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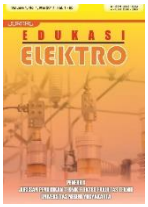

Development of Color-Based Object Follower Robot Using Pixy 2 Camera and Arduino to Support Robotics Practice Learning

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Abstract— The purpose of this study is to find out how robot vision works and the level of media feasibility in the robotic practice course and student responses in the Mechatronics Vocational Education study program. This research is a type of R&D research with a 4D development model (Define, Design, Development, and Desiminate). The result of how the vision robot works is where the robot follows objects based on color using the Pixy 2 camera that has been programmed in the PixyMoon application where the way this robot works is to follow the more dominant object. The results of the feasibility level of vision robots as learning media are determined by the results of the validation of media experts and material experts. Based on the results of the validation of media experts, the overall robot vision was declared very feasible with a percentage of 86.7%. Then from the results of material expert validation, overall, the robot vision companion guidebook is included in the very feasible category with a percentage of 87.5%. From the results of the assessment by students, from all aspects of the overall assessment it can be concluded that robot vision is in the very feasible category with a percentage of 90.8%.

Keywords: Robot Vision, Development, Mechatronics

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1 Background

The process of implementing student learning in an educational institution is influenced by many factors, namely: teaching staff, learning process, facilities and infrastructure, tools and materials, management of educational institutions, and so on. Learning activities are often less effective because the cognitive abilities of students in one class are very heterogeneous. Some groups of students have been able to understand and complete a subject, but there are other groups of students who have difficulty understanding the subject. Innovative and creative learning is needed to foster learning enthusiasm and strengthen students' memory of the material being studied.

The Mechatronics Vocational Education study program is a study program that studies automation and robotics systems. The automation system is a field of knowledge that studies the combination of hardware and software work, so that a multifunctional machine or system will be formed that can be used to facilitate human activities. Robotics is a field of science that studies the structure and working principles of robots, starting from robot sensors, robot mechanics and robot brains. Technological advances continue to grow rapidly in various fields. Technological advances that are currently developing are synonymous with developments in automation and robotics technology.

Therefore, the Mechatronics Vocational Education study program is one of the study programs that must be fully developed to keep abreast of world technological developments.

Mechatronics studies the systems and structures of a robot in general. One of the subjects studied in the robot visual system is robot vision. Robot vision is a robot that has the ability to receive and process information from certain images or objects so that it can be interpreted as a robot that has a sense of sight. The sense of sight in the robot can be formed by using a camera sensor that has been designed and programmed as a robot eye. Like human eyes, robot eyes are also able to distinguish the color of an object that is visible. Data originating from objects or images captured by the robot's camera sensor provides information to the robot about the specifications of the object, namely in the form of the color of the object, so that the robot is able to know the state or object it sees. The purpose of making this tool is to make it easier for students to carry out Robotics practicum on robot vision and find out the level of media feasibility.

2 Literature Review

2.1 Robotic

The term robot first appeared in 1920, derived from the word 'robota' which in Czech (Eastern European countries) means forced labor [1]. As technology develops, various robots are made with specialties or specialties. Robots with special features are closely related to the needs of the modern industrial world. Today they are increasingly demanding the existence of a tool with high capabilities that can help complete human work or complete work that humans cannot complete.

Basically, robots are divided into two parts, namely car robots and non-car robots [2]. A mobile robot is a construction robot whose characteristic is having an actuator in the form of a wheel to move the entire body of the robot, so that the robot can move from one point to another. Non-mobile robots are robots that only stand at one point continuously in carrying out their functions.

2.2 Object Follower Robots Based on Color

Color-based object follower robots are robots that are designed to have object sight senses that are able to detect the color and shape of objects [3]. Objects in the form of objects seen by robots and robots process data originating from these objects, especially data in the form of object colors, which then based on these data the robot will perform a special action that has been pre-programmed by humans. Robots that have the ability to detect objects like this are better known as robot vision [4].

Computer vision aims to make useful decisions about real physical objects and landscapes based on the images obtained from sensors. the goal of computer vision is to develop algorithms take an image as input and produce a symbolic interpretation describing which objects are present, at what pose, and some information on the three-dimensional spatial relation between the objects [5].

2.3 Pixy 2 Camera

Pixy 2 can detect programmed objects. In addition, Pixy 2 has an algorithm that detects and tracks lines and detects colors that can be used on the robot. The algorithm on the Pixy 2 camera can detect intersections and road signs and when programmed on the robot can tell things like: turn left, turn right, go straight, etc. [6]. Pixy 2 can run at 60 frames-per-second, so it can speed up the robot's performance [7].

