PROTOTYPE OF BUSHING HANDLING ROBOT USING ATMEGA 8535 MICROCONTROLLER

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Abstract – **Buldozer performance declination is usually caused by the broken of seal adjuster track repeatedly. Therefore, undercarriage replacement including bushing frame is carried out to overcome this problem. This replacement process caused several problems such as safety and environmental pollution, and also the accuracy of bushing placement in its frame so it needs robot as an aid equipment. Having tested the robotic prototype is able to carry out the process such as bushing handling although it only used similar object to bushing. This prototype has been able to grip, lift up and put the object in the intended place.**

Keywords – *Bushing, Microcontroller ATMega 8535, Bulldozer, direct current motor*

I. INTRODUCTION

Technology used in the industry is rapidly developed nowadays. On the other hand, new problem that has to be taken care of has arisen such as maintenance problem, equipment replacement and also environment friendly waste management. South Sumatra as an energy resource became a reason of establishment of many mining companies especially coal. Companies attempted to improve coal production target in order to fulfil the demand of coal. However, the problem of repeatedly broken seal adjuster track on the Bulldozer unit caused the declination of its performance. To improve the bulldozer performance, the bushing frame on the main frame recoil spring must be replaced. This was because the condition of existing bushing frame in which corrosive and friction effect the seal bushing so it was damaged and torn apart, and finally caused the leaking of oil frame and all inner parts undercarriage components worn out rapidly. The decision to periodically replace the bushing is the right method to return undercarriage condition to its state, but there are some problems in the implementation of this activity, such as: in the pre-heating process for new bushing by heat it in oil as a conductor, the handling would be very difficult so it needs heavy equipment to take out bushing from the oven. This conventional method had a risk of warning because of the environmental pollution and safety aspect of the dangerous working process as seen in figure 1 below.

Figure 1. Conventional *preheating* process

By considering this matter, the conventional preheating was replaced by heater process as seen in figure 2 so the process could be carried out safely and environment friendly, nevertheless after using heater the handling problem still had a constraint as it needed hoist crane as a tool. Delay became the weakness of this method because the lack of accuracy in placing the bushing and also the waiting of hoist crane which is used for other activity.

Figure 2. Manual *bushinghandling* process after using *bushing heater*

Based on the above the author choose the robot to solve this problem. Robot is chosen because it could be designed to do high accuracy working process and has high productivity to improve the production volume. The designed robot utilize motor as its mover and could be controlled by wire or wireless and operated not necessarily close to the heater bearing in mind the bushing temperature is very high when it's out from the heater. Robot movement will be functioned as bushing material handling from heater to bushing frame, by gripping, lifting, turning, and releasing, until object is installed as designed condition.

II. BASIC THEORY

The word "ROBOT" firstly used in New York in October 1921 in a theatre performance called "RVR", written by Karel Capek. Word ***Robot*** itself came from ***robota*** which means working.[1]

The most acceptable definition came from "*Robot Institute Of America*".[2]: "A robot is something that can be programmed and reprogrammed, which has designed mechanical manipulator/ mover to handling goods, components or special tools with a number of flexible programmes/ adjustable for implementing various tasks". Based on that definition, robot could be declared as Programmable Automation. While the term Robotic based on Webster definition : "Technology to design, create, and operate robot" [2]. Robot manipulator could be classified by several criterias such as resources, geometrics, and kinematics structure comprised in the application area and controlling method. This classification is very useful to determine the suitable robot to do specific task [3].

2.1 Configuration of the Manipulator

Manipulator is also known as robot's arm. Classically manipulator could be divided by 4 groups that are polar, cylindrical, cartesian, and joint- arm [4].
Manipulator with polar configuration illustrated in Figure 3. The body could perform left and right turn. The body joint could lift up and down the base of the arm in polar. The end of the arm could be stirred forward and backward translationally. This configuration is quite solid because the arm joint and forward-backward movements are mechanically densed. The ability to reach up and down is not good because the body did not lift the arm vertically, but had typical movement that was capable to manipulate spherical workroom with the simplest movement algorithm compare to the other configuration types.

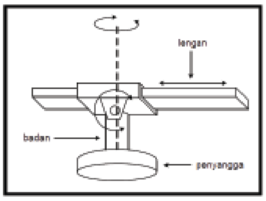


Figure 3.Polar Configuration [4]

The following cylindrical configuration in Figure 4 had capability to reach in the better cylindrical room, although end of the arm angle against stanchion line is fixed. This configuration is adopted widely for gantry system or crane because of its solid structure for load hoisting task. The obvious example is the crane system used for buiding skycrappers [4].

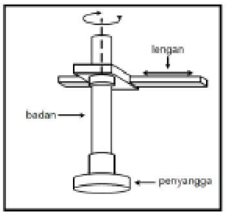


Figure 4. Cylindrical Configuration [4]

Manipulator with cartesian configuration as displayed in Figure 5, is relatively the most solid for hoisting heavy load. This structure is widely used permanently in factory installation for hoisting and moving production goods as well as lifting heavy equipments when carried out installation activity. Crane in a shipyard is also adopting this structure [2], [4].

