Robot learning module for elementary school students based on wheel robots

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ABSTRACT

Robotics is a very complex science, so as to introduce the science of robotics to kindergarten and elementary students which will be presented in a way that is easily understood by children. The science of robotics that is easily understood by children is logic as it is introduced in the form of robotic movements forward, backward, turn right, turn left, and others. With the above background, this paper contributes to creating a media that facilitates the learning of elementary school students to make logical robot programmers and download programs to the microcontroller. Logic robotics learning modules used for elementary school children must be easy to use and easy to understand. This learning module uses the AT89S51 microcontroller and Borland delphi visual programming. This module is a very easy lesson, so students can run robot application programs. Applications such as program robots include figures such as the distance the robot travels forward, backward distance, distance, and distance left. After entering the number, then compile the program and enter the program into the mobile robot.

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1. INTRODUCTION

Elementary school students are one of the groups who mostly like robots. For this reason, the introduction of robots for elementary school students is delivered in a way that is easily understood by children, such as introducing the robot to move forward, backward, turn right, turn left, and so on. In order to be easy to understand, a learning media is needed that makes it easier for elementary school students (elementary schools) to make programs to download programs to the microcontroller. The emergence of mechatronics in the form of a robot as a form of implementation has penetrated into the world of education. Several previous researchers have conducted research on educational robots. Educational Robotics as a boundary object was investigated by Malinverni [1]. Educational Robotics for children with neurodevelopmental disorders: A systematic review researched by Pivetti [2]. Data on the involvement of robotic students in a synchronous-hybrid course was investigated by Lei [3]. SEPT Learning Factory for Industry 4.0 Education and Applied Research was researched by Elbestawi [4]. An open source anthropomorphic robot for children was investigated by Lupetti [5].

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One of the robots used as learning media is a mobile robot. This simple mobile robot is designed simply to be driven by a DC motor using battery power. Mobile robots have been widely studied by robot researchers. Planning and control of autonomous mobile robots for intralogistics: Literature review and research agenda researched by Fragapane [26]. A survey on modularity and distribution in series-parallel hybrid robots was investigated by Kumar [27]. Kinematics-based four-state trajectory tracking control of a spherical mobile robot driven by a 2-DOF pendulum was investigated by LI [28]. The localization of moving robots for inspection of bridge bearings was investigated by Peel [29]. Reciprocal visibility by a non-collision glowing robot studied by Di Luna [30]

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Operator - mobile robot collaboration for synchronized part movement was investigated by Ramasubramanian [36]. A New Approach for Beacon-Based Mobile Robot Localization using Kalman Filter was investigated by Moreira [37]. A mobile robot for marking free access floors at construction sites was investigated by Tsuruta [38]. The analysis and use of fuzzy intelligent techniques for humanoid robot navigation in obstacle-prone zones was investigated by Rath [39]. Integrating Correlation Acquisition with Location Optimization for Accurate Positioning of Indoor Light Wave Robots was researched by Liu [40].

The design and motion analysis of a reconfigurable wheel-legged mobile robot was investigated by Zhang [41]. A flexible robotic teleoperation architecture for intelligent oil fields was investigated by Caiza [42]. Review: Path planning strategy for mobile robot navigation was investigated by Patle [43]. Control of Hilare Robot Based on Speed Constrained Stepper Motor for Waypoint Navigation was investigated by Mathew [44]. A lightweight and inexpensive robotic system for insect vision was investigated by Sabo [45]

The membrane computing framework for social navigation in robotics was investigated by Pérez-Hurtado [46]. The hybridization of IWO and IPSO for mobile robot navigation in a dynamic environment was investigated by Panda [47]. The application of a vision system to a mobile robot navigation using markers was investigated by aganowska [48]. Reset-Free Trial-and-Error Learning for Robot Damage Recovery was investigated by Chatzilygeroudis [49]. Robotic soil measurements of aeolian processes were investigated by Qian [50]. To control the movement of the robot using a microcontroller. So that the robot can move according to the wishes of the microcontroller user, it is filled with the program that has been

made. Downloader is an electronic circuit that is used to transfer programs from a computer to a microcontroller.

This paper contributes to creating a robotics logic learning module that is used for elementary school children to be easy to use and easy to understand. With this learning module, students can run the application, enter a number stating the number of wheel turns into the input based on the direction (forward, backward, right, and left), then compile the program and enter the program into the mobile robot. The problem is how to make a robotics learning module for elementary school students so that they can make a robot program just by entering input into a learning application module to filling the program into the microcontroller on the mobile robot.

