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Educational Robotic Construction Kit: Bioloid

Jea-Kweon Han*, In-Yong Ha*
Byoung-Soo Kim *

* ROBOTIS Co., LTD.,
Seoul, Korea (Tel: 82-2-2168-8787; e-mail: jkhan@ robotis.com)

Abstract: Bioloid is an educational robotic construction kit for building robots using special modular DC servo blocks. These smart serially controlled servos allow the user to build multiple types of robots such as humanoid, puppy, spider or car. In this paper, we have introduced the concept and contents of Bioloid. It is suitable for both the people who try to study robots without professional backgrounds and who are interested in various area of a robot such as dynamics, vision control or speech recognition. For this reason, we are convinced that it will contribute to development of robot industry.

1. INTRODUCTION

Bioloid is an educational robotic construction kit for building robots using special modular DC servo blocks. These smart serially controlled servos allow the user to build multiple types of robots such as a humanoid, a puppy, a spider or a car.

As well as great hardware, the GUI based software utilities were developed in order to make servo control easy. The list below is the main contents of Bioloid.

- CM-5 Controller board (Atmel ATMega128 @ 16Mhz)

- 18 controlled servo's(UART@1Mbps one-wire RS485)

- 1 Sensor module

- Rechargeable battery pack (9.6V)

- 2 Programming Utilities (freeware)

- Power Supply

- Serial Cable (9pin D-type)

- An assortment of frames, wheels & tires, and spacers, bushings, nuts & bolts
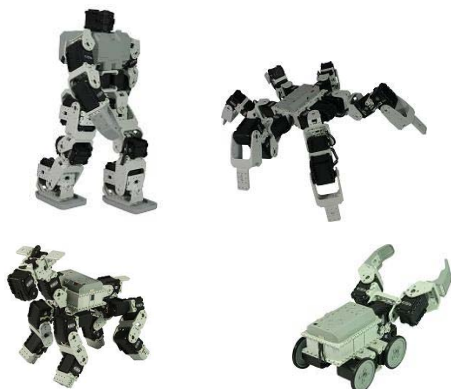

Fig. 1. The Application of Bioloid

2. DEVELOPMENT OF A DC SERVO MODULE FOR ROBOTS

Unlike conventional R/C servos that use PWM, the DC servo module, Dynamixel, used for the Bioloid kit are special bilateral servos operating on a network with feedback function. It has wide range of motion (300 degree) with an option for continuous rotation for use as wheel actuators. The main features being:

- Reduction Ratio: 1/254

- Holding Torque: 12.5kg-cm (@ 7V)

- Speed: 0.196sec/60° (@ 9.6V)

- Serial Network (TTL) (7343bps ~ 1Mbps)

- Feedback of Shaft Position, Velocity, Temperature, Input & Load Voltage

- Ability to specify the Compliance Driving Settings

Fig. 2. DC Servo module: Dynamixel.

3. DEVELOPMENT OF A SENSOR MODULE

The Bioloid kit includes a sensor module with various functions as below.

- One IR receiver

- 3 IR reflection sensors (Left, Right & Front) that can be used to measure distance and luminosity

- One microphone, and One piezo-electric sounder that can be used to play musical scales or simple a beeping sound.

4. UNITS DEVELOPMENT OF A CONTROLLER

A controller, CM-5, is based on popular 16Mhz processor Atmega128 from Atmel. The controller board comes inside an encasing with leds and buttons that allow for some touch-activated operations and status lights that indicate various states of the robot modes.

Bioloid comes installed with a default firmware and bootloader. The default firmware allows for software utilities to operate via the serial cable interface. The firm ware on the CM-5 can be replaced by proprietary software that the user can create using standard Atmel compiler tools.