In a real application usually stanchion, body and arm are constructed so as the load distributed evenly throughout the structure.

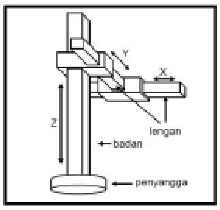


Figure 5. Cartesian Configuration [4]

The fourth configuration is joint-arm structure. This construction is the most popular for regular task in a factory, particularly to carry out fuction as factory worker, like hoisting goods from the conveyor, welding, installing nut-bolt component in a product, etc. With special wrist tool, this joint-arm structure was suitable for reaching in the narrow workroom with various reach angle. This form is known as planar manipulator. In general, its configuration is like the following figure 6. All joints designed for turning horizontally, except end of effector. This structure is widely used in kinematics and dynamics studies particularly those related to verification analysis of an approach or the latest control theory.

One of the consideration was that outerspace robotic application did not require gravitation concern in the dynamic analysis it was only influenced by the robot inner body itself [4].

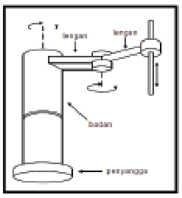


Figure 6. Planar Manipulation [4]

There were plenty of robot utilization in the industry, for instance that researched by Dong Shu Wang who designed robot for industrial welding which has a structure as the following figure:

Figure 7. Welding Robot Structure[5]

On the above figure, welding robot structure scheme has 6 revolute joints in which all these six joints will be controlled by genetics algorithm coding after their weight points were optimized [5]. While the gripper on the end of robot's arm where the bushing is held will be settled by the type of the object [6].

2.2 Microcontroller

Microcontroller utilility on the robot's arm has an important role as a brain or programme processor for moving the robot's arm. ATMEL Microcontroller is used for this tool because it has advantages in terms of ability and price. Basically the differenciation for each class are memory, peripheral, and its function. Microcontroller used in this research is AVR microcontroller ATMega 8538 type. The selection of this type is based on its capacity which is fit to the sofware capacity created. Moreover, it also has timer facility. ATMega 8535 microcontroller is 8-bit IC CMOS which has low power in its operation and based on RISC AVR.

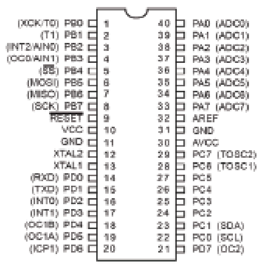


Figure 8. Pin Configuration of ATMega 8535 Microcontroller [7]

ATMega 8535 microconttroller could be executed in one instruction in one clock cycle, and capable to reach 1 MIPS per MHz, so the designers could optimize the low power with high speed. ATMega 8535 microconttroller has speciality compare to AT89C51, AT89C52, AT89S51, dan AT89S52 type microcontroller, in which ATMega 8535 microcontroller has ADC 8 channel 10-bit port input [7].

III. MATERIALS AND METHODS

The recent reserach was still prototype in the laboratorium scale. The purpose of this research is that when the real robot is built, it will work properly as desired, because its shape and ability have fit to the requirements.
In conduction this research, a diagram was used to show the steps that needed, as seen in the figure 9 below

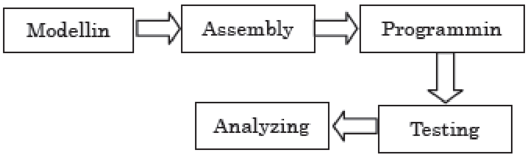


Figure 9. Step of The Making of Prototype Bushing Handling Robot

Having set up the required steps as shown in Figure 9, the next step will be designing the robot blue print before producing it. Mechanical design is most important part because before producing the robot we will be able to see the robot's structure and shape in visual design as it has a very close likeness with the original. *Solid Work* was used to make the mechanical design easier. Below is is the figure of the robot design:

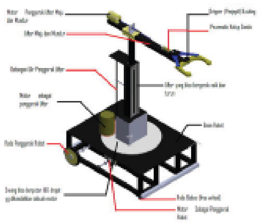


Figure 10. Design Prototype of B*ushing* Handling Robot

IV. RESULTS AND DISCUSSION

In the previous chapter, it has been explained how to design this research. After the producing step, the tool had to be tested to get the required data. The test is carried out to proof that the prototype is able to function well and able to be applied in the daily life. Below is the figure of the tool that successfully produced and ready to be tested.

