**P r o c e e d i n g I n t e r n a t i o n a l C o n f e r e n c e , 2 0 1 3 , * , * * - * *
The 4th Green Technology Faculty of Science and Technology
Islamic of University State Maulana Malik Ibrahim Malang**

Implementation Of Multi Sensor System For MSR-H01 Hexapod Robot

Yunifa Miftachul Arif[1], Fachrul Kurniawan[2]

[12]Teknik Informatika, Fakultas Saintek, UIN Maulana Malik Ibrahim Malang, Malang, Indonesia

Email: yunif4@gmail.com

ABSTRACT

This research discusses about the system control model of hexapod robot. MSR-H01 is the hexapod robot kit, which equipped with pBrain system that controls every mechanics movement. Data communication between the microcontroller and pBrain using RS 232 serial communication standard. The hexapod robot use a lot of input sensors with microcontroller ATMega 128 as the main controller. The sensors are ultrasonics that serves to determine the environmental conditions and obstacle around the robot. The ultrasonic sensors also give reference to microcontroller to determine the motion commands that send to pBrain. The results shows that the robot can walk along the wall on a flat track with a maximum speed of 0.15 m / s.

Keywords
control, hexapod robot, ultrasonic sensors, microcontroller.

INTRODUCTION

Robot is an automated equipment that made to replace the functions that had been performed by humans . However, in the subsequent development , the robot is defined as a programmable multi- functional manipulator , that the programming was intended to do a specific task (Arif, 2011). In order to work automatically, robots need sensors to determine the condition of the environment . The robots that can migrate is referred as a mobile robot , generally also have sensors that are used to detect objects around the robot , especially the object in the movement path area.

The growth of technology also make more rapid progress towards sensor technology. Starting from the proximity sensor, metal, temperature, heat, light, and the image sensor can be obtained easily and inexpensively . To determine the distance of the object and the obstacle , the mobile robot use the proximity sensor . The proximity sensor is able to use this type of ultrasonic sensors or infrared sensors .

The proximity sensors that used in this research are type of ultrasonic sensors. Sensing process that performed on the sensor uses the reflection of sound methods for calculating the distance between the sensor with the target object (Hani, 2010). The ultrasonic sensor is a sensor that works by utilizing voice wave, so the bright and the dark interference from ambient light becomes smaller . This is different with the working principle of infrared sensors , which utilizes reflected light to determine the distance , making it more vulnerable to the interference of light in the environment .

Mobile robot system is expected to detect and determine the condition of the broader environment , not just in front of the robot but also the side of or behind the robot mechanics . Therefore, by knowing the wider environmental conditions , the system will be able to plan the movement of the robot path toward the goal , find the shortest path and can plan the movement to avoid the obstacle . By using more sensors , the robot is expected environmental conditions to determine the wider environment condition and detail as expected .

MATERIALS AND METHODS

Function Oriented Robot

Robot systems that discussed in this study belongs to the function oriented robot model , which has the main components , such as: mechanical robots , sensors , actuators and controller system (Pitowarno, 2006).

Fig. 1 Illustrated the function -oriented robot system.

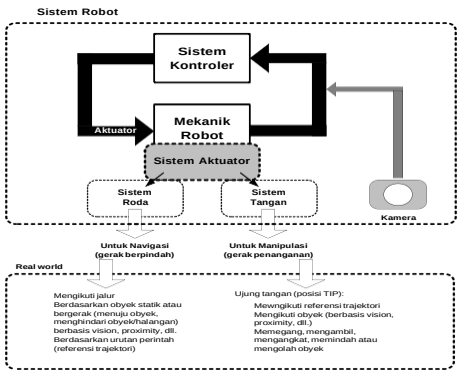

Figure 1 *Function Oriented Robot System*

MSR-H01 Hexapod robot

This research uses the MSR - H01 Hexapod robot as a mechanical system which is then controlled using a microcontroller ATMega 128 . MSR - H01 is a robot module that has 6 pieces each leg with 3 DOF (Degree Of Freedom) of every leg . Each DOF is driven by a servo motor -type xx as the actuators. Model MSR - H01 Hexapod robot is shown by **Fig. 2**.