Fig. 1. CMUCam5 Pixy 2 Camera

2.4 Arduino

Arduino Uno is an ATmega328-based microcontroller board that has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a clock speed of 16 MHz, a USB connection, a power jack, an ICSP header, and a reset button [8]. This board is powered by connecting to a computer with a USB cable or external power by an AC-DC adapter or battery. 14 digital input/output pins (0-13) function as input or output, programmable. Especially for the 6 pins 3, 5, 6, 9, 10 and 11, it can also function as an analog output pin where the output voltage can be adjusted. The value of an analog output pin can be programmed between 0-255, where it represents a voltage value of 0-5V [9].

3 Method

The research conducted in this study is a type of research and development (R&D), which aims to develop a new product or perfect an existing product. This product can be interpreted as hardware (hardware) or software (software), such as interactive learning models, guidance models and so on [10]. The development model is important for conducting development research, from several studies of the learning development model, the results are suitable for the media tool, namely the 4D model. The 4D development model consists of 4 stages namely, 1) definition, 2) design, 3) development, 4) deployment. This development model is adapted to the microcontroller tool media [11]. This stage is described as follows:

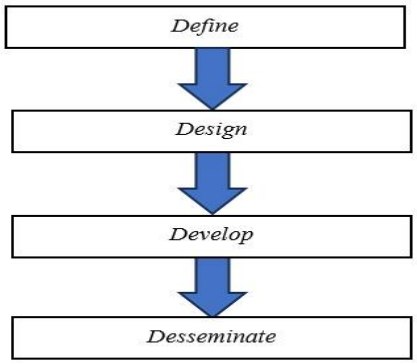

Fig. 2. 4D Development Models

4 Data Collection Technique

The development procedure is an overview of the steps taken in carrying out research. Based on the development model used in this study, namely the 4D development model (Define, Design, Development, and Desiminate) in robotics learning media (tools) with the development procedural steps depicted in the image below:

4.1 Define

This step is used to determine the fundamental problems faced by educators (lecturers). Defining that is by analyzing the necessary consideration of various alternative development of learning media, such as learning media and learning models. Next, an analysis of the students was carried out. This step is carried out to examine the characteristics of students.

4.2 Design

This stage aims to design learning media. The learning media created are in the form of tools and jobsheets so that the design process is carried out by making a layout view of the tool and jobsheet cover.

4.3 Develop

This stage is one of the most important parts because it determines whether the resulting product is suitable for use. To determine the feasibility of the product, validation is carried out by experts. The form of validation that is carried out is by providing instruments in the form of questionnaires to see the suitability of the eligibility standards of the learning media (tools and Jobsheets) which will later be used as research data.

4.4 Disseminate

This stage carries out a limited scale deployment to find out how the response from students is in the use of the given learning media. Previously, students were targeted for testing the use of tools and microcontroller jobsheets that had been developed. To find out the response from students, students were distributed questionnaire sheets to be filled out.

5 Instrument Testing

Based on the data collection technique used, the research instrument is related to the tool. The intended research instrument is a documentation instrument in the form of recording and writing instruments as well as questionnaires for data collection. Instruments in the form of questionnaires will be distributed to media experts and material experts.

5.1 Instruments for Media Experts

Several criteria must be met in making learning media, the criteria in question are educative or material, technical, and aesthetic [12]. The criteria that are based as a reference for media assessment are the combined results of the above opinions which are then developed into a research instrument grid which will be further developed into a research instrument questionnaire for media experts.

5.2 Instruments for Material Experts

Instruments for material experts are used as materials to obtain Jobsheet feasibility data. Jobsheet adapted to the designed media.

5.3 Instruments for Students

This user trial instrument for students is used as material to obtain data regarding student responses to the quality of robot vision. The instrument grid for students is based on criteria in the form of media assessments, but in some of the instrument assessment criteria there are assessments related to Jobsheet evaluation.

6 Data Analysis Technique

This study uses descriptive quantitative and descriptive qualitative data analysis techniques. The data obtained from the questionnaire using a Likert scale with a choice of four responses needs to be changed for the purposes of quantitative descriptive analysis. Changing the data for the purposes of quantitative analysis, namely by giving a score to the response options strongly agree, agree, disagree, and disagree. The research data is converted into a score and then the average answer is calculated based on the score of each answer. The next step is a qualitative analysis to determine the level of feasibility of the tools and guidebooks based on the statements of the respondents. The score of the respondent's answer is changed in the form of a percentage. After presentation in the form of a percentage, it can be seen the level of eligibility.

