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FOREWORDS

We apologize for the late publication of this JOE volume. There have been more manuscripts being proposed for publication but selection and revision of the approved articles have taken quite a long time. We are pleased that this volume publication can be realized.

In this volume, we also present a wide combination of subject matters. The first two articles deal with foreign or second language-teaching processes that may be useful for language-teaching theories and practices. Two other articles deal with more spesific aspects of language-teaching processes, one being errors analysis, the other needs analysis. One article is concerned with junior-high-school educational management and one other with students reading literacy. The three remaining articles are on interesting subjects of robotics, sport anxiety, and multimedia. Happy reading.

Editors

CONTENTS

Developing microcontroller–based sorting and placing robots in automation practice subject of vocational high school

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Abstract: *This study was aimed at developing microcontroller–based sorting and placing robots as training kit of Otomation Practice subject in Vocational High School. The study was research and development involving six steps: need assesment, planning, developing, testing, repairing, and finishing. The subjects were 10 teachers of Industrial Electronic Study Program of Vocational High School. Data were collected using an observation guide, and analyzed quantitatively using descreptive statistic in the form of means. Findings of the study showed that the microcontroller–based sorting and placing robots had been developed with good feasibility degree, which was shown by expert validation average score of 2.93.*

Keywords: *microcontroller, sorting and placing robots, automation*

1. Introduction

The automation system plays an important role in the industrial production process. This status is due to the contribution of automation system implementation on the production process financial efficiency that is able to reach 60% until 80% (Kumar, 2001: 8). The automation system application used in industries is for example the use of robot for working in the production process, as an examples was microcontroller–based sorting and placing robots. However the use of robot in industry has some cons such as its expensive price and if it is broken, it should be repaired by an expert or the robot making company. This matter certainly becomes a special challenge especially for an industrial worker to master the robotic technology.

The Vocational High School, especially on Industrial Electronics Skills Program, which is an education institute that produce graduates to work at industry, is obliged to give its students many competencies, including robotic. This objective has been actually realised by allocating Automation Subject material at an education unit level curriculum.

The Automation Subject material was taken by the XI class student containing two competencies namely Programmable Logic Controllers (PLC) automation base and microcontroller. However, in relation with above issues, Indarto (2009: 65) conducted a research that gained some facts such as: (1) in all of the Vocational High School especially on Industrial Electronics Skill Program in Yogyakarta there were no robots developed

as as training kits; (2) the reason for the unavailability of robots as training kits in the Vocational High School was that robotic materials were difficult for students, hence, ideally, a support is needed for Vocational High School students for their capability in mathematics, kinematics, dynamics, and control which are sufficiently high and costly; and (3) the material of automation education and training given to the students was only PLC and microcontroller basics so the robotic application has not been achieved.

Therefore, there is a need to conduct research and development in microcontroller–based sorting and placing robots as a cheaper, practical, understandable and comfortable automation training kit for students. Furthermore, Kumar (2001: 1) proposed a robot that is a multifunctional manipulator and can be programmed and made with the aim to benefit a certain work.

The basic elements contained in the robotic system include: (1) a mechanical system; this system is physically direct looking system which generally consists of pe-level, body, hinges, and bearings; (2) the driving system, consists of motors and actuators that convert electrical energy into mechanical system motion; (3) a controlling system that functions similar to the human sensory system, which provides feedback in the form of digital and analog signals to the computers system about the the robot system state; (4) computer and software systems that process element which function to control the robot system activity and to respond to the desired work; and (5) the interface system; which is a communication network that allows the robot connected to the outside world.

Another opinion is given by Pitowarno (2006: 2) who states that the robotic system was built based on the function to be executed and desirable. The robots should have a specific function or function-oriented so that its contribution to human welfare can be expected. The robot design and construction are expected to be able to work rapidly, precisely, efficiently, usefully and easily to be learned as well as being able to be applied in the real world.

Parts of the robot are: (1) robot controlling system, which consists of a series of processors (Central prossesing Unit – CPU), memory, the interface input/output component, signal conditioning for analog or digital sensors and drivers for actuators; (2) the robotic mechanical system, which consists of a movement function or known as the degrees of freedom; (3) robotic sensor, which is a device or component functioning to detect movement results or environmental phenomenon required by the controller system; (4) actuator, which is an electro-mechanical device that produces the movement energy; (5) wheel system, a mechanical system that can move the robot to move its position; (6) arm system, a manipulator that function for manipulating (holding, turning, poking, moving. and processing) an object; and (7) the real world, which is defined as an area of working or robot workspace. To control the robot, the controlling system is needed, one of them is a microcontroller-based controlling system.