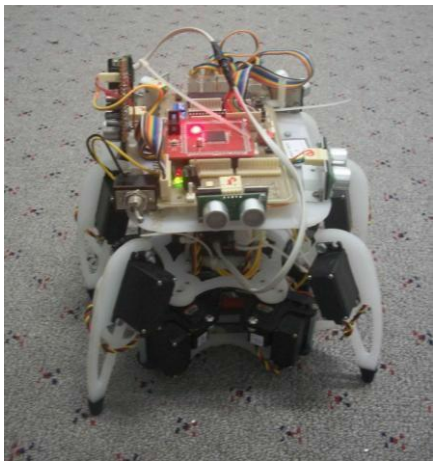

Figure 2 MSR-H01 Robot Kit

MSR - H01 is equipped with a hardware system that controls each mechanical servo system , the system is called the pBrain (Micromagic System, 2009). Furthermore pBrain can communicate with other systems such as a computer or other type of microcontroller minimum system.

Atmel AVR Microcontroller ATMega 128

AT Mega 128 ss a control function input / output that used in this research. AVR is a series of 8-bit CMOS microcontroller Atmel artificial , based on RISC architecture (Reduced Instruction Set Computer). Almost all instructions are executed in one clock cycle. AVR has a 32 x 8 general-purpose registers, timer / counters flexible with compare modes, internal and external interrupts, a serial UART, programmable Watchdog Timer, and power saving mode. AVR also has In-System Programmable on-chip Flash allows the program memory to be reprogrammed in the system using the SPI serial connection . ATmega128 is an 8-bit CMOS microcontroller low-power RISC -based architecture is enhanced .

Most of instructions is done in one clock cycle, the ATmega128 has a throughput approaching 16 MIPS per MHz makes the system designer to optimize power consumption versus processing speed (Datasheet ATMega128).

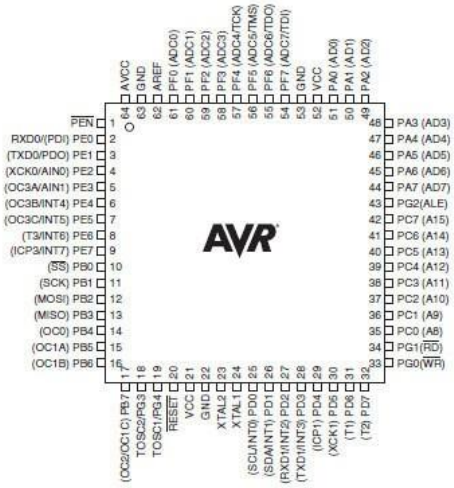

Figure 3 ATMega 128

ATmega16 pins on the 53 - pin programmable I / O line package as shown in Figure 3 . Software programs that are used to fill in CodeVision AVR microcontroller AVR is C programming language.

Ultrasonic sensors

The ultrasonic is a sensor that works on the principle of reflection of sound waves and used to detect the presence of a particular object in the area above the operating frequency 40 KHz to 400 KHz . Large amplitude of the electrical signal generated depending on the sensor unit receiver remote objects is detected nearby .

Sensing process that is performed on the sensor, uses the reflection method to calculate the distance between the sensor with the target object . The distance between the sensors is calculated by multiplying half the time spent by the ultrasonic signal travels from the sender circuit signal (Tx) to the signal received by the receiver circuit (Rx) with a propagation speed of the ultrasonic signal in the propagation medium digunakannnya , namely air . Propagation speed of the ultrasonic signal in air is 342 m / s , equal to the propagation speed of sound in air. In this

research, ultrasonic sensors are used as robot sensor to determine the distance of objects around him (Suprapto).

System Design And Implementation

Design of hexapod robot is the main topic in this research that divided into several sections, ranging from sensors, microcontroller minimum, and actuators. There are illustrated by the block diagram that shown in **Fig. 4** .

