Paper:

Device Distributed Approach to Expandable Robot System Using Intelligent Device with Super-Microprocessor

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Conventional robot system design is either classified as a built-in centralized approach in which one processor on a robot controls all devices or as a module distributed approach in which several processors in a built-in network communicate and each processor controls several devices. The built-in centralized approach is limited by the number of devices on the robot. The module distributed approach has no such limitation, but requires changes in software or built-in network topology when devices are added.
This paper describes a device distributed approach to realize a simple, expandable robot system that enables a number of devices to be attached or added to a built-in robot without significant changes to software and hardware. The robot system based on a device distributed approach consists of a serial bus connected to intelligent devices. Each device such as sensors and actuators has a processor for communication and calculation, so devices are added by connecting them to the serial network.
We developed intelligent servos and intelligent sensors as prototypes of intelligent devices using super microprocessors with a 3 3 mm footprint, and build small humanoid robots to confirm the expandability of a robot, in which intelligent servos realize a wiring saving robot, a many DOF robot, and easy device addition.

Keywords: robot system, intelligent device unit, sensors, actuators, small humanoid robot

1. Introduction

Experimental research using small humanoid robots enables researchers to realize whole-body behavior and visual-auditory interaction in the real world. In these experiments, researchers must make trials using humanoid robots. Therefore a robot system able to realize robots with various sensors and actuators easily is important. In other words, an expandable robot system is required that does not limit the number of devices and that enables devices to be added easily.

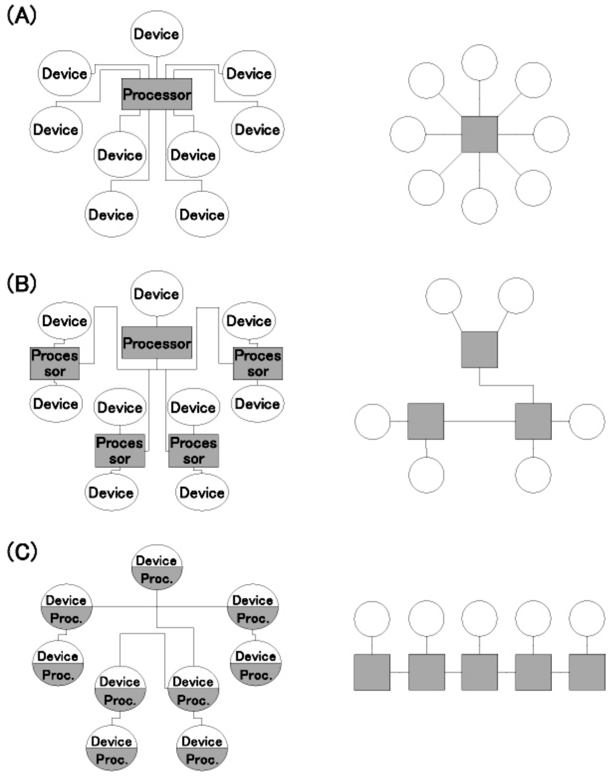
In this paper, we propose a simple, expandable robot system using bus-connected intelligent devices each having a processor. This enables researchers to build a robot with a number of devices and to add devices without changing software and hardware. This architecture realizes a rapid prototyping environment for building robots.

Designs of previous robot systems commonly use a built-in centralized approach in which one processor on a robot controls all devices. This limits the number of connectable devices. Some researchers developed a module distributed approach in which several processors communicate while each processor controls several devices. Although this approach removes the restriction on the number of devices, software and hardware must be modified when adding devices to an existing network.

We prototyped intelligent servos and sensors using a very small microprocessor with a 3 3 mm footprint, which we call a super-microprocessor. Small humanoid robots are developed using intelligent units. These robots have proven that our proposed approach reduces wiring required for a robot, enabled us to develop a robot with a number of degrees of freedom, and enabled us add devices easily.