According to Agfianto (2002: 1), the microcontroller is a chip in which combined with the I/O parallel and series, a set of memory that is Read Only Memory (ROM) and Random Access Memory (RAM). Microcontroller as a microprocessor technology breakthrough and microcomputers, meet the market needs and new technologies. As a new technology, that is the semiconductor technology

containing more transistors, requiring only a small space and can be mass produced to make the price cheaper. As a market need, the microcontroller presents to meet the tastes of the industry and consumers about the needs and desires of better and sophisticated aids. In the world of education, particularly at Vocational High School in the industrial electronics skill program, the microcontroller-based controlling system is urgently needed as a training kit.

According to Estellita (2008: 46), one of the Vocational High School strategies in preparing educated and skilled human resources is to provide and develop the training kit. The development of training kit needs an attention in order to create a conducive learning atmosphere in an effort to produce skilled and qualified graduates. Availability of adequate training kit in the types and amounts in accordance with the demands of competence is a fundamental matter to fulfill. Absence of adequate means of practice will not be able to produce skilled and competent graduates.

Related to the robot as a training kit at Vocational High School, Pitowarno (2006: 6) proposed further the need of finding an interesting way of innovation in introducing and learning of robotic skills to the students. The students at Vocational High School no longer need materials by presenting them as mathematical, dynamic, and complicated mechanical systems. The approach taken in the best learning system at Vocational High School is by presenting some robotic application system that will increase students' interest in learning robotics. Thus the robotic training kit in the Automation Subject at Vocational High School needs to be made practical, simple, and easily understandable by students.

The supporting teaching materials in the form of student worksheets can be a driving force for students who are studying these subjects to learn the basics of practical robots fun. The relevant research conducted by Thiang, et al. (2000: 1) about a robot that uses fuzzy logic as a basis for controlling the movement of the car. In that study, a sufficient controlling system performance is indicating the car's movements that can be controlled on the basis of fuzzy logic control. Research conducted by Simarta (2004: 1), which examining the Fire Fighting robots prototype with the controlling basis used was AT90S8535 microcontroller, indicating the accuracy of the microcontroller work as the controlling basis altough fires extinguished by the robot was still limited both in number as well as position.

Research conducted by Sidiq & Sutopo (2004) on controlling the robot arm based on microcontroller AT89C51 using ultrasonic transducers shows that the ultrasonic transducer can detect a cylindrical obstacles on the semicircular robot track with a radius 25 cm. Research conducted by Widodo, Achmad, & Sutanto (2005: 1) on anti-bumping robot car that used 68HC11 microcontroller controlling basis, also showed a sufficient performance although the car was still a simulated car or toy car.

Other study conducted by Maulana (2003: 1) on the coordinated robot functioning of the car robot movement in X and Y coordinates could also work according to its function, but again the car used was not the real car but a toy car instead. Another research conducted by the Adhi, et al. (2004: 1) of the conveyor robots to control the bottle conveyor automatically. It has a good performance according to the job description as planned.

Based on the above studies, it seems that a robot made in those researches can work

sufficient as the planned work description, which is one of the causes of sensitivity and accuracy of the existing sensors. Therefore, it is important to take high precision and accuracy in making the robot by selecting high quality sensor.

2. Methods

This study is a research and development, which has six steps namely: needs assesment, planning, developing, testing, repairing, and finishing. The techniques of collecting data used in this study were observation. The data collected using a check list, and an observation sheet. Data were obtained in the form of performance testing data of a prototype robot and data validation was done by two materials experts and two media experts. The data analysis technique used in this research was in the form of description.

3. Findings and Discussion

After doing the research steps of needs assesment, planning, and developing, the prototype of microcontroller–based sorting and placing robots was obtained in Automation Practice Subject of Vocational High School especially on Electronics Industry Skill Program, as shown in Figure 1, Figure 2, Figure 3, and Figure 4.

The next research step was performance test of microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School, namely working functional testing and objects placement location. The results of working functional testing on the robot prototype shown as Table 1.

