Design Robot Arm Movement followers fingered Man using a *flex sensor* with a microcontroller system ATMega 32

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Abstarct. Fingered robotic arm has been used in industry and used in terms of education. Designing fingered robot arm is divided into two parts, the human arm control part (Transmitter) and fingered Robotic Arm (Receiver). Fingered Robotic Arm based of microcontroller that used ATMega 32A on controller and ATTiny 2313 on robot, and use KYL 1020U as wireless tranmission media. Finger of robot is controlled by a flex sensor Spectra Symbols 4.5 inch Series SEN 08606 by utilizing the resistivity of the flex sensor. Flex Sensor is phisically flexible bend sensor so it can followed the movement of human finger motion. Resistance range of flex sensor around 10 KΩ – 40 KΩ. Flex sensor as fingered robotic arm controller has an error with range around 13% - 37,7%. Each increasing 1^o bend of Flex Sensor will increas the resistivity 113 Ω. Increasing of resistance value to bend degree of flex sensor will be invertly proportional with the value of resistivity on Miniservo Motor HS-81, when resistivity on Flex Sensor increas, resistivity on motor will be decreas. Mechanical and Electronic balance design is required to produce the maximum performance of fingered robotic arm.

Keyword : Flex Sensor, resistivity, fingered robotic arm, microcontroller, KYL 1020U

I. INTRODUCTION

World technologies are increasing fastly, exactly on robotic. Nowadays, robots are always involved in human life. Robot is an electrical-mechanic equipment or an equipment which moved automaticaly/ moved by the human order. There are so many kinds of robots such mobile, manipulator, humanoid, flying, footy, network, animalia and cyborg robot[1].

In Industry or factory, robot makes the human jobs easier. Sometimes robot used for a hard, danger and continues jobs, it because robot has a good acuracy and high speed. Robot leg is one of the robots that used in industry as baggage transfer. From economic industry, robot give a lot advantages such as labor savings, improved product quality, reduced material costs and improved overall results[2].

Fingered Robot is a technology that can help people in every job, fingered robot arm simulates the movement of arms and human fingers. In making the fingered robot, it require five (5) pieces of the servo motor as the driving robot arm and five (5) motors miniservo to move the finger robot, the servo motor need a module servo controller to drive and to regulate the motion movement of the robotic arm in order to move it unison and balanced. Robotic arm designed to follow the movement of human arm, with servo drive motors in each joint and robot finger. The robot is controlled using a microcontroller by using ATMega32A, so that the motion of the robot system becomes automatically match to the program created on a controller.

Robot control system is controlled by 5 Flex Sensors as motion sensors on the fingers and potentiometer as motion control to the robot arm. But nowadays, the use of robot arm still dependent on wiring to the robot controller, as an innovation in this design, Report data delivery system or a signal for driving the robot is using a wireless system with KYL 1020u.

II. MANIPULATOR ROBOT BASIC CONCEPTS

Manipulator is a mechanical system that shows the movement of the robot. The mechanical system

consists of a link arrangement (order) and the joint (hinge) which is capable of producing a controlled movement, a feedback circuit is open or closed feedback circuit connected to the joints and can perform movements freely. Some terms in the manipulator robot, namely[3]:

1. Joint is the connection between the link to determine the movement. Picture 1. is an example of joint on the robot.

Picture 1. Joint on the robot

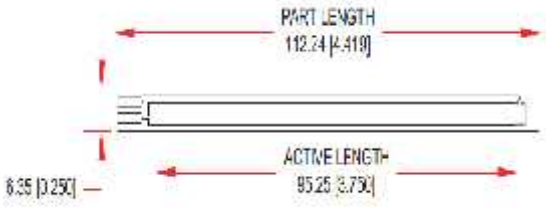
2. Links are parts of rigid frame that connected together to create a kinematic series.

FLEX SENSOR

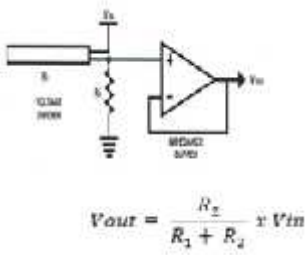
Analog phenomenon commonly measured in the robot's internal systems related to the position, velocity, acceleration and tilt / heeling. Meanwhile, as measured from the outside of the robotic system are associated with the determination of the robot coordinates position to the working room reference[4].