2. Robot System Design

In this section, we classify design of a robot system into three approaches — a built-in centralized approach, a module distributed approach, and a device distributed approach based on the relationship between processors and devices in a robot system. We summarize these approaches for simplicity and expandability of a robot



(A) On-body centralized, (B)Module distributed , (C) Device distributed

Fig. 1. Robot system design concept.

system, which involves the limitation on the number of devices attached to a robot and is able to add devices without difficulty.

2.1. Built-in Centralized Approach

The built-in centralized approach has one processor on a robot and all devices in the robot such as actuators and sensors are connected to this processor as shown at left in **Fig.1(A)**. This approach uses a star network topology as shown at right. Research-oriented robots [1-5] use this approach. In our remote-brain robotics approach [6], the first generation with one microprocessor built in introduces this approach.

This simple approach has the advantage of easy maintenance and simple software design, but, the number of devices able to be attached to a robot is limited to the number of I/O ports of the built-in processor. When adding devices to a system, a new device can be added if an unused I/O port exists on the processor, but not without such an I/O port. All electrical connections must be rewired when adding a new device, which requires much time.

2.2. Module Distributed Approach

The module distributed approach has several processors on the robots, which communicate through the built-in network, while each processor controls several devices as shown at left in **Fig.1(B)**. The star-bus network topology is used as shown at right in the figure, where each processor functions as a hub and each device function as a node. In the remote-brain robotics approach, the second generation uses a built-in LAN approach.

This approach removes the restriction of the number of devices attached to the robot, the problem of the built-in centralized approach. When adding devices even with no I/O port available, new devices can be added to the network by adding new processors.

Adding new processors to a built-in network may require that software configurations be modified, which requires developers to rewrite programs for each processor - a time-consuming job. Alternatively, plug and play software is required to reduce modifications. These makea module distributed approach difficult to implement.

2.3. Device Distributed Approach

The device distributed approach consists of bus-connected intelligent devices in which each device has a processor with communication and computation as shown at left in **Fig.1(C)**. A bus network topology is used as shown at right.

This approach does not limit on the number of devices added, which simply involves adding a device to a robot bus network, without software or other modification or rewiring of the built-in bus network.

Therefore, the device distributed approach enables a robot to have devices added simply and expandably, without limitation on the number of devices added.

2.3.1. Device Distributed vs Module Distributed Approach

The module and device distributed approach uses a master processor that sends and receives messages to all devices. In the device distributed approach, when adding new unit to the existing network, software in this master processor must be changed, and software in devices remain the same. In the module distributed approach, when adding new units, software in both master and device processors must be changed, or sophisticated, complex software providing plug-and-play required. In general, software with complex configuration requires time consuming development and is difficult to maintain. The device distributed approach enables expandable robot system with a simple software architecture.

The device distributed approach is regarded as a special case of the module distributed approach, when each processor in the module has only one device. However when adding a new device to a robot based on the module distributed approach, new subject arises, i.e., a new device is connected to an existing module processor or a new device and new processor are connected to a built-in bus as an additional module. This procedure causes another problem if there is enough space for new modules inside robot’s body. By introducing the device distributed approach, adding a

Table 1. Classification table of robot system design.

	(A)	(B)
On-body Centralized	×	△
Module Distributed	○	△
Device Distributed	○	○

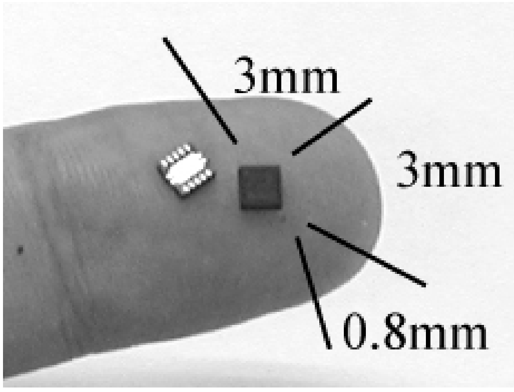


Fig. 2. Super micro processor: Cygnal C8051F300.

new device to a robot via a bus network is very simple and no software or other device modification or rewriting of the built-in bus network is required.