The testing results of the placement location of the objects carried out by robot prototypes as shown in Table 2. In this test, the robot pedestal was determined at the

Figure 1. Robot is Ready to Work

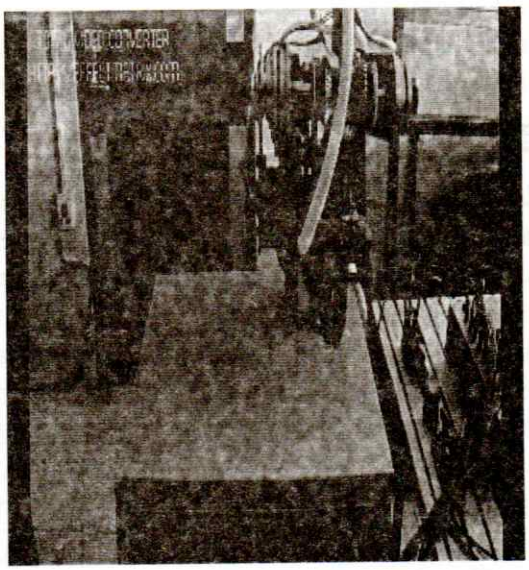

Figure 2. Robot Takes the Red Object

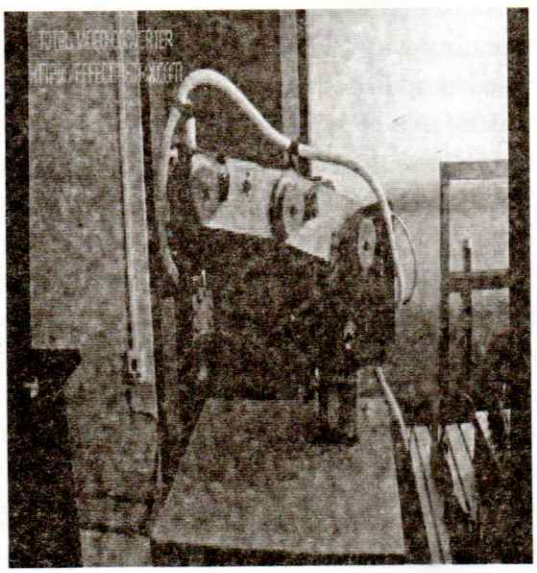

Figure 3. Robot Puts The Red Object

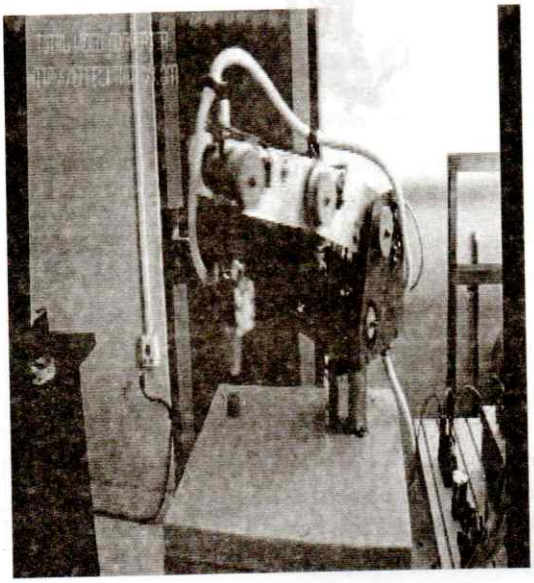

Figure 4. Robot Leaves the Red Object

coordinates $(X,Y)=(0,0)$ and the starting point of the objects at the coordinates $(X,Y) = (-30.25)$.

The next research steps was expert validation of the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School. Validation of the robot prototype was done by two materials experts and two media experts. The validation results carried out by material experts of the robot prototype was presented in Table 3. The validation results conducted by media experts on the robot prototype as shown in Table 4.

The resulted microcontroller–based sorting and placing robots has the displacement range of testing objects in a radius of 700 mm in accordance with the robotic arm range. Clamping objects is carried out by the principle of gripping or pinching. Motor rotation at the top or clamping structure causes forward or backward movement of the puller, which results in a clamping or streching movement on the gripper. By using the motor as the main activator, the resulting motion includes base rotation, middle and end arms swinging movement, rotary and swinging clamp movements and gripping movement. The robot movement is controlled by a microcontroller.

Generally speaking, the working function of microcontroller–based sorting and placing robots as a training kit of Automation Subject at Vocational High School especially on Industrial Electronics skill Program is as the following. For example, in the automatic control mode, before the program is executed, in the items drawing location there are the red items with the position $(X,Y) = (-30.25)$ as well as a robot arm on the stand by condition.

