shows that the Average Correct Answer 13 is 43% and the Wrong Answer 17 is 57%.

**Table 1.** Pre-Test Results

| Question No. | Pre-Test Question  | Results Answers from 30 students |    |              |    |
|--------------|--|----------------------------------|----|--------------|----|
|              |  | Correct Answer                   | %  | Wrong Answer | %  |
| 1            | Is it necessary for the Line Follower Robot to follow the line on the arena? (Answer Key: a) | 17                               | 57 | 13           | 43 |
| 2            | Components that function to inhibit and regulate the electric current? (Answer Key: b)       | 10                               | 33 | 20           | 67 |
| 3            | The component used as a rectifier is ? (Answer Key: a)                                       | 8                                | 27 | 22           | 73 |
| 4            | To be able to rotate the wheel of the Line Follower Robot,                                   | 19                               | 63 | 11           | 37 |

| Question No.   | Pre-Test Question   | Results Answers from 30 students |    |              |    |
|----------------|---|----------------------------------|----|--------------|----|
|                |   | Correct Answer                   | %  | Wrong Answer | %  |
|                | what is needed? (Answer Key: a)   |                                  |    |              |    |
| 5              | The source of energy for the Line Follower Robot so that it can run or function is? (Answer Key: c) | 16                               | 53 | 14           | 47 |
| 6              | Which of the following components functions as a regulator? (Answer Key: a)                         | 8                                | 27 | 22           | 73 |
| 7              | Components used to disconnect and connect the flow of electricity is? (Answer Key: c)               | 13                               | 43 | 17           | 57 |
| <b>Average</b> |   | 13                               | 43 | 17           | 57 |

From the table 1 is shown that the average number of correct answers was made by 13 participants (43%) while the average number of wrong answers was made by 17 participants (57%). Meanwhile, the post-test results showed an increase in the number of participants who answered correctly as shown in Table 2. The table shows that the Average Correct Answer 27 is 90% and the Wrong Answer 3 is 10%.

**Table 2.** Pre-Test Results

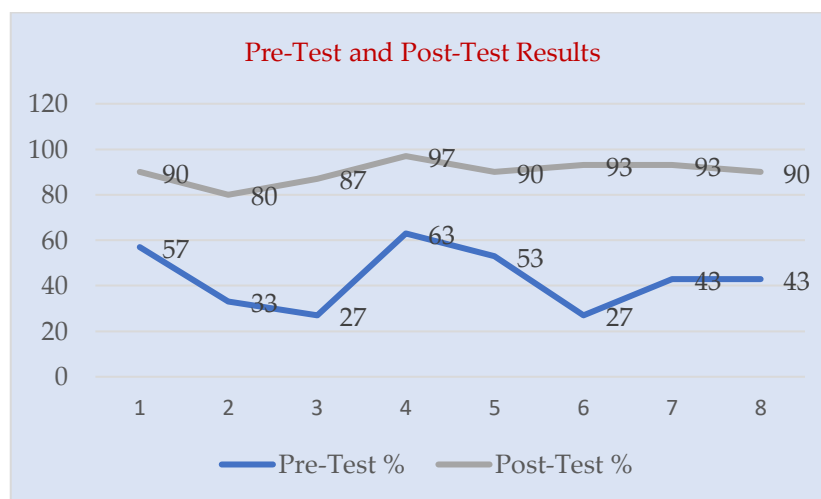
| Question No.   | Pre-Test Question   | Results Answers from 30 students |           |              |           |
|----------------|---|----------------------------------|-----------|--------------|-----------|
|                |   | Correct Answer                   | %         | Wrong Answer | %         |
| 1              | Is it necessary for the Line Follower Robot to follow the line on the arena? (Answer Key: a)        | 27                               | 90        | 3            | 10        |
| 2              | Components that function to inhibit and regulate the electric current? (Answer Key: b)              | 24                               | 80        | 6            | 20        |
| 3              | The component used as a rectifier is ? (Answer Key: a)  | 26                               | 87        | 4            | 13        |
| 4              | To be able to rotate the wheel of the Line Follower Robot, what is needed? (Answer Key: a)          | 29                               | 97        | 1            | 3         |
| 5              | The source of energy for the Line Follower Robot so that it can run or function is? (Answer Key: c) | 27                               | 90        | 3            | 10        |
| 6              | Which of the following components functions as a regulator? (Answer Key: a)                         | 28                               | 93        | 2            | 7         |
| 7              | Components used to disconnect and connect the flow of electricity is? (Answer Key: c)               | 28                               | 93        | 2            | 7         |
| <b>Average</b> |   | <b>27</b>                        | <b>90</b> | <b>3</b>     | <b>10</b> |

Table 2 shows that the average number of participants who answered correctly was 27 participants (90%), while the average number of participants who answered incorrectly was 3 participants (10%). To find out the increase in participants' knowledge and understanding in participating in the training, a comparison of the results of the pre-test and post-test was carried out as shown in Table 3.

**Table 3.** Comparison of Pre-Test and Post-Test Results

| Question No.   | Pre-Test Question   | Results Answers from 30 students |           |           |           |
|----------------|---|----------------------------------|-----------|-----------|-----------|
|                |   | Pre-Test                         | %         | Post-Test | %         |
| 1              | Is it necessary for the Line Follower Robot to follow the line on the arena? (Answer Key: a)        | 17                               | 57        | 27        | 90        |
| 2              | Components that function to inhibit and regulate the electric current? (Answer Key: b)              | 10                               | 33        | 24        | 80        |
| 3              | The component used as a rectifier is ? (Answer Key: a)  | 8                                | 27        | 26        | 87        |
| 4              | To be able to rotate the wheel of the Line Follower Robot, what is needed? (Answer Key: a)          | 19                               | 63        | 29        | 97        |
| 5              | The source of energy for the Line Follower Robot so that it can run or function is? (Answer Key: c) | 16                               | 53        | 27        | 90        |
| 6              | Which of the following components functions as a regulator? (Answer Key: a)                         | 8                                | 27        | 28        | 93        |
| 7              | Components used to disconnect and connect the flow of electricity is? (Answer Key: c)               | 13                               | 43        | 28        | 93        |
| <b>Average</b> |   | <b>13</b>                        | <b>43</b> | <b>27</b> | <b>90</b> |

Table 3 shows that the average number of participants who answered correctly during the pre-test was 13 participants (43%) while the average participant who answered correctly during the post-test was 27 participants (90%). The following graph compares the results of the pre-test and post-test for those who answered correctly, shown in Figure 10.



**Fig. 10.** Pre-Test and Post-Test Results

From Figure 10 it can be seen that there is an increase in knowledge/understanding of robotics based on the results of the pre-test and post-test, namely 47%.

#### 4. Conclusion

From the community service activities that have been carried out at SMP Muhammadiyah 1 Godean, it can be concluded as follows. The activity has been completed followed by 30 students. The results of the Pre-Test showed that the average number of participants who answered correctly was 13 participants (43%) and the average wrong answer was 17 participants (57%). The results of the Post-Test showed that on average 27% of participants (90%) answered correctly and the average number of incorrect answers was 3 participants (10%). Based on the results of the Pre-Test and Post-Test, it was shown that knowledge about robotics, especially the Line Follower (LF) increased by 47%.

#### Acknowledgment

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#### Author Contribution

The activity plan to introduce line follower robots was carried out with 30 students from grade 7. In this training, 10 line follower robots were used and a track area for the arena to test assembly skills.

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#### Conflict of Interest

The authors declare no conflict of interest.

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