7 Research Result

7.1 Results of the Define

The purpose of this stage is to determine and formulate the goals and problems of learning media. The things that were done at the define stage in this study were to make observations in the mechatronics vocational education study program. The results obtained in this process are as follows: 1) students' understanding of robot vision is still low, 2) the completeness of tools to support practical

Robotics learning is still lacking, 3) the completeness of learning media to support Robotics Practice learning is still lacking. Some of these factors are the reasons for the need for learning media in the form of Robotics Practical Tools which are expected to be able to increase student understanding in practicum learning.

7.2 Results of the Design Stage

The result of this design stage is a practical tool layout design. Creating a Learning Tool layout is by using components according to the designed media. In Fig. 3 this is the result of media design.

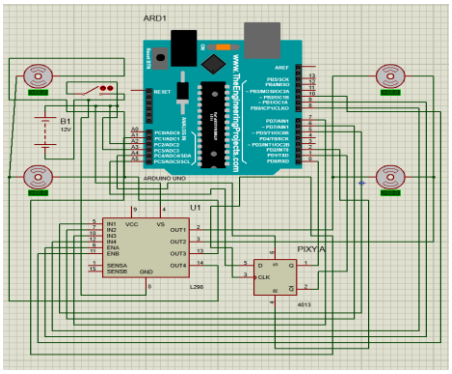

Fig. 3. Robotics Learning Media Layout Design

7.3 Results of the Develop

This development stage is the stage of making tools in real form. The development of learning media tools as a whole is by pairing all the components on the robot vision according to the previously designed layout. Fig. 4 is the result of the overall development of the Vixion Robot Tool.

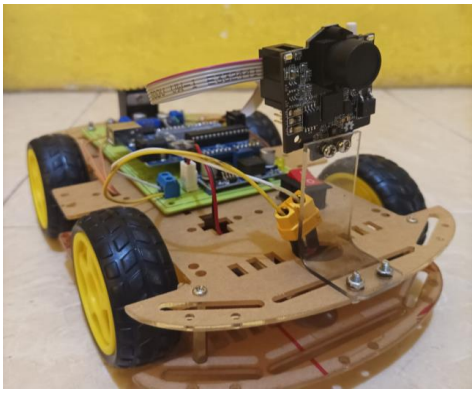

Fig. 4. Overall Vixion Robot Tool Development Results

8 Product Trial Result

This development research is to produce the final product in the form of robotics practice learning media tools. The data obtained in this study were in the form of the feasibility of learning media tools which were assessed by material experts and media experts, as well as responses from students.

8.1 Assessment of Relevant Aspects of Material

The results of the assessment of the relevant aspects of the material can be seen in Table 1.

Table 1. Material Relevance Aspect Assessment

No	Assessment Indicator	Item Average Score
1	Knowing the suitability of the material with the syllabus	3,5
2	Knowing the level of competence	3,75
3	Knowing the completeness of the material contained in the learning media	3
4	Knowing the level of understanding of the material contained in the media	3,3
5	Knowing the scope of material contained in the media	3,5
6	Knowing the level of suitability of conditions between students and the required learning media	3,25
Total Rating Score		20,3

8.2 Assessment of Technical Aspects of Learning Media

The results of the assessment of the technical aspects of learning media can be seen in Table 2.

Table 2. Assessment of Technical Aspects of Learning Media

No	Assessment Indicator	Item Average Score
1	Know the completeness of the components	3,75
2	Knowing the quality of the design	3,5
3	Know the ease of operation and maintenance	3,5
Total Rating Score		10,75

8.3 Assessment of Graphical Feasibility Aspects

The results of the graphical feasibility aspect assessment can be seen in Table 3.

Table 3. Assessment of Graphic Feasibility Aspects

No	Assessment Indicator	Item Average Score
1	Job sheet size	3
2	Jobsheet cover design	3,6
3	Jobsheet content design	3,5
Total Rating Score		10,1

8.4 Student Response

The results of the student response assessment can be seen in Table 4.

Table 4. Student Respon

No	Assessment Indicator	Item Average Score
1	Quality of content and purpose	3,7
2	Instructional (learning) quality	3,6
3	Technical Quality	3,5
Total Rating Score		10,9

9 Final Product Review

The type of research used in this study is Research and Development (R&D) using the 4-D model (Define, design, development, disseminate). The research was conducted to produce learning media products in the form of learning tools to be used in robotics practice courses in the Mechatronics Vocational Education study program Faculty Of Engineering, Universitas Negeri Makassar. Learning modules are developed through a process of due diligence by material experts, due diligence by media experts, and student responses. The following is a table of eligibility categories.

