



**INTERNATIONAL CONFERENCE  
ON EDUCATION, TECHNOLOGY, AND SCIENCE**

**Improving The Quality of Education  
To Face The Impact of Technology**

**University of Muhammadiyah Purwokerto**

**December 28<sup>th</sup>, 2013**

**P R O C E E D I N G S**



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**International Conference on Education, Technology, and Science**

**NETS 2013**

**Improving The Quality of Education to Face The Impact of Technology**

**PROCEEDINGS**

**Universitas Muhammadiyah Purwokerto**

**Purwokerto, December 28th, 2013**

**Preface**  
**Rector of UMP**

Assalamu' alaikum wr. wb.

Alhamdulillah, that UMP will carry out prestigious event namely "National Olympiad and International Conference on Education, Technology, and Science (NETS) 2013" is a very great news for me. NETS 2013 is the first event which is conducted in collaboration between UMP and PWM Central Java. It is a great event which is constructively supported by ITB, UNiSA, UTeM, and several institutions under UMP partnership to smoothen the event.

Recently, technology grows very fast. This fast growth affects on the quality of education in Indonesia. Based on this condition, UMP and PWM Central Java formulate a program which later it is formed into "NETS 2013". This event is also a contribution to Islamic Higher Education Institution to prepare candidate of future leaders who have competitive skills to compete positively in comprehending knowledge and technology.

In NETS 2013, there are some events which are arranged in a sequence such as: International Conference on Education, Technology, and Science (ICETS) with Prof. Dr. Ir. Imam Robandi, M.T., Mr. Ganjar Pranowo, Mr. Simen Lourds, and Dr. Hiroshi Takeda; Seminar (Call for Paper) including some disciplines of science covering Education, Engineering, Medicine, Science, Social, Politic, Religion, Law, Culture, Arts, Agriculture, and Technology; National Olympiad for Student and Teacher (NOST) which is joined by students, teachers, and schools; and Expo. In NETS 2013 competitions, participants are fighting over trophies, medals, certificates, and advisory fund reaching up to Rp250.000.000,- ; furthermore, there is also a fellowship to study in UMP.

As the Rector of The University of Muhammadiyah Purwokerto, I do really expect that conducting this event could encourage all of us to be more advanced nation not only on economic side, but also on social life. It is also expected that this event will increase our awareness on how important it is to develop and advance technology in education.

That is all I could deliver now, for further information you may access our website on [www.ump.ac.id](http://www.ump.ac.id).

Last but not least, "Let's join and support NETS 2013 in UMP".

Wassalamu' alaikum wr. wb.

Purwokerto, 28th Decembe 2013  
Rector,

Dr. H. Syamsuhadi Irsyad, M. H.

**Preface**  
**The Chairman of NETS 2013**

Assalamualaikum, wr. wb.

Today is the valuable and precious milestones for education in Indonesia in general and Muhammadiyah in particular because all levels of education from elementary schools to university get together to build relationship and networking in the national Olympiad and international conference hosted by University of Muhammadiyah Purwokerto.

We deserve rejoice and pride because there are more than 1705 participants, 215 officials and 300 invited guests. This is also a great honour for University of Muhammadiyah Purwokerto to have the Governor of Central Java and the staffs, the regents from four regions and the staffs, the chief of Central Muhammadiyah Board , the Education division of Muhammadiyah Board, the directorate of higher education, Rectors of University of Muhammadiyah throughout Indonesia and rectors of universities in Purwokerto, companies and stake holders, media , travel biro as well as the colleagues, persistent fighters for Muhammadiyah in the region and territory.

As the chairman of this events, I 'd like to report that there are more than 1616 teachers and students who will be joining the national Olympiad and there are more than 311 researchers, lecturers and students will be taking part in the International Conference. Again, I'd like to emphasis that this event is really a pride for us because the participants are coming representing five big islands in Indonesia, they are Sumatra, Kalimantan or Borneo, Java and Sulawesi.

This event holds thirty one types of competitions and organizing six international conferences. There are twenty five competitions for students, four competitions for teachers and three competitions for schools. The international conference covers fields of Educations, Engineering, Science and Agriculture, Health and Medicine, Culture and Arts, social, Politics, Economics, Religion and Law.