Table 1 summarizes the three approaches. The built-in centralized approach limits the number of devices in a robot - a restriction not shared by the other two approaches. The module distributed approach requires time-consuming software reconfiguration and the device distributed approach enables easy, simple software configuration.

2.4. Related Work

Previous research on the robot system design, especially distributed design, uses the module distributed approach. To the best of our knowledge, the device distributed approach for building a simple, expandable robot system design has not been addressed. Indeed, previously proposed systems build a robot device distributedly, either focusing on simplicity and expandability or on adding device to an existing built-in system easily, or developed units with a processor and a device and a real robot using their own systems.

Fujita et al. proposed Open-R [7], in which sensors and actuators have common interfaces and hot plug-in and plug-and-play capabilities. This system has no limitation on the number of devices on a robot, but adding additional devices is not described in detail.

They developed a quadruped robot AIBO and a humanoid robot SDR-3X/SDR-4X based on Open-R architecture. SDR has the Intelligent Servo Actuator (ISA) which a small microprocessor, a DC motor and gears in one module package, similar to our device distributed approach with intelligent devices each having

Table 2. Specifications of Cygnal/C8051F300 supermicro processor.

CPU Core	8051
Clock	25Mips/Peak
Flash Memory	8k byte
RAM	256 byte
Operating Voltage	2.7-3.6V
Internal Oscillator	Yes
I/O ports	8 (5V talerant)
Uart	1
I^2C/SMBus	Yes
Timer	16bit × 3
ADC	8bit × 3
PCA	Yes
Package	MLP11

a device and a super-microprocessor. Sensory devices in SDR do not have their own processors, which our intelligent sensors have. Therefore, adding additional sensors to SDR may require changes in software and wiring configurations.

Yamasaki et al proposed Responsive Link, which has real-time and reactive functions and a Responsive Processor that is a SPARC-based system-on-chip processor [8]. It also supports hot plug-in and plug-and-play and enables developers to develop a distributed system with arbitrary topology. Therefore, it is able to realize the device distributed system, but the developed chip is designed to control from two to four motors from one processor.

Koyasako et al. developed On-body LAN [9] to remove restrictions on the number of devices in the first generation of remote-brain robots with the built-in centralized approach. They have developed electrical circuit modules connected by the I2C bus. This module is small enough to attach to small humanoid robots and controls up to five servomotors, so this is the typical module distributed approach.

Furuta et al. developed a small humanoid robot with a built-in network system [10]. They developed both built-in brain and I/O modules responsible for controlling up to three motors.

Fukushima et al. proposed a TITechWire [11]. They developed an original bus that has real-time and extendaability and modules with IBM-PC-compatible small processors able to control several motors and sensors.

3. Prototype of Intelligent Device

We developed servos, sensors, and communication units as prototypes of intelligent devices using commercially available super-microprocessors.

```
 1:  for (i = 0; i < MOTOR_MAX; i++) {
 2:    TARGET=i+1;
 3:    SMB_DATA_OUT_NO = 3;
 4:    SMB_DATA_OUT[0] = ref[i];
 5:    SMB_DATA_OUT[1] = pgain[i];
 6:    SMB_DATA_OUT[2] = dgain[i];
 7:    SLA_Write();
 8:    SLA_Read();
 9:    pot[i] = SMB_DATA_IN[0];
10:  }
11:  TARGET=ADXL_ID;
12:  SMB_DATA_OUT_NO = 0;
13:  SLA_Write();
14:  SLA_Read();
15:  adxl[0] = SMB_DATA_IN[0];
16:  adxl[1] = SMB_DATA_IN[1];
17:  adxl[2] = SMB_DATA_IN[2];
```

Fig. 3. Software examples in intelligent communications unit.