Table 5. Eligibility Category

No	Score In Percent	Eligibility Category
1	0% - 25%	Not feasible
2	>25% - 50%	Less Eligible
3	>50% - 75%	Worthy
4	>75% - 100%	Very Worth it

The results of the assessment by media experts and material experts regarding the feasibility of learning media can be seen in Fig. 5

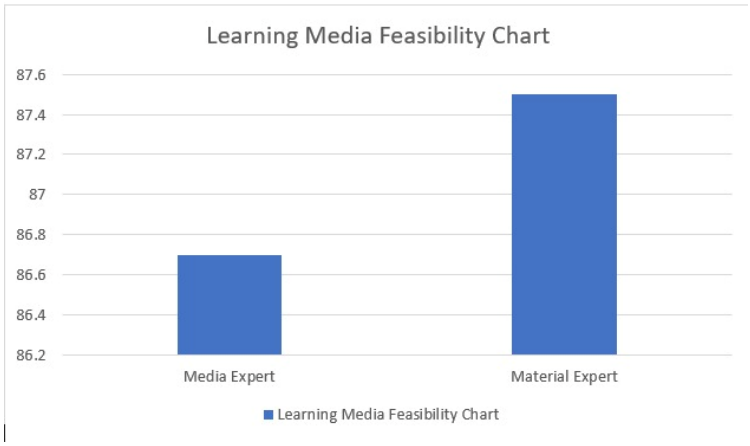

Fig. 5. Learning Media Feasibility Graph

Based on the results of the assessment by material experts, it can be concluded that the Jobsheet made is in the very feasible category. The aspect assessed is the feasibility of the material. The score on the feasibility aspect of the material indicates that the material presented on the Jobsheet uses robotics practice tools in accordance with the media being developed and can support the learning process in the Faculty Of Engineering Universitas Negeri Makassar mechatronics vocational education study program. The score for the feasibility aspect of the material on this Jobsheet is explained in a clear and easy-to-understand manner, so that the presentation feasibility aspect is included in the very feasible category. The validation process was carried out by 2 validators as material experts, from the results of the validation carried out, the results of the Jobsheet were declared feasible for use. The results obtained from the validation of the instrument sheet in the aspect of material quality were 87.5% in the very feasible category.

Based on the results of the assessment by media experts, it can be concluded that the practical tool in the form of a robot vision made is in the feasible category. The aspects assessed are aspects of material relevance and technical aspects of learning media. The gains obtained from validation by media experts are categorized as feasible based on the aspects assessed. The results obtained can help students carry out robotics practicum with robot vision as a learning medium in mechatronic vocational education Faculty Of Engineering Universitas Negeri Makassar. From the results of the validation carried out, it was obtained that the robot vision tool for robotics practice was declared very feasible to use. The results obtained from the validation of the instrument sheet in the media feasibility aspect were 86.7% in the very feasible category.

Student responses can be identified by applying learning media to 10 students in the mechatronics vocational education study program and then doing practicum using learning media. Next, students are asked to respond to learning media by filling out a questionnaire containing 12 statement items. The test results by users (students) obtained media feasibility, namely 90.8% in the very feasible category.

10 Conclution

The result of how robot vision works is where the robot follows objects based on color using the Pixy 2 camera which has been programmed in the PixyMoon application where the way this robot works is to follow objects that are more dominant. Robot vision detects colors with good room light intensity and it is more advisable to be outdoors so that the lighting is even better because this robot only has a camera with pixels under 1 Mega Pixel. This robot can only follow objects with a distance of less than 1 meter so by testing the object it must be right in front of the camera, robot vision cannot walk backwards. Robot vision to follow objects based on color to test objects the color of the object must be only 1 color. If the object has another color, it is possible that the robot will fail to

follow the object and also the robot vision cannot run quickly, therefore the object being followed must have the same speed as the robot.

The results of the feasibility level of robot vision as a learning medium are determined by the results of the validation of media experts and material experts. Based on the validation results of media experts, overall robot vision is declared very feasible with a percentage of 86.7%. Then from the validation results of the material experts, it can be seen that overall, the robot vision assistant jobsheet is included in the very feasible category with a percentage of 87.5%. From the results of the assessment by students it can be seen that from all aspects of the overall assessment it can be concluded that robot vision is in the very decent category with a percentage of 90.8%.

The gains obtained from validation by media experts are categorized as feasible based on the aspects assessed. The results obtained can help students carry out robotics practicum with robot vision as a learning medium in mechatronic vocational education FT-UNM. From the results of the validation carried out, it was found that the robot vision tool for robotics practice was declared very feasible to use. Students are asked to respond to learning media by filling out a questionnaire containing 12 statement items and categorized as appropriate for use.

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