Flex Sensor is a flexible sensor that has a length of 4.5 inch. This bend sensor patented by Spectra Symbol. The flexible sensor obstacle is changed when the metal pads are outside seam. Specifications[5]:

1. Temperature range: -35^{o}C to +80^{o}C
2. Barriers flat: 10K Ohm
3. Tolerance barrier: ±30%
4. Scope obstacles pressure: 60K Ohm
5. Rated power: 0,5 watt to 1 watt



Picture 2. flex sensor dimension diagram Series SEN 08606



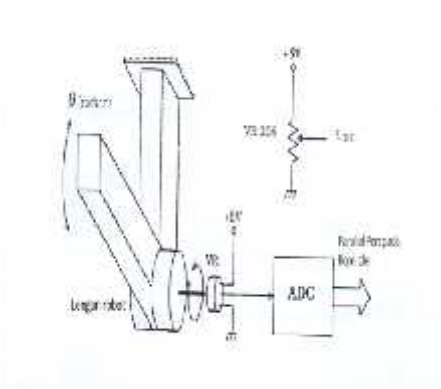
Picture 3. Flex Sensor Basic Concept

(Source: https://www.sparkfun.com/datasheets/Sensors/Flex.pdf)

POTENTIOMETER

In the joint motion fingered robotic arm, it takes a potentiometer which worked as a position control to regulate the movement of servo motors to be controlled by a microcontroller ATMega 32A.

Potentiometer is the most simple but very useful analog sensor for detecting the position of rotation, such as the position angle of the actuator based on the value of resistance in the rotation axis. Picture 4 shows the potentiometer circuit as the controller of the arm robot position. To get the linear result, potentiometer used Linear Potentiometer manifold.



Picture 4. Potentiometer as position controller

(Source : Endra P.,*Robotika : Desain, Kontrol, dan Kecerdasan Buatan*, Yogyakarta : ANDI, 2006, hlm. 60)

MICROCONTROLLER ATMega32A

Microcontroller ATMega32A is a type of Atmel AVR microcontroller products that have many types. AVR microcontroller (Alf and Vegard's Risc processor) has an 8-bit RISC architecture, where all instructions packed in code 16-bit (16-bits Word) and most of the instructions are executed within one clock cycle.

Microcontroller ATMega32A is a type of AVR microcontrollers. On each IC are pin-pound which has its own function, picture 5 is an Atmega32A microcontroller pin configuration and its functions.

Picture 5. Pin configuration on Microcontroller ATMega32A

(Source : Atmel, Datasheet ATMega32A)

ATMega32A pin configuration can be seen in picture 5, it explained functionally ATMega32A pin configuration as follows:

1. VCC is the pin that serves input pin voltage to the microcontroller.
2. GND is the ground pin on the microcontroller.
3. Port A (PA0..PA7) is a pin I / O and ADC input pin.
4. Port B (PB0..PB7) is a pin I / O and special function pin, they are the Timer / Counter, interruptions, and ISP.
5. Port C (PC0..PC7) is a pin I / O and special function pin, namely the I2C, and Timer Oscillator.
6. Port D (PD0..PD7) is a pin I / O and special function pins.
7. RESET pin is used to reset the microcontroller.
8. XTAL1 and XTAL2 are an external clock input pin.
9. AVCC is an input voltage pin for ADC.
10. AREF is the reference input voltage pin ADC.

C Programming Language

The writing structure of **C Programming Language** in general consists of four blocks, namely:

a. Header
b. Global constant declarations or global variables
c. Function or procedure
d. Main courses

PREPROCESSOR

a) Preprocessor #include

Usually used to include the header files (.h) or library files. Include files used to tell the compiler to reads a file that include first to recognize the definitions used in the program, so it is not considered as an error.

#include <. . . . . .> for the standard file location that has been set by tools usually on include folder or directory compiler folder.

#include ". . . . . ." for the location of the file that we set by ourself.

Io.h header file is a file that contains all informations / or definitions of special function registers and bits or pins microcontroller.

b) Preprocessor #define

Used to define constants or macros.