2. METHODS

The research procedure in question is the procedure for achieving the research targets as written in the research objectives. The procedure for this research is shown in Figure 1. The figure shows that before starting the research, the research objectives are first determined. The contribution target is expected to be able to design learning robots for elementary school students.

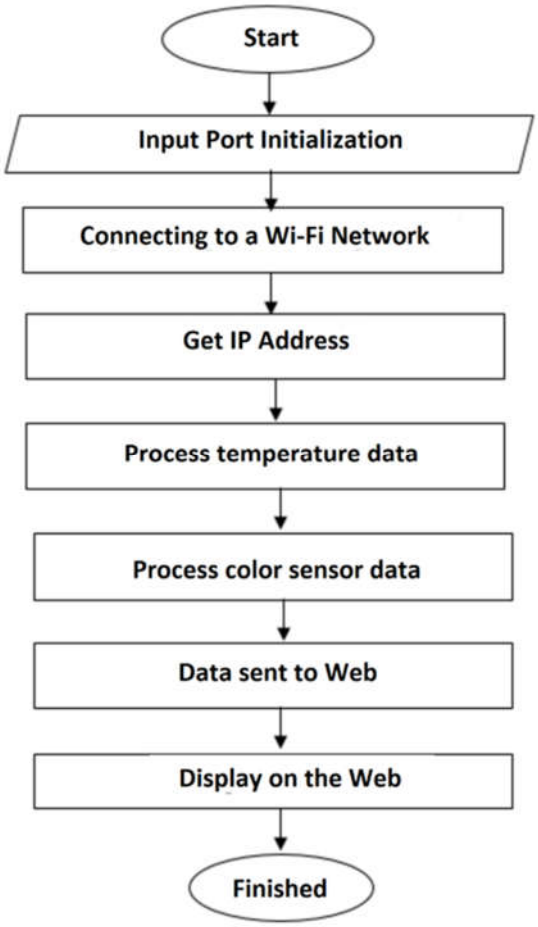


Fig. 1. Research Procedure Flowchart

2.1. Needs Analysis

In the limitation of the problem, it is stated that the application can create a program so that the movement of the robot can run in the desired direction and step. So based on the limitation of the problem, the basic requirement for the system to be made is that the application can be inputted with numbers to determine the robot's steps according to the direction. Applications can save files with the extension c. Applications can enable the compiler program (SDCC) to convert c files into hex files. The application can activate the progisp program which functions to transfer .hex files to the microcontroller with the help of a downloader. Optocoupler sensor which serves to regulate one step and regulate the turning motion of the

robot. The use of a microcontroller that functions to store commands so that the robot can move according to the input in the application. Sending the program to the microcontroller can use a USB connection so it is easy to use.

2.2. Initial Specifications of the Tool

The components of the learning robot system are shown in table 1. The table shows that the robots built include software and hardware. In general, this system has the following specifications, namely the sensor components are optocoupler, DC motor control components, DC motors, microcontroller system components, Delphi as GUI (Graphical User Interface).

Table 1. Component

No	Component Name	Specification
1	Power supply	11.1 Volt Battery
2	Wheel drive	7.2 Volt DC Motor
3	Rotation sensor	optocoupler
4	Software	Delphi 7

2.3. Tool Design

The block diagram of the system that will be made is shown in Figure 2. The figure shows that the microcontroller on the robot is programmed using a PC or laptop using a USB downloader. To drive a DC motor, a DC motor is connected to the microcontroller. The optocoupler is used to read the wheel rotation. The optocoupler data is read by the microcontroller.

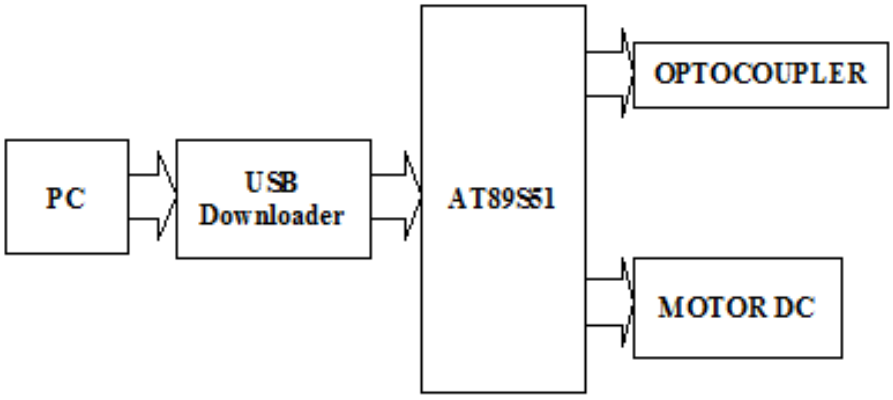


Fig. 2. System block diagram

The tool designed consists of two main parts, namely a Personal Computer (PC) for software development and a mobile robot for learning robot movement practices.