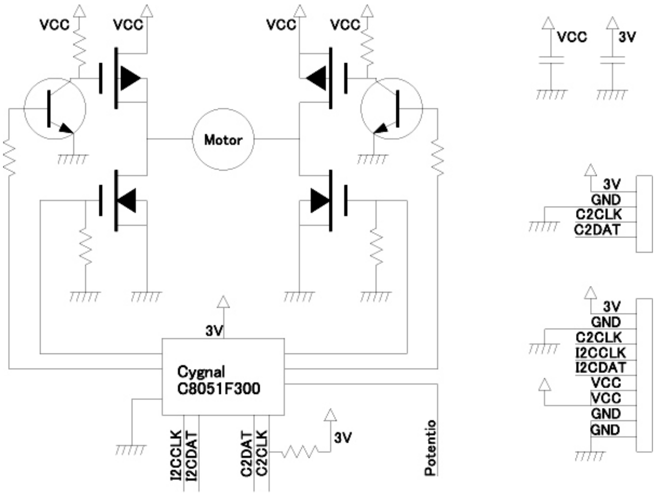


Fig. 4. Basic circuit diagram of intelligent servo unit.

3.1. Cygnal C8051F300

Cygnal C8051F300 manufactured by CYGNAL Integrated Products, Inc., is shown in **Fig.2** and specifications are listed in **Table 2**. A package of this processor is MLP-11 which is 3 3 mm. It contains 8 Kbyte flash memory, 256 byte RAM memory, a high-speed 8051uC core, 25 Mhz internal clock, 8 bit ADC, UART and SMBus serial port, 16 bit counter and timer, and a programmable 16 bit counter array. The MLP-11 package has 11 port pins, two for ground and power supply, one for reset signal, and eight for the I/O port. A crossbar decoder maps port pins onto internal hardware peripherals on the device.

3.2. SMBus for Communication Bus

SMBus is used for communication protocol for connecting intelligent devices.

SMbus is compatible with the I2C serial bus. SMBus is two-wire with clock and data signal, bi-directional serial bus. Data can be transferred at 100 Kbps and 400 Kbps. The SMBus interface operates as a master and/or slave, and functions on a bus with multiple masters.

3.3. Design of Communication Protocol

This section describes a communication protocol of intelligent devices.

The built-in SMBus of intelligent devices has one intelligent communication unit that operates as a master and transmits data to all devices and receives data from them.

A communication unit transmits target position, proportional gain, and derivative gain to intelligent servos and receives potentio data. In intelligent sensors, a communication unit transmits dummy data and receives sensor values.

The following is the data transmission format of developed system:

[ID] + [Number of data] + [Data0] + [Data1]...

Receiver first checks ID, then reads Number of data that indicates the number of subsequent data. This format enables a communication unit to communicate with any device that sends data, for example, while a switch sends 1 byte data whereas accelerator sends 3 bytes data which is x, y, z to the communication unit

3.4. Communication Bus Lines

This section describes two types of communication bus for intelligent devices. One is for sensor modules and the other for servo modules. The ommunication bus for sensor modules has five lines and that for servo modules has nine lines. Five communication bus lines are as follows: since the communication bus for intelligent devices uses the SMBus, two lines are used for clock and data signal of SMBus, one line is reset signal and two lines for ground and power supply. The Nine lines communication bus includes two lines for motor power supply and two lines for ground. Since current limitation for each line is 1 A, two lines are used for motor power supply.

3.5. Adding Devices to Existing Serial Bus

The procedure for adding devices to a built-in serial bus is as follows: (1) Assign new ID to an additional device. (2) Connect an additional device to the built-in serial bus. (3) Add additional codes to receive data from an additional device in communication unit software.

Procedure (2) does not require rewiring of serial bus network cables. For procedure (3), **Fig.3** shows in the adding of an accelerator. In this example, the system continues operating by adding seven lines in existing software code.

Lines 1 to 10 are program code for communicating with servos and communication units. Lines 11 and on are additional programs for adding an accelerator.