Furthermore, the start button is pressed so that the robot will work automatically. Because of objects color sensor capturing

Table 1
Results of Working Functional Testing on The Robot Prototype

Number	Working Function	Test I	Test II
		Yes/No	Yes/No
1	In the automatic mode, objects selecting and organizing robot made could move and organize the red items into the right position?	Yes	Yes
2	In the automatic mode, objects selecting and organizing robot made could move and organize metallic objects, to the right position?	Yes	Yes
3	In the automatic mode, objects selecting and organizing prototype robot made could move and organize the black objects in the right position?	Yes	Yes
4	In the automatic mode, objects selecting and organizing robot made, if the organizing of red objects have reached the 2 pieces then the next red object would be placed in the exactly decided next position?	Yes	Yes
5	In the automatic mode, objects selecting and organizing robot made, if the organizing of metallic objects have reached 2 pieces the next metallic objects would be placed in the exactly decided next position?	Yes	Yes
6	In the automatic mode, objects selecting and organizing robot made, if the organizing of black objects have reached 2 pieces then the next would be placed in the exactly decided next position?	Yes	Yes
7	In the manual mode, objects selecting and organizing robot made could move and organize the red objects in the right position?	Yes	Yes
8	In the manual mode, objects selecting and organizing robot made could move and organize the metallic objects in the right position?	Yes	Yes
9	In the manual mode, objects selecting and organizing prototype made could move and organize the black objects in the right position?	Yes	Yes
10	In the manual mode, objects selecting and organizing robot made, if the organizing of red objects have reached 2 pieces then the next red objects would be placed in the exactly decided next position?	Yes	Yes
11	In the manual mode, objects selecting and organizing robot made, if the organizing of metallic object have reached 2 pieces then the next metallic objects would be placed in the exactly decided next position?	Yes	Yes
12	In the manual mode, objects selecting and organizing robot made, if the organizing of the black objects have reached 2 pieces then the next black objects would be placed in the exactly decided next position?	Yes	Yes
13	Stop operation could stop as the cycle has finished ?	Yes	Yes
14	Emergency system could stop the process immediately?	Yes	Yes
15	Reset operation could restore the system to standby position?	Yes	Yes

Table 2
Testing Results of Things Placement Location by Robot Prototypes

Number	Item	Setting		Testing		Setting		Testing	
		X1 Cm	Y1 Cm	X1 Cm	Y1 Cm	X2 Cm	Y2 Cm	X2 Cm	Y2 Cm
1	Placement location of red objects	37	0	37	0	36.5	4	36.5	4
2	Placement location of metal objects	33	24	33	24	32.5	28	32.5	28
3	Placement location of black objects	29	30	29	30	28.5	34	28.5	34

Table 3
Validation Results Carried Out by Material Experts of the Robot Prototype

No	Aspect	Indicator	Average Score	Category
1	Benefit aspect	Suitability of robot prototype with the syllabus	3.5	Very good
		Suitability of robot prototype with the subject of learning	3.5	Very good
		Suitability of robot prototype to increase automation competence for students.	3.0	Good
		Suitability of robot prototype to easily students comprehension in mastering the automation competence	2.5	Good enough
		Suitability of the robot prototype for the development of automation materials	3.0	Good
2	Technical aspect	Completeness of input / output component	3.0	Good
		Design quality	2.5	Good enough
		Easily operation	3.00	Good
		Quality of materials	3.00	Good
		Component layout	2.5	Good enough
		Functioning components	3.00	Good
		Quality of robot prototypes	3.00	Good
		Suitability of job description	3.00	Good
		The accuracy of the items placement	3.00	Good
		Rate of items placement	2.5	Good enough
		Strength of the prototype	3.00	Good
The average score total			2.94	Good

the red color of the objects, the sensor works to provide input to the microcontroller unit, then in accordance with the microcontroller programming, the microcontroller output will run some drivers to drive some of the DC motors namely M4, M3, and M2 rotated

Table 4
Validation Results Conducted by Media Experts on the Robot Prototype

No	Aspect	Indicator	Average-Score	Category
1	Material relevancy aspects	Suitability of robot prototype with the learning materials	3.0	Good
		Suitability of robot prototype to drive learning	3.0	Good
		Relevancy of robot prototype to draw the attention	3.0	Good
		The benefit of robot prototype to help teaching task for teachers	3.0	Good
		Suitability of robot protrotype to improve the students curiosity	3.5	Good
		Suitability of robot protrotype to enhance the students learning interest	3.0	Good
		Suitability of robot protrotype to motivate the students learning	3.0	Good
2	Technical aspect.	Completeness of input / output component	3.0	Good
		Design quality	2.5	Good enough
		Ease of operation	3.0	Good
		Quality of materials	2.5	Good enough
		Component layout	2.5	Good enough
		Functioning components	3.0	Good
		Prototype quality	3.0	Good
		Job description suitability	3.0	Good
		Acuracy of the items placement	3.0	Good
		Items placement rate	2.5	Good enough
		Prototype strength	3.0	Good
The average score total			2.92	Good

to the right so that the gripper moves down towards the red items.