2.3.1. Personal Computer (PC)

The PC functions to transmit data that is used to control the running of the mobile robot. The program from the PC is sent to the microcontroller via USB Downloader.

2.3.2. Mobile Robot

In the mobile robot section, there are several components, namely USB Downloader which is used as a communication tool between the PC and the mobile robot. The AT89S51 microcontroller is a minimum system circuit of the ATMEL type microcontroller which functions to control the mobile robot. An optocoupler is an encoder circuit that functions to control the number of rotations of a DC motor. The motor driver is a DC motor driver circuit that functions to control a DC motor.

2.4. Software

The software needed as a control unit (microcontroller) operation command based on the program created through the learning module application is shown in Figure 3. The figure shows that various types of programming languages can be used to create applications on the microcontroller, including assembler language, C and C++. . While the software used by the PC as an interface to enter values which are then sent to the microcontroller is Borland Delphi 7.

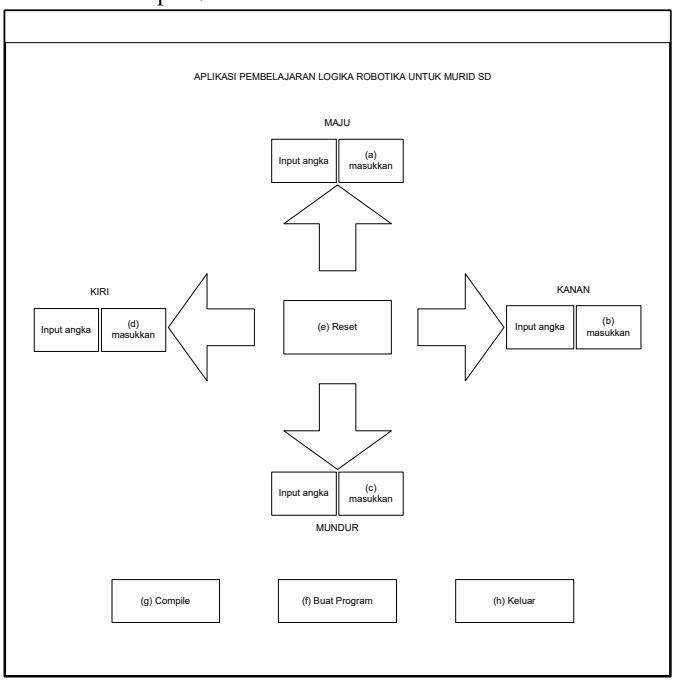


Fig. 2. Application interface design

The following is an explanation of Figure 3 buttons on software design. Enter button, serves to enter the number forward that has been entered in the number input field. Enter button, serves to enter numbers to the right (turn right 90o) that has been entered in the number input field. Enter button, serves to enter numbers backwards that have been entered in the number input field. Enter button, serves to enter numbers to the left and right (turn left 90o) that has been entered in the number input field. Reset button, serves to clear all number input boxes and memo boxes. Create program button, serves to display the script program c in the memo column according to the numbers and directions entered. The compile button, serves to save the script that has been displayed in the memo column to form a file c. Then the c file is compiled into a hex file. After the process is complete, the PROGISP software will appear to enter the hex file into the microcontroller on the robot. Exit button, serves to exit the application.

Apart from the above, there are several hidden components in the software which are shown in Figure 4. The picture shows that the edit text, main menu, save dialog and memo are not displayed on the application menu. The hidden component is an auxiliary component. When the application is run the auxiliary component does not appear. The following is an explanation of the auxiliary components shown in Figure 4. Edit text forward direction, serves to display the number 1 when the enter button is pressed. Edit text towards the right, serves to display the number 2 when the enter button is pressed. Edit text backwards direction, serves to display the number 3 when the enter button is pressed. Edit text towards the left, serves to display the number 4 when the enter button is pressed. Edit text, serves to display a combination of edit text according to the direction. For example, if we want to move forward and backward, the number 13 will appear (1 = forward and 3 = backward). The purpose of this text edit is to distinguish the combination of robot motion directions because each one or two directions uses a different c program. Save dialog, serves to save the script program that appears on the memo. Files are saved in the form of files with the extension c. Main menu, serves to create a menu at the top of the menu instructions and profiles. In the instructions menu there are three sub menus namely software, hardware, and usage. Memo, serves to display the program script according to the input steps and directions. The script will appear after pressing the Create Program button.