This example shows that the proposed communication protocol of intelligent devices enables the

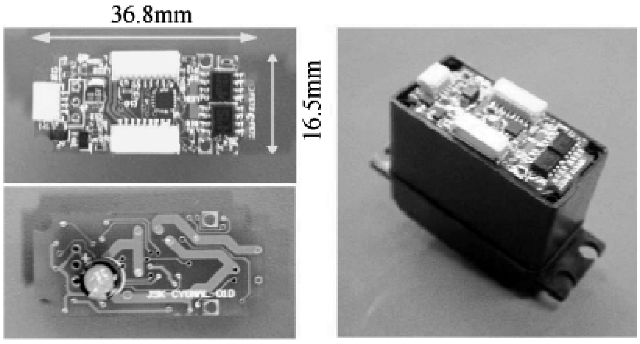


Fig. 5. Intelligent servo for S9204 module.

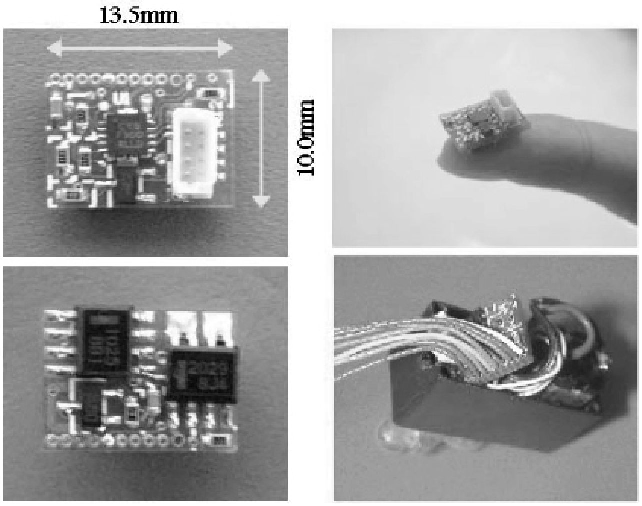


Fig. 6. Intelligent servo for S3102 module.

expandability of our robot system, in which new devices are added to a built-in serial bus network without changing existing software.

3.6. Intelligent Device

3.6.1. Intelligent Servo

Figure 4 shows a basic circuit diagram for intelligent servos. This circuit consists of a super-microprocessor, motor driver, connector for serial bus communication lines, connector for download lines of a processor, motor output, and potentio input. **Fig.5** shows a developed board designed to install S9204 servo modules from Futaba Corporation. The developed board is 36.8 mm 16.5 mm. A processor on the board reads potentio voltage of servo modules, then sends output signals calculated by using PID control to an H bridge circuit of a motor driver. Output of H bridge is connected to a motor inside the servo module. This unit has two connectors for serial communication lines so the board functions as a through connector of the serial bus.

Figure 6 shows the developed board designed to install S3102 servo modules from Futaba Corporation. The board is 13.5 mm 10.0 mm. Because of the limitation on the size, the connecter for serial communication lines is removed and lines are directly attached to the board.

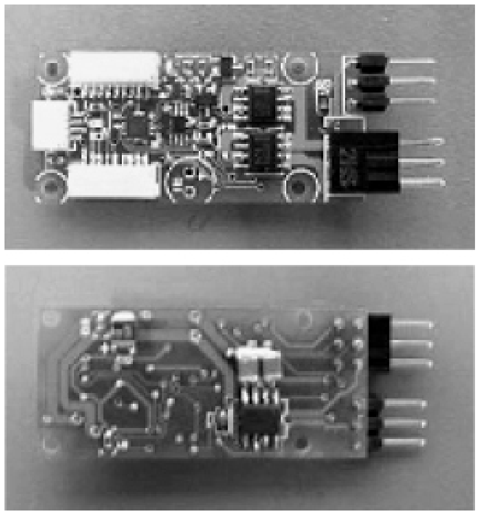


Fig. 7. Intelligent servo unit for Maxon motor.