We are proud to mention that we have at least fifteen experts coming from higher education, one from high schools, two industries and one national research centre (LIPI). The experts and scholars are coming from some outstanding universities and institutes such as University of South Australia, Tottori University Japan, Institute Teknologi Melaka, Malaysia, Henderson Secondary School Singapore, Boromanjani College of Nursing Thailand, Surabaya Technology Institute, Bandung Technology Institute, Gadjah Mada University, Bogor Agriculture Institute, and University of Muhammadiyah Purwokerto.

On behalf of the committee, we'd like to express our deep gratitude and thanks to all sides for their sincere helps and supports that make this event possible to happen in UMP. Last but not least, we have tried and done our best in organizing this event, however, we realized that weaknesses and shortcomings may exist. And for that particular reason we'd like to apologize to you all. Hopefully, the next year NETS will be much better and much improved. Have a great competition and conference!

Wassalamualaikum wr.wb.

Purwokerto, 28th Decembe 2013

**The Chairman**  
**Regawa Bayu Pamungkas, ST., MT.**

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## Keynote and Invited Speakers

### Keynote Speakers

Prof. Imam Robandi (ITS, Indonesia)  
Mr. Simen Lourds (Singapore)  
Dr. Hiroshi Takeda (Tottori University, Japan)

### Invited Speakers

Elvia Shauki, Ph.D. (University of South Australia, Australia)  
*Prof. Dr. Mifedwil Jandra Mohd. Janan* (UTM, Malaysia)  
Panarut Wisawatapnimit (Boromarajonani College of Nursing, Bangkok, Thailand)  
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Herman Soemantri, ST., M.Si. (PT. Pertamina)

## Development of Library Codes for Programming the Humanoid Robot Based on CM-510 Module

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### Abstract

Since twenty years ago, when the Indonesia robot contest firstly was held, the techniques and methods of mapping cruising as a aspect of the mobile robot ability undergone more progress. In the contest, the robot teams of Universitas Ahmad Dahlan (UAD) has been using the humanoid robot type or the boloid robot type. The robot programmed by the original software i.e. roboplus. This roboplus program had limitations, particularly in the task programs, because the functions and values was given by the manufacturer so that the programmers in difficult circumstances. This research will develop the library codes for programming the humanoid robots based on the CM-510 module. The library codes developed uses the programming language of Atmel Studio 6 based on C language that can ease for programmer.

The methods used in this research are the design, implementation and testing. Firstly, the designing was done by exploring the functions that provided by the task roboplus. Exploration results used to develop the algorithm and flowchart of the developed library codes. Furthermore, the algorithm implemented by the programming using Atmel Studio 6 software. Testing was done by comparing the results of running the library codes to the default roboplus programs.

The research done has produced five library codes for access: (1) LED (light emitting diode) on the CM-510 module, (2) ADC ports; (3) accelerometer sensor, (4) gyroscope sensor, and (5) LM-35 sensor. Functions produced from this research are two i.e.: (1) to make the robot motion, and (2) to access the switch on the CM-510 module. The developed library codes and functions are simpler and make programmers feel easier.

Keywords: *library code, programming, humanoid robot, CM-510 module*

### Introduction

Since twenty years ago, when the Indonesia robot contest firstly was held, the techniques and methods of mapping cruising as

a aspect of the mobile robot ability undergone more progress. In the contest, the robot teams of Universitas Ahmad Dahlan (UAD) has been using the humanoid robot type or the boloid robot type. The robot programmed by the original software i.e. roboplus. This roboplus program had limitations, particularly in the task programs, because the functions and values was given by the manufacturer so that the programmers in difficult circumstances. This research will develop the library codes for programming the humanoid robots based on the CM-510 module. The library codes developed uses the programming language of Atmel Studio 6 based on C language that can ease for programmers.

Through this research, also will proven that the developed library codes can be used to access the additional sensors such as temperature sensor LM 35. By using the sensor, the humanoid robot can be applied as a fire extinguisher robot in legged division and programming can be done easily.

Development of programming to access the accelerometer sensor has done before by Haryati & Kusumaningrum (2008), Riskiyanto (2011), Alma'i, et al. and Chrismawan (2012). Meanwhile, the development of programming to access the gyroscope sensor has also done by Mubarak (2011) and Riskiyanto (2011) as well as Setyawa and Roni (2011), while the application of dynamixel by Balwell (2011). Mostly, the developments done using the manufacturer's default program. This research will develop the library codes that will make the programmer feel easier in accessing the needed sensors in the development of humanoid robot applications.