5. COMMUNICATION

Bioloid uses standard UART serial communications (as used in RS232) at 1mbps. However, the wiring of the serial bus is such that only one line is used for both RX and TX. This is also known as RS485. The schematic below shows how the 3-wire serial bus is implemented within the CM-5. Users can add proprietary sensor boards to the Bioloid control bus.
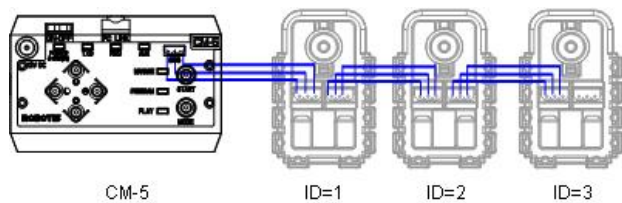

Fig. 3. *Schematic of Connecting Dynamixels*

6. COMMUNICATION VERSATILE CONSTRUCTION USING UNIVERSAL CONNECTION MECHANISM

Bioloid robots can be constructed in different ways thanks to its ingenious brackets and various mounting locations with each component. The diagram below shows the casing of both the AX-12 and AX-S1. You can see on this diagram that there are a number of mounting locations where M2 nuts can be slotted in and held in position. This design allows the many frames included in the Bioloid kit to connect to the AX-12's and AX-S1's easily.
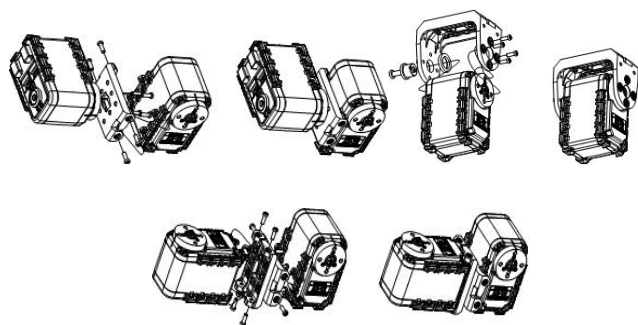

Fig. 4. *Assembling modules*

7. DEVELOPMENT OF SOFTWARE UTILITIES

There are two software utilities that come with the Bioloid kit. These are:

- Motion Editor: a GUI that allows users to create motion sequences

- Behaviour Control Program: a GUI that allows users to program sequences of events/motions.

Motion Editor in conjunction with the Behaviour Control Program allows the programmer to use the Motion Editor to generate the robots motion sequences and then use the Behaviour Control Program to implement the logic (or intelligence) of the robot.

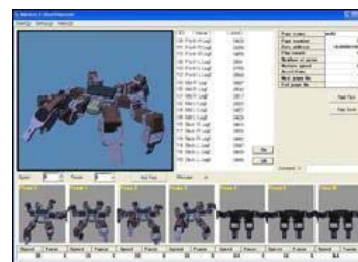It is also possible to program the Controller using freeware C compilers

Fig. 4. *The Software Utility*

8. DEVELOPMENT OF SOFTWARE UTILITIES

In the case of humanoid, it takes 2 seconds to walk 550 mm. As considering its height is 352mm, it can walk 0.78 times the distance of its height. Comparing it with a human whose height is 170 cm, it supposes the velocity of gait to be 4.7km/h.
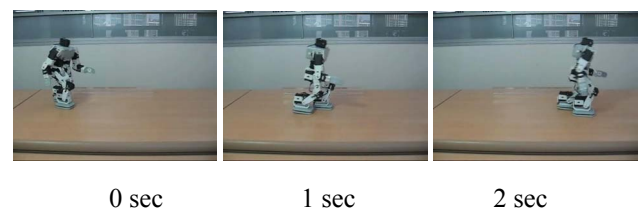

| 0 sec | 1 sec | 2 sec |

Fig. 5. T*he Test of Bioloid-Humanoid's Gait*

9. CONCLUSIONS

In this paper, we have introduced Bioloid's concept and contents. This robot kit is suitable for the people who try to study robots without professional background or who are interested in other area excluding dynamics such as vision or speech recognition. For this reason, we are convinced that it will contribute to development of robot industry.