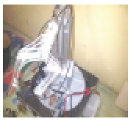
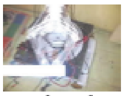
Figure 11. Protoype of Bushing Handling Robot

After the production, a test was required on the prototype to find out whether the designed made was as appropriate as expected. The most important test was the ability test of the robot in gripping an object, lifting it, and placing it. Below is the figure of object's shape that had to be lifted:

Figure 12. Object that Need to be Lifted

This object were made from several types of pipes with diameter of 4 inch and 3 inch with weight range from 450 gram to 620 gram. The test run on direct current motors which were used to move the mechanical parts in robot i.e., Base, Arm, Lifter, Booster, Gripper, and robot's activator parts. Considering that load size of the testing objects were various, thus only pipes that met the selected criteria were tested. The first test was the gripping ability directly on the pipes with various weight and dimension in order to get the general dimension and weight which can be lifted sucessfully or not by the robot. The table below will explain the purpose of this test on the gripper:

Table 1. Gripper Test

Figure	Description
 *Gripper*	 Open condition of *gripper*
	 Closed condition of *gripper*

From the test result shown that the width dimension of the gripper when it is opened was 20 cm, and 1 cm when it is closed and the length of *impact point* of the gripper was 41 cm.

The measurement and selection the object for the test can be started after the details of the gripper's gripping capacity were obtained.

Table 2. Objects pipes specification with direct test

Object	Pipes dimension		Weight	Remark
	Length (cm)	Diameter (inch)	(gram)	
1	10	4"	450	Good
2	20	4"	500	Poor
3	30	4"	620	Fail
4	10	3"	450	Good
5	20	3"	500	Poor
6	30	3"	620	Fail

From the test result, there were some pipes "failed" for selection, because the gripper was not able to grip properly. Thus, the pipes which have suitable and sufficient dimension and weight were acquired. From that test 1 ideal pipe will be selected for the measurement object. The next test was carried out on the vertical arm which was moved by continuous current motor, in which vertical arm was one of the Cartesian Arm's that can move up and down. This arm in it's working cycle would carry an object from a certain place by moving its arm from down to up until reaching the maximum limit thus the object could be moved. In other word, the continous current motor at this arm will have a load only when the arm moving up.

Table 3. Current Test on Direct Current Motor as Vertical Arm Mover

Test No	Voltage		Measured Current (A)			
	Without Object	With Object	Without Object		With Object	
	V_1	V_2	Up	Down	Up	Down
1	12,67	12,63	1,97	1,42	2,16	1,46
2	12,69	12,65	1,82	1,39	2,17	1,42
3	12,65	12,62	2,03	1,44	2,18	1,37
4	12,64	12,62	1,95	1,43	2,17	1,39
5	12,58	12,59	2,06	1,38	2,19	1,38
	TOTAL		9,83	7,06	10,87	7,02

Therefore the average of difference value of output current result of driver motor's direct current to move vertical arm while carrying an object will also be higher compare to horizontal arm (similar type of motor).

The next test is for *Gripper End of Effectors* or *gripper* is the most important part, its function is to grip an object (pipe) and move it from one place to the another. The gripper measurement is carried out when the gripper gripped and released an object. The measurement result showed that the voltage output was bigger when it closed (gripping) than when it opened (releasing).

Table 4. Current Test on Direct Current Motor as Vertical Arm Mover

Test No	Voltage		Measured Current (A)			
	Without Object	With Object	Without Object		With Object	
	V_1	V_2	Up	Down	Up	Down
1	12,69	12,64	0,2	0,3	0,24	0,42
2	12,68	12,64	0,18	0,34	0,2	0,45
3	12,66	12,62	0,21	0,4	0,18	0,44
4	12,63	12,61	0,17	0,33	0,19	0,46
5	12,59	12,58	0,16	0,29	0,22	0,45
	TOTAL		0,92	1,66	1,03	2,22

V. CONCLUSION

1. The Bushing Handling Robot Prototype can work as excpected i.e gripping, lifting and putting an object at the intended place
2. The Bushing Handling Robot Prototype has been able to lift an object with the dimension of 4 inch diameter, 20 cm length and about 500 gr weight
3. The difference of output current value of the driver motor when it's arm went up and down was big enough due to the influence of gravitation force.

REFERENCES

[1] J. Casper, Human-Robot Interactions during the Robot-Assisted Urban Search And Rescue Response at The World Trade Center, Computer Science and Engineering, USF, South Florida, 2002,MS Thesis
[2] Koivo, A.J., Fundamentals For Control of Robotic Manipulators, John Willey & Sons, New York, 1989.
[3] Spong, Mark W., Hutchinson S., Vidyasagar M., Robot Modelling and Control, First Edition, John Willey & Sons Inc., New York
[4] Pitowarno, E., *ROBOTIKA: Desain, Kontrol, dan Kecerdasan Buatan*, CV.ANDI Yogyakarta, 2006.
[5] Wang, Dong-Shu, Xu, Xin-He, Genetic Neural Network And Application In Welding Robot Error Compensation, Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, Guangzhou, 2005.
[6] Kirst, Rudy, Device for Automatic Interchange and Coupling of Gripper to Robots or Manipulating Devices, U.S. Patent number 4.759.686, 1988.
[7] Atmel corp. 8-bit Microcontroller with 8K Bytes In-System Programmable Flash ATMega 8535, *http://www.alldatasheet.com/ATMega8535*, (Accessed at 21 Feb 2012)