### Method

This section will describe briefly: humanoid robot, module CM-510 as the main controller to the robot, Dynamixel AX-12 + as robot actuators, gyroscope sensor, accelerometer sensor, LM-35 sensor, roboplus, Atmel Studio 6 GCC, and development procedures of the library codes using Atmel Studio 6 and testing it.



### The Humanoid Robot

Definition of robot can be found from dictionaries e.g. Online Merriam-Webster Dictionary. From that dictionary, the robot is defined as a machine that looks like a human being and performs various complex acts (as walking or talking) of a human being. Meanwhile, from Bioloid User's Guide, humanoid or bioloid robot is defined by Robotis (2006) as a robot kit where the user can build anything they desire, just like the Lego sets. But unlike the Lego sets, the robot is built with blocks that are actuated, so the joints can move. The name of bioloid comes from the words "bio", "all", and "oid" meaning that any living thing can be built in the form of a robot.

### The CM-510 Module

According to Robotis (2006), CM-510 is defined as a controller module that can be used to store and execute the programs in robotics and control application with the AX series Dynamixel actuators. The controller module is equipped with ports for connection to an external sensor device. Module CM-510 controller is based on ATmega2561 microcontroller from the AVR family of 8-bit RISC.



Figure 1. The CM-510 module

### The AX-12+ Dynamixel Output Module

Furthermore, dynamixel is one type of output modules that can be connected to the CM-510 controller. The module is capable to measure the position, velocity, temperature, voltage and torque. Figure below shows the dynamixel AX-12+ and its internal schematic.



Figure 2 (a). The Dynamixel AX-12+ module

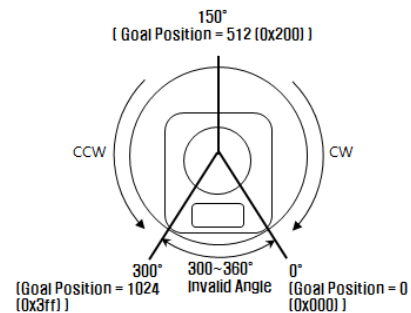


Figure 2 (b). Internal Schematic of AX-12+ The GS-12 Gyroscope Sensor

The Gyroscope sensor is a transducer that is used to measure the acceleration and vibration. This sensor can read the dynamic angular velocity (angular rate). After computing using the integral of data from time to time, the displacement of angle or tilt angle can be calculated. This sensor responsible for maintaining the stability of the robot body so that when the robot perform in difficult movements, still standing upright. Gyroscope sensor specification GS-12, i.e.: (1) range of the angular velocity measurement  $-300^\circ/\text{sec}$  up to  $+300^\circ/\text{sec}$ , (2) operating temperature:  $-40^\circ\text{C}$  up to  $+85^\circ\text{C}$ , (3) voltage of 4.5 V to 5.5 V.

### The MMA7361 Accelerometer Sensor

The accelerometer sensor used in this study is MMA7361 with three-axis, namely X, Y and Z axis. This sensor used on a robot to measure the tilt angle (tilt) when the robot is in static condition. In this case, the robot does not move but just the angle changes, such as the robot falls forward or backward. When the system is rotating or moving, accelerometer sensor can not follow the rapid movement due to slow response and has noise. Readings by the accelerometer sensor on the robot is done by changing the acceleration motion on the robot into a voltage.

### Temperature LM-35 Sensor

LM-35 is a sensor that can measure the temperature. This sensor will change the temperature into a voltage. The sensor works with a voltage of 5 V and from the datasheet, the sensor can read the temperature with sensitivity of  $10\text{mV}/^\circ\text{C}$ .

### Roboplus Software

Roboplus Software is a combination of three software i.e. roboplus manager, roboplus motion and task roboplus. Each has a different function. Roboplus manager serves to regulate roboplus devices that connected to the CM-510

or CM-700. Motion is one of the facilities provided by roboplus, and this program used to design the motion system of the humanoid robot. In this program, there are facilities of page, step, basic poses editor, and poses utility. Roboplus task is one of the facilities provided by roboplus that serves to create and design a program that is used to call the program motion.

#### Atmel Studio 6

Atmel Studio 6 GCC is a C compiler that provided by AVR Studio. AVR Studio is an application by Atmel for making ease in the microcontroller programming. This application is quite complete because it has been equipped with a downloader and simulators. Atmel Studio 6 GCC is a free software, so there are many libraries provided on the Internet.