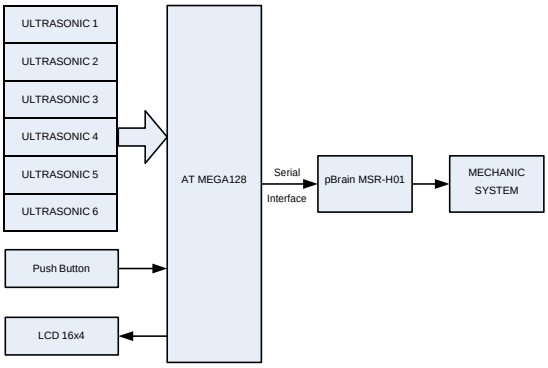

Figure 4 *Block Diagram Sistem*

Hexapod robot constructed using 6 ultrasonic sensors to detect objects. Each sensor is connected directly to the microcontroller ATmega128, as a reference microcontroller to give commands to the motion control of mechanical systems by pBrain MSR - H01 .

System that shown in **Fig. 5** is equipped using a pushbutton input that serves as the user interface between the robot and a human, especially for command start , reset , and other commands . 16x4 LCD is used as the output of a system which can display some information , especially relating to the condition of each sensor .

Control System Based ATMega 128

ATMega 128 in this study is used as the main control that regulates all forms of robot motion through pBrain , the condition of the ultrasonic sensor input and commands from the push button . Configuring PORT I / O ATMEGA 128 is shown through **Table 1** ..

Tabel 1 *Configuration I / O PORT ATMEGA 128*

PORT	Function
A.0, A.1	Triger and Echo Ultra 1
A.2, A.3	Triger and Echo Ultra 1
A., A.5	Triger and Echo Ultra 1
A.6, A.7	Triger and Echo Ultra 1
B., B.1	Triger and Echo Ultra 1
B.2, B.2	Triger and Echo Ultra 1
C.0 – C.7	LCD Display
D.2, D.3	RX, TX serial communication
F.0 – F.3	Push button

Electronic circuit which includes of ATMega128 minimum system which becomes the main control hexapod robot in this research is shown in **Fig. 5.**

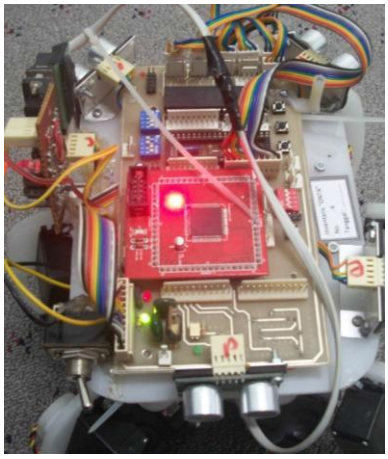

Figure 5. *Electronic circuit of Hexapod robot*

Ultrasonic Sensors Configuration

Ultrasonic sensors prepared by the concept of circular as shown in **Fig. 6**. The aim is that the robot can know all objects existing conditions in the surrounding environment .

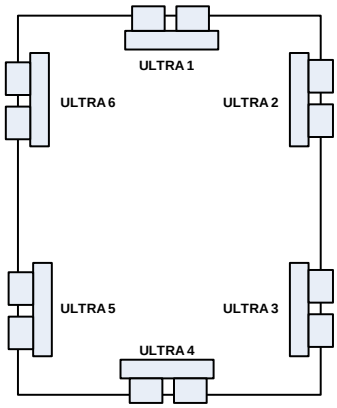

Figure 6. The Structure of ultrasonic sensor

RESULT AND DISCUSSION

Hexapod robot that became in this research can be automatically moves based on input from the ultrasonic sensors is controlled by ATMega 128 . Furthermore, the output of ATMega 128 associated with pBrain kit that can be translated into mechanical movement of the robot. pBrain has characteristics, waiting " @ @ @ " character from microcontroller before execute the commands through simkontrol. The Commands sent to the pBrain microcontroller is shown in **Table 2** . While examples of an initial order to be able to communicate with pBrain is shown in figure 7 which contains the source code in C language programs are created using AVR CodeVision .

```
File  Edit  Format  View  Help
while(datax[0]==0);
while(hit<500)
{
  sprintf(lcd,"%3d %d",datax[0],hit);
  lcd_gotoxy(0,0);
  lcd_puts(lcd);
  hit++;
};

lcd_gotoxy(9,0);
lcd_putsf("@@@");
rx_buffer1[0]=0;datax[0]=0;hit=0;

            for(x=0;x<3;x++)
            {
             putchar1('@');     //@
             delay_ms(10);
            };

while(datax[0]==0);
putsf1("SIM CONTROL");
putchar1(13);          //ENTER
```