Writing sample :

#define
Indentifier
Konstanta

Example : #define max 100

When max appear, it changes to 100

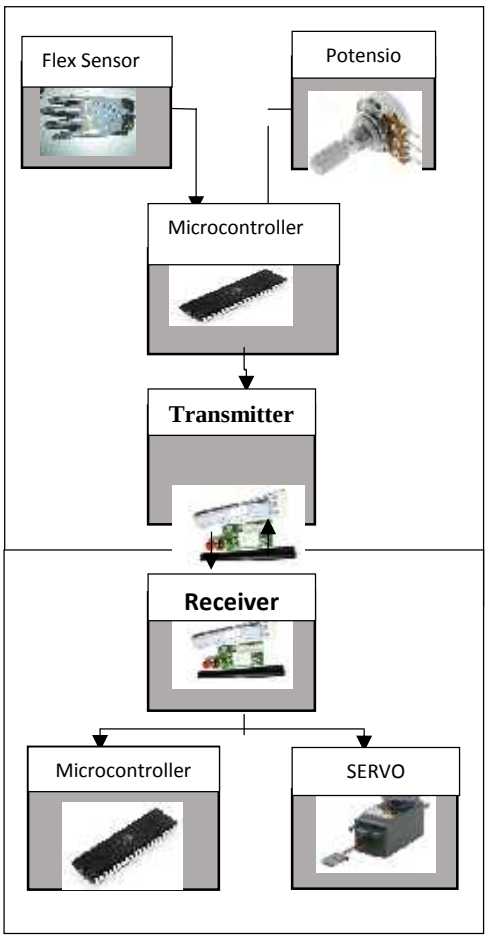
#define
Indentifier
Macro

Example : #define kuadrat
(x) x*x

III. Research Method

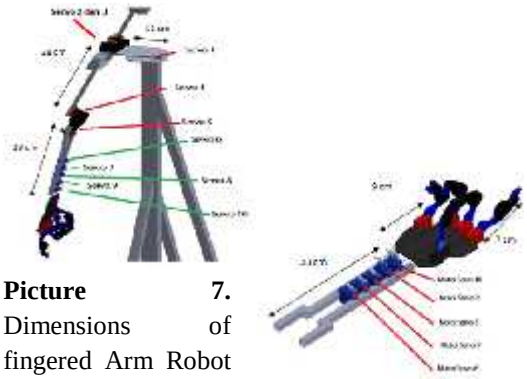
System Planning, The research aims to establish a communication system between the flex *sensor* with the servo motor, can reduce errors that occur at the sensor. When using the system design, the design tool has the objective to get a good final

result as expected, in addition, the presence of design will make it easier to find and repair damage to the equipment or circuit. With the good design it will obtained a device according to the designer tool wishes itself. Under these conditions, in the design of planning mechanical, electronic design, hardware design and software design. Hardware designing built a system block diagram as follows:



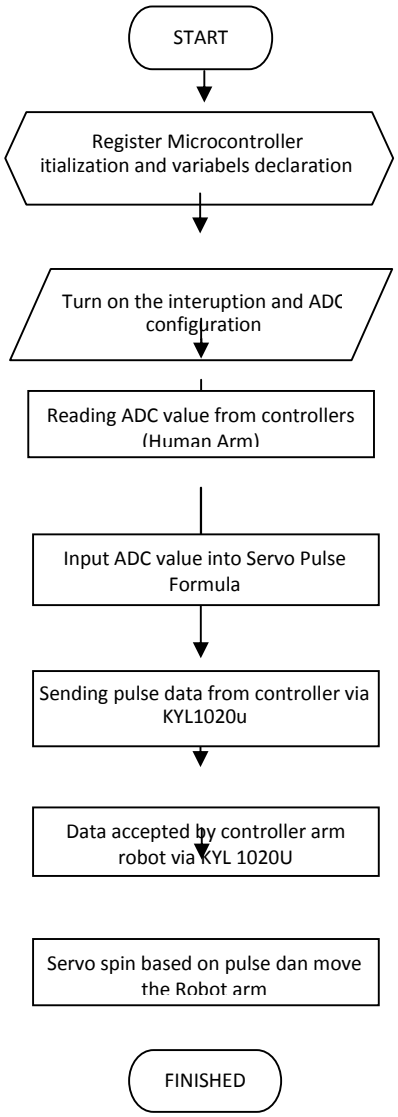
Picture 6. Diagram Block

Mechanical Design, The design of arm robot that made by the authors has joints like human arm, this arm has 9 DOF (Degree of Freedom) which the arm uses 10 servo motors as the driving force. The fingered arm robot consists of 4 DOF in the arms and 5 DOF contained in his fingers, the arm using 5 pieces of the servo motor as the joints driver and there are 5 pieces of the servo motor mounted on the fingers of a robot as a fingers robot driver.