When the gripper almost touching the red objects, the motor M6 rotates to the left briefly to open the gripper. If the gripper has touched the red-colored object, then the M4, M3, and M2 motors stop, and the M6 motor rotates to the right momentarily to move the gripper in order to clamp the red object. Then M4, M3, and M2 motors rotates to the left which causes the robot arm lift the arm and gripper upward to some extent, then the movement of M4, M3, and M2 motors stop, followed by M1 motor rotating to the right to move the whole arm robot to the right to a certain extent.

After the movement of the robot arm reaches a certain position in accordance with the program, then the motor stops and continued by M1, M4, and M3. M2 motors moving to the right so that the arm and gripper move down to touch the specified

location that is $(X,Y)=(30.0)$ and M4, M3, and M2 motors stop again. Furthermore, M6 motor rotates to the left to open the gripper so that the red object is detached from the grip of the gripper and occupies the location $(X,Y)=(30.0)$ as decided. Then M4, M3, and M2 motors rotate to the left so that the robot arm and gripper move upward to the specified limits, and then M4, M3, and M2 motors stop again. Later, M1 motor rotates to the left so that the whole robot arm moves to the left until the robot arm touches stand-by position and M1 motor stops again.

If the robot desires to stop working on this position, the stop button is pressed so that the program stops. But if the robot is wanted to keep working, then repeat the robot working process as mentioned above, but with the placement organization of metallic and black objects in the different positions from the red object position. Similarly, if the black or red or metal object has been placed at each of its location as many as 2 pieces, then other objects of the same color will be placed at the other side of the organized objects of the same color.

If during the object selection and organization processes the robot working system is having trouble, then the emergency button must be pressed immediately, so the program stops and the robot will stop working. After the trouble is completely fixed, the reset button can be pressed so that the system will return to the starting position (stand-by) and is ready to rerun. In the manual control mode, the working process of selecting and organizing of the red metallic and black objects in principle is the same as that objects selecting and organizing by an automatic control mode above, though in the manual mode, for doing some steps the start button needs to be pressed at every single step.

By paying attention to the testing data of robot prototype working function and location of the objects placement as described above, it is shown that the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School has a good performance indicated by the working function in accordance with planning and placement of the objects at the right location. This happens because the validity of the control programming based on microcontroller and the components used in the control system can work due to their functions.

The validation results carried out by materials experts on the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School gained an average total score of *2.94*. This means that the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School has feasible and good materials for use in teaching automation practices in the classroom. In the validation activities carried out by materials experts for the robot prototype, a recommendation to be revised is givem, regarding the suitability of a robot prototype to be easily understood by the students in mastering the automation competence, design quality, component layout, and placement rate of objects, while other indicators including are already good.

Validation done by media experts on the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School gained an average total score of *2.92*; included in the good category. This means that in terms of media, the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School is feasible to be used for learning in the class. But other

indicators that still need to be improved are design quality, materials quality, components layout, and placement rate of objects. In the total average score between validation results of the microcontroller–based sorting and placing robots in Automation Practice Subject of Vocational High School by materials and media experts, the total average result obtained is *2.93* which is included in the good category.

Seeing that the testing results of the robot prototype working function show a good results, the accuracy of objects placement location, and the validation total average score carried out by materials and media experts of *2.93* as mentioned above, it can be said that the robot prototype has a good feasibility degree. This will give good reasons that the microcontroller–based sorting and placing robots are feasible for use as training kits at Automation Practice Subject in Vocational High School especially on Industrial Electronic Skill Program.

This study differs from previous studies that previous research is generally on the use of certain controlling basis ie MC, PLC or microcontroller individually for a particular control as well. Even if the controlling basis is the same as that of this research, the controlled objects as well as controlling work function are different from this study. In this study, the controlling basis used is a microcontroller for controlling the objects sorting and placing robots with the results used as the training kit of The Automation Practice Subject in Vocational High School especially on Industrial Electronics Skill Program.

This study is still limited to the stage of needs assesment, design, developing, testing, expert validation, revision, and finishing so that it has not reached the implementation, evaluation, and final revision. To determine the effectiveness of microcontroller–based sorting and placing robots, the robot prototipe must be implemented in the Automation Practice Subject learning.

4. Conclusion

The microcontroller–based sorting and placing robots has been developed as an automation training kit for the Vocational High School especially on Industrial Electronic Skills Program. Through the careful carrying-out of the research conduct and validation, the research product has been atained with a good feasibility degree, as shown by good performing test results, and an expert validation average score of 2.93 which is in the good category.

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