#### Development of Library Code in Atmel Studio 6

The first stage in the development of the library code are exploring and trying the original program of task roboplus using the PC. The next step is understanding the functions provided by the task roboplus. The next process is making the program flowchart. This flowchart will be used to help researcher making the program library, i.e. the programming and the new library according to the algorithm of the Task Roboplus using Atmel Studio 6 software.

The library name begins with lib word and \*. a extension. Making library file begins with selecting the programming type provided by Atmel Studio 6, i.e. the GCC Static Library. Furthermore, choosing the microcontroller to be used in the library. The next step is save the settings that have been done with the extension \*. a. The next process is write a program or code that is used to fill the microcontroller on the editor sheet. These files are then processed into object files, and object files packaged into a library file (\*. a).

#### Testing

Testing was done by running the roboplus original programs and the developed library programs.

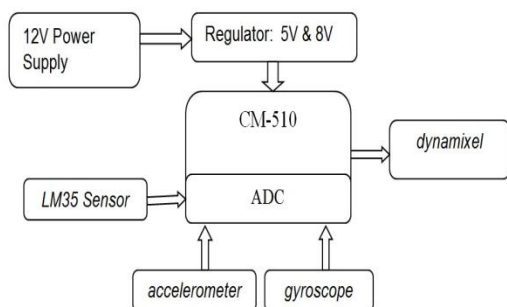


Figure 3. Hardware for testing

Results of running these two programs were compared in terms of performance and the ease of writing programs. Testing requires hardware support as shown in the figure 3.

## Result and Discussion

### Input-Output Function Testing

Input-output function testing was done by programming to control all the LED and the button on the CM-510. The results show that the task roboplus program can just access AUX LED, meanwhile the developed library program can access all the LEDs in the CM-510 module.

The next step is testing for controlling the button on the CM-510 module using the developed library program. According to the test, the program can be used to access all the buttons on the CM-510 module. The tests have shown that the library program can effectively to control all the LEDs on the CM-510 module and also shown that the programmers can make programs easier because it is available in the library programs.

### LM-35 sensor testing

The LM-35 testing sensors using library program has result the data as presented in the figure below.

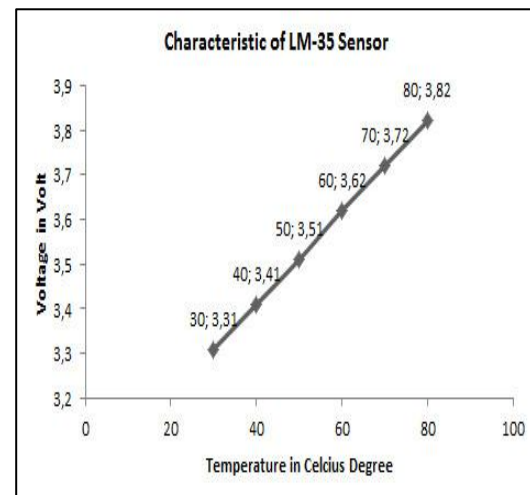


Figure 4. Characteristic of LM-35 sensor

The figure above shows that the relationship between voltage (V) and temperature (°C) that resulted from LM-35 testing is linear. This characteristic is similar to the information provided by the manufacturer through the datasheet. This mean that the LM-35 can convert the temperature to voltage effectively when programmed using the developed library program. So, the developed library can be used to control the temperature sensor LM-35 effectively.

### Testing of Gyroscope Sensor

The results of test using the task roboplus programs and library programs for the X-axis gyroscope shown in the figure below.

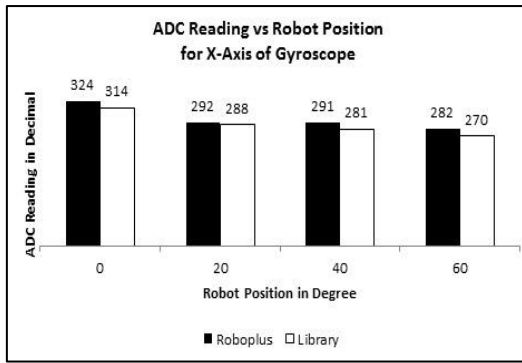


Figure 5. ADC reading for X-axis of gyroscope

As for the Y axis of the gyroscope, test results are shown in the following figure.