Picture 7. Dimensions of fingered Arm Robot and Fingers Part

Software Design, This flow diagram explaining the process of sending data pulses of all servo motors that we have set previously from the microcontroller ATMega32 to ATtiny2313. Pulse data on all of these servo motors are taken from the program that manages the movement of the arm robot.



Picture 8. arm robot Flowchart control

IV. RESULT AND DISCUSSION

Study of flex sensor Spectra Symbols 4.5 Inch Series SEN fingered 08 606 implementation to the arm robot. Discussing about the flex sensor, changing the resistance value of the degree of curvature in the use of flex sensor as a position sensor driving finger on fingered robot to the arm robot. Measurement is only conducted using a sample of the flex sensors on the little finger because the specification used on the five fingers are the same, the testing process performed include:

1. Measurement Supply
2. Resistance Measurement to change the degree of curvature without load
3. Comparison of electricity on the Transmitter and Receiver

Circuit Testing Supply, in electronic device, the supply is the source of a device itself. The following table is given supply measurements on fingered Arm Robot in Table 1 and Table 2 for the measurement of supply at the control arm.

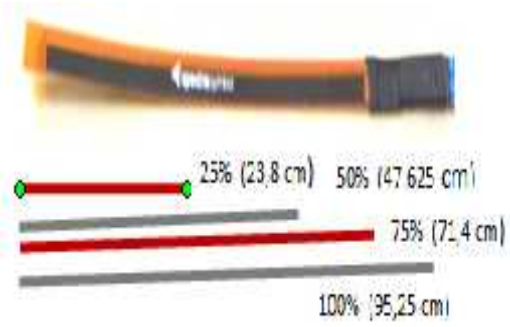
Table 1. Arm Robot Measurements Table

No.	Components Measured	Measurement Result	
		V	I
1.	DC Source (Battery) series TURBO GTZ5S	11,56 V	367 mA
2.	Output Regulator (UBEC)	5,12 V	3,3 A
3.	*Supply* Mikrokontroler ATTiny 2313	5,02 V	0,10 A
4.	*Supply* Modul KYL1020u (Reciever)	5,12 V	24,37 mA
6.	*Supply* Motor Servo Arm	4,8 V	6,7m A
7.	*Supply* Motor Servo Finger	4,8 V	10mA

Table 2. Arms control Measurements

No.	Components Measured	Measurement Result	
		V	I
1.	DC Source (Battery) Merk Eveready	8,9 V	310 mA
2.	Output Regulator (7805)	5,02 V	0,8 A
3.	*Supply* Mikrokontroler ATMega 32A	5,02 V	0,10 A
4.	*Supply* Modul KYL1020u (Transmitter)	5,02 V	72,2 mA
5.	*Supply* Potensiometer	5,02 V	0,25 mA
6.	*Supply Flex Sensor*	5,02 V	0,2m A

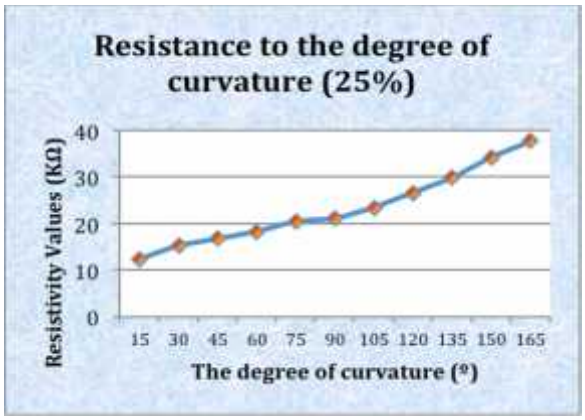
The following picture is an illustration of long flex sensor pad which divided into 4 sections with different percentages to get accurate results at measurement.



Measurement Without load carried on a three (3) pivot point of a flex sensor, ranging from 25%, 50% and 75%.
Table. 3 is a table with the load resistance changes without bending with the pivot point length 25% of the flex sensor overall length.