Figure 7. *SourceCode of initial communication with the microcontroller pBrain*

Table 2 *Microcontroller commands to pBrain*

Key	Description
+	Raise Power Hexapod
-	Reduce Power Hexapod
SPACE	Stop hexapod
!	Emergency Stop (turn off the servo directly)
W	Forward
S	Backward
A	Turn left
D	Turn right
Q	Crab left (oblique way)
E	Crab right (slanted street)
1	Wave mode 1 (slow)
2	Wave mode 2
3	Wave 3 modes
4	Tripod mode (fast path)
5	Onroad modes (flat terrain , fast)
6	Offroad modes (slow , terrain obstacles)
7	Lowering the transfer rate 0.1second feet
8	Increase the transfer speed of foot 0.1second
9	Resetting the transfer rate to the default leg

R	Reset the position of the foot to normal
B	Enable 3D mode full balance
C	Full 3D mode disables balance

While the example command to generate mechanical motion robot sent to pBrain shown by **Fig. 8.**

```
File  Edit  Format  View  Help
while (1)
{
  while(PINF.1);
  lcd_clear();
  lcd_gotoxy(9,0);
  lcd_putsf("WAKE");
  putchar1('+');        //berdiri
  delay_ms(6000);

  putchar1('6');        //offroad mode
  hit=0;
  while(hit<6000)
  {
    sprintf(lcd,"%d",hit);
    lcd_gotoxy(0,0);
    lcd_puts(lcd);
    putchar1('r');      //jalan ditempad
    if (!PINF.1) goto vv;
    hit++;
  };

  for(x=0;x<5;x++)
  {
        putchar1('8');        //increase speed
        delay_ms(10);
  };
```

Figure 8. SourceCode motion commands to the microcontroller pBrain

Fig. 8 shows some of the basic commands are sent to pBrain. Among them is a standing order by sending the characters " + ", go into the off-road mode with the character " 6 ", the way place with character " r ", and increase the speed by sending the character " 8 ". Offroad mode in question is the movement of a robot with legs on tiptoe , so that the robot body can be lifted higher, with the aim to pass through irregular terrain / wavy.

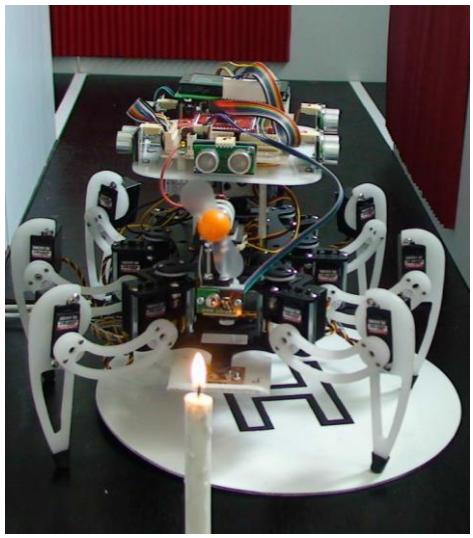

Figure 9 Trials the robot on the track

In the pilot phase, the hexapod robot models run on some tracks, flat, flat on the carpet and bumpy. **Fig. 9** shows the test robot when run on a flat track. Track corrugated referred to in this research is a flat track with some obstacle barrier , thus forming a bumpy track . Modes are tested in this study using off-road mode and the results are shown in **Table 3.** .

Table 3. Test hexapod robot in 3 tracks

Trial	***Track***	**Average speed**
1.	Flat	7 m/s
2.	Carpet	13 m/s
3.	Wavy	16 m/s

According to the test results shown in **Table 3** , that is basically using offroad mode hexapod robot can still run on 3 different tracks . In terms of speed , hexapod robot can run faster on flat track to reach 7 m/s .

CONCLUSION

Conclusions and further research plans can be described from the results of this research are as follows :

1. Control systems using proven off-road mode can be used by the MSR - H01 hexapod robot to be able to move on a flat track , carpet , or wavy. With a maximum speed of 7 s / m on a flat track , and the latest on a bumpy track with a speed of 16 s / m.
2. Need more research on the use of other hexapod control modes, including onroad mode and a tripod mode . So further research directions can discuss automation system mode changes based on environmental conditions encountered .

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