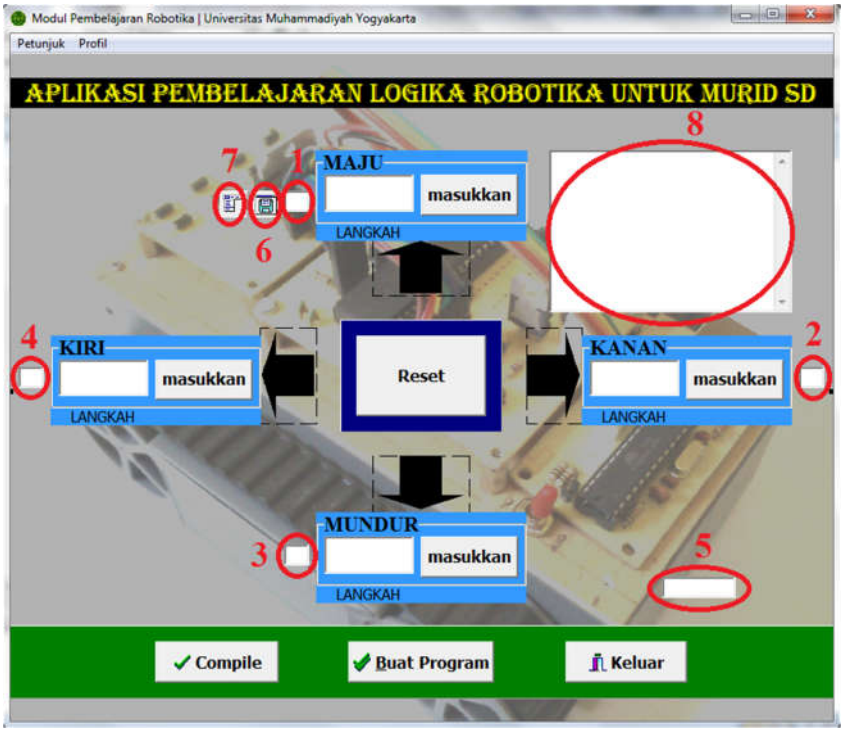


Fig. 3. Auxiliary components

3. RESULTS AND DISCUSSION

3.1. Ways of working

Below is a block diagram of how the tool works. When the system is first turned on, elementary students turn on the personal computer and then run the application. After the application appears, the user (student) enters input in the form of numbers in the provided columns based on the direction of the robot. The numbers entered in the application indicate the number of steps or the number of revolutions of the robot's wheel.

If entering numbers has been completed, the user will press the "create program" button. This button will create a file in c format, which contains program scripts in C language form. To compile the c file using the SDCC software. The compile button in the application functions to compile the c file into a hex file which will later be downloaded to the microcontroller using the downloader. After completing the process of downloading the hex file to the microcontroller, the robot is ready to run and will run the command according to the input in the application by elementary students. For tutorial instructions for use, please see the attachment.

3.2. Application display test

Applications are made using the Delphi program. Applications that have been created are then compiled so that they can be formed into a setup file so that the application can stand alone without depending on the Delphi program. In this test, it is done using a Personal Computer (PC) or laptop. The application can be said to run well if the input and direction of the robot made by the application are in accordance with the direction of movement and steps of the mobile robot.

The most important thing in the application is how the application forms a c file based on the input steps and directions of the robot. Suppose we want the robot to move forward by 1 step, then enter the number 1 in the forward direction then create a program.