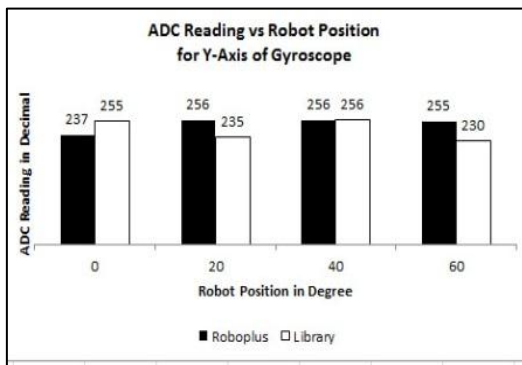


Figure 6. ADC reading for Y-axis of gyroscope

Based on the pictures above, the ADC readings for each robot position showed relatively similar results between roboplus programs and library programs for the X axis and Y axis. So that the developed library program can be used to access the gyroscope sensor and can control it accurately.

### Testing of Accelerometer Sensor

Accelerometer testing was conducted under stationary condition of sensors. Thus, this test aims to test the sensors for measuring the acceleration of gravity. The test was conducted using the task program of roboplus and the developed library program. Test results for the X, Y, and Z-axis of the accelerometer sensors, is shown in the following table.

Table 1. ADC Reading for each axis of accelerometer

$\theta$ ( $^{\circ}$ )	ADC Reading for X-Axis		ADC Reading for Y-Axis		ADC Reading for Z-Axis	
	Roboplus	Library	Roboplus	Library	Roboplus	Library
0	321	320	188	190	285	283
45	322	325	243	246	397	398
90	324	326	351	357	437	439
180	330	331	506	506	239	238

The table above shown that the ADC readings for all axis accelerometer has a value that is relatively similar between roboplus with library programs. This shows that the developed library program can be used to access the accelerometer and provide accurate and effective performance. The advantages of the library program is able to display the value that containing decimal numbers and is easy to write the programs.

### Testing of Dynamixel AX-12 + Sensor

The test results of program to drive the Dynamixel servo shown in table below.

Table 2. Data of AX-12 testing

Number of Test	Goal Position	Degree ( $^{\circ}$ ) of Servo	
		Roboplus	Library
1	0	0	0
2	512	150	150
3	1024	300	300

Goal position is the value sent to the servo for performing the movement. The value for the Dynamixel servo AX-12 + is from 0 to 1024. When the value sent is 1024, servo will move towards the maximum angle i.e. 300 degree. According to the table above, by using the roboplus program or the library program, the servo can move matching to the characteristics of servo Dynamixel AX-12 +. In addition, compared to roboplus, the developed library programs can be used to turn the servo over 7 steps.

### Conclusion

The research done has shown that the developed library programs can be used to access: (1) LED (light emitting diode) on the CM-510 module, (2) ADC ports; (3) accelerometer sensor, (4) gyroscope sensor, and (5) LM-35 sensor. This research also produced

the functions that can be used to make the robot motion, and to access the switch on the CM-510 module. The developed library codes and functions are simpler and make programmers feel easier.

## References

- Alma'i, V. R., Wahyudi, & Setiawan, I. *Application of Accelerometer Sensor for Position Detection*: Faculty of Engineering, Universitas Diponegoro.
- Balwell, N. S. (2011). *Designing of 2 DoF Bilateral Teleoperation System Using Dynamixel AX-12+ With Torque Parameter Control for Increasing the Haptic Sense*. Thesis S1, Unpublished, Faculty of Engineering, Universitas Indonesia.
- Chriawan., Y. A. (2012). *Portable Brakes Test Device for Wheels 4 Vehicle Using Accelerometer Sensor and Force Sensor Based on Microcontroller*. Thesis S1, Unpublished, Faculty of Engineering, Universitas Kristen Satya Wacana.
- Haryati, M., & Kusumaningrum, N. (2008). *Application of 3-Axis Accelerometer for Mesasuring the Tilt of the Satellite Model on Air Bearing*. *TESLA*. 10 (2): 1-2
- Mubarak. (2011). *Rotation Detector Using Gyroscope Sensor Based on ATmega8535 Microcontroller*. Thesis S1, Unpublished, Universitas Diponegoro.
- Riskiyanto.(2011). *Designing of Stabilization System for the Humanoid Robot Using Accelerometer and Gyroscope Sensor*. Thesis S1, Unpublished, Faculty of Engineering, Universitas Ahmad Dahlan.
- Robotis. (2006). *Bioid User's Guide*. Seoul: Robotis, Inc.
- Setiawan, Roni. (2011). *Designing of Soccer Humanoid Robot Using a Motion Programming*. Thesis S1, Unpublished, Faculty of Engineering, Universitas Negeri Yogyakarta.