Tabel 3. Resistance Changes Against degree toward curvature (No Load) (Positions 25%), the initial state = 11.3 KΩ

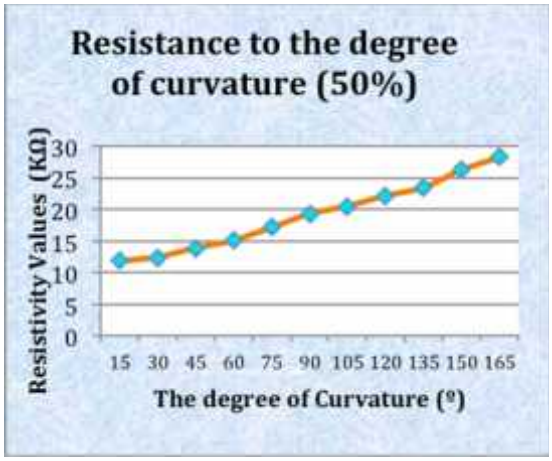
No	Curvature Degree (º)	Resistance Value (KΩ)	Value Resistance Difference (ΔKΩ)
1	**15**	**12,25**	**0,95**
2	**30**	**15,3**	**3,05**
3	**45**	**16,7**	**1,4**
4	**60**	**18,2**	**1,5**
5	**75**	**20,5**	**2,3**
6	**90**	**21**	**0,5**
7	**105**	**23,4**	**2,4**
8	**120**	**26,5**	**3,1**
9	**135**	**29,8**	**3,3**
10	**150**	**34,2**	**4,4**
11	**165**	**37,7**	**3,5**
Average			**2,4**



Picture 9. Graph of Resistance Changes degree toward curvature (25%)

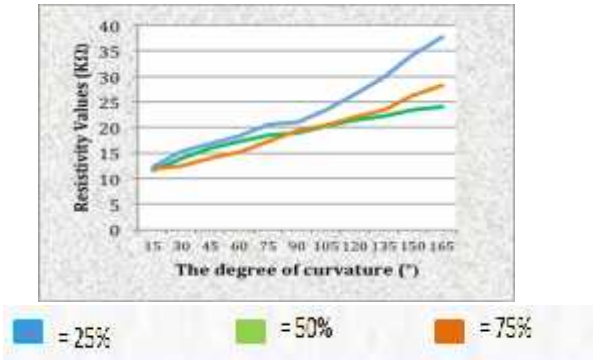
Tabel 4. Resistance Changes Against degree toward curvature (No Load) (Positions 50%), the initial state = 11.3 KΩ

No	Curvature Degree (º)	Resistance Value (KΩ)	Value Resistance Difference (Δ KΩ)
1	**15**	**11,9**	**0,6**
2	**30**	**12,4**	**0,5**
3	**45**	**13,9**	**1,5**
4	**60**	**15,1**	**1,2**
5	**75**	**17,2**	**2,1**
6	**90**	**19,3**	**2,1**
7	**105**	**20,4**	**1,1**
8	**120**	**22,1**	**1,7**
9	**135**	**23,4**	**1,3**
10	**150**	**26,3**	**2,9**
11	**165**	**28,3**	**2**
Average			**1,54**



Picture 10. Graph of Resistance Changes degree toward curvature (50%)

Once there is the value in three (3) pivot points, picture 11 shown the graph comparisons at each pivot point bending.



Picture 11. Comparison of resistance to the curvature of the shaft buckling 25%, 50%, 75%

V. CONCLUSION

1. Flex Sensor Characteristics on the measures which used in the Arm Control has a resistance value 11.3 KΩ to 37.7 KΩ has an error with range from 13% to 37%.
2. Every change in 1^o curvature in Flex Sensor is directly proportional to the increase resistivity of 113 Ω.
3. The increase in resistivity values of Flex Sensor Spectra Symbols 4.5 Inch Series 08 606 SEN is inversely proportional to the value of resistivity in mini servo motors HS-81 while on the move, when the resistivity values of Flex Sensor increase, the engine resistivity decreases.
4. The use of Flex Sensor as controlling robot finger can be used because the physical form is flexible so that it can follow the human finger, but in terms of electrical resistance, generated values experiencing sizable error.

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