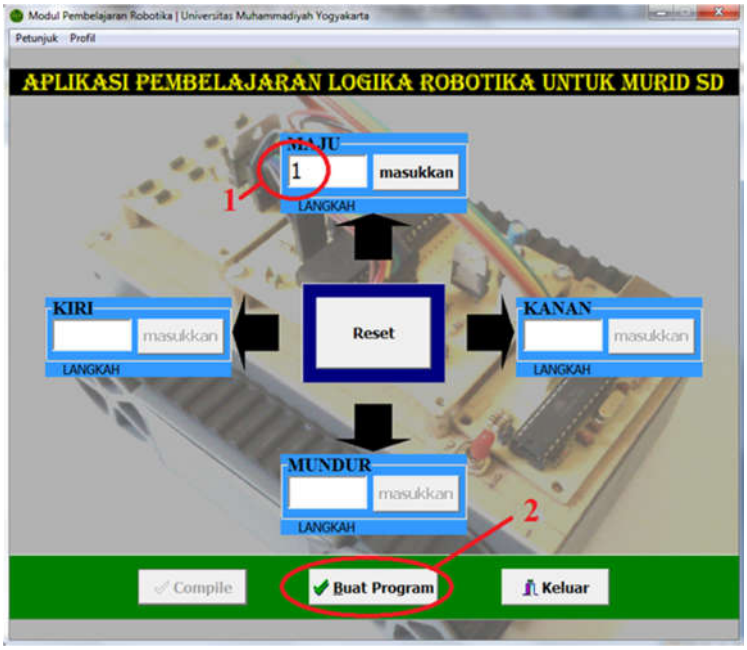


Fig. 3. Application display

3.3. Robot movement test

The robot movement made is one-way and two-way combination. Robot movement includes forward motion, backward motion, turn right and turn left. While the robot steps from one step to five steps. The distance of the robot's steps is shown in table 2. The table measures each step of the robot's movement, where 1 step gets a distance of 33.4 cm.

Table 2. Robot Step Distance

Step	Movement distance (cm)
1	33,4
2	66,9
3	97,8
4	132,7
5	165,6

The accuracy of the robot's movement is measured and shown in Table 3. The table shows that the expected forward and backward movement is 0o. However, it has a value of 2 for the forward test results and 1.75 for the backward test results.

Table 3. Robot movement accuracy

Movement	Accurate (expected)	Test result
Proceed	0	2o
Back off	0	1,75o
Turn right	90	85o
Turn left	90	95o

The robot mohvement experiment is measured and displayed in table 4. The table contains 16 trials namely Forward, Backward, Right, Left, Forward and turn right, Forward and backward, Forward and turn left, Turn right and forward, Turn right and backward, Turn right and turn left, Back and forward, Back and turn right, Back and turn left, Turn left and forward, Turn left and turn right, and Turn left and back. All 16 moves have been Ok done.

Table 4. Robot movement experiments

No	Movement Experiment	Results

1	Proceed	Ok
2	Back off	Ok
3	Right	Ok
4	Left	Ok
5	Go forward and turn right	Ok
6	Forward and backward	Ok
7	Go forward and turn left	Ok
8	Turn right and go forward	Ok
9	Turn right and back	Ok
10	Turn right and turn left	Ok
11	Back and forward	Ok
12	Back off and turn right	Ok
13	Back off and turn left	Ok
14	Turn left and go forward	Ok
15	Turn left and turn right	Ok
16	Turn left and back	Ok

3.4. System Validation

In system validation, testing or checking the operation of the tool as a whole is carried out. This validation is carried out to prove that all components and program functions are as expected. This check is done in two ways, namely checking software and checking hardware.

Checking the software is done by checking the application whether the input entered in the application is in accordance with the robot's movement, in addition to whether the buttons available in the application can work according to their functions. Hardware checking is done by checking the battery, control circuit and motor driver, and checking whether the optocoupler is working properly in calculating the rotation.

If the software and hardware meet the requirements, it can be concluded that the Robotics Logic Learning Application Module for Elementary School Students can be considered valid and suitable for use as a learning module for elementary school students.

A survey of 20 elementary school students, five grade 4 students, ten grade 2 students and five grade 1 students using observation sheets, related to learning methods or delivery of material, content, and skills, only 95% of respondents prefer robotics extracurricular education, 5% of students don't like it. Robotics logic learning is preferred by all elementary school students because of the attractive appearance of the program. Elementary students prefer a colorful display. The use of learning programs and modules is very easy, so elementary school students can use them at home accompanied by their families.

4. CONCLUSION

After completing the making of the tool and conducting the experiment, conclusions can be drawn. The robotics logic learning module fulfills the constructivist learning process and is presented with interactive learning materials. The working principle of this Robotics Logic Learning Application Module for Elementary School Students is by running the application and then entering the number of robot steps according to the direction then the input is processed to enter the program into the robot with a USB cable. The learning module is made using Delphi 7 software. The compiler used is SDCC which is based on DOS so it is easy to use. To send the program from the Personal Computer to the robot using a USB downloader with the help of PROGISP software. The hardware in the form of a mobile robot with tank wheels is equipped with a control circuit, a driver circuit, and a downloader circuit. Robot movement consists of forward, backward, turn right, and turn left. Applications can make one-way movements or two-way combinations. The robot moves not really straight because it is caused by the difference in the rotation of the right and left wheels. The motion of turning right or turning left of the robot is not really 90o because it is caused by lack of precision in calculating gear rotation by the optocoupler.

DECLARATION

Author Contribution

The research procedure in question is the procedure for achieving the research targets as written in the research objectives.

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Conflict of Interest
Declare conflicts of interest or state "The authors declare no conflict of interest."

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