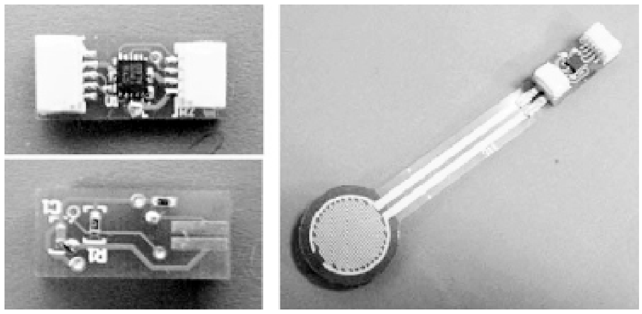


Fig. 8. Intelligent sensor for FSR.

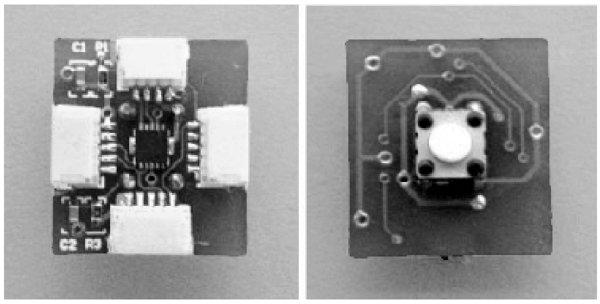


Fig. 9. Intelligent sensor for switch.

Figure 7 shows the developed board for Maxon motors. This motor has an encoder so intelligent servos for Maxon motors are designed to read encoder values. Other functions are the same as that of other servos.

3.6.2. Intelligent Sensor

Figure 8 shows the developed intelligent sensor for FSR force sensors.

FSR is a polymer thick film (PTF) device that exhibits a decrease in resistance with increased force applied to the active surface of the device.

FSR is used as an element in a voltage divider, with a

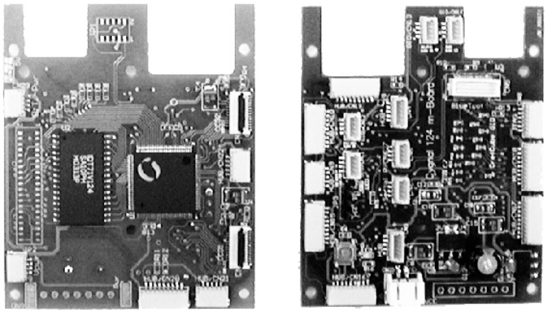


Fig. 10. Intelligent communication unit.

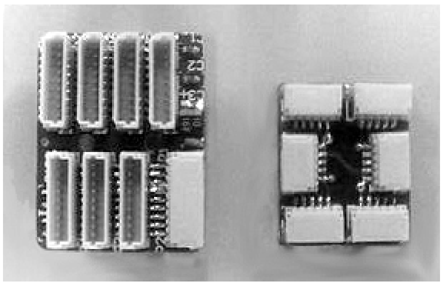


Fig. 11. Through connectors.

fixed resistor as the other element. A voltage is applied to the divider and the FSR sensor measures output voltagefrom the resistor and FSR junction.

Figure 9 shows the developed sensor for switches. A switch is attached to the circuit board with a super-microprocessor. This processor measures switch on/off operation.

3.6.3. Intelligent Communication Unit

Figure 10 shows the developed communication unit. This unit communicates with all intelligent devices on a robot, receives all data transmitted from these devices, and sends all data to the external brain PC. This unit uses C8051F124 as a processor, since the unit requires memory to store all data from built-in devices, whereas memory of the C8051F300 processor, used in other units, is not enough. C8051F124 has 8448 byte RAM and 128 Kbyte flash memory. The unit is designed to be attached to an embedded computer that has an ARM processor and embedded Linux OS.

3.6.4. Through Connector

Figure 11 shows the developed through connector. This unit functions as a through connector for a built-in serial bus network especially when the S3102 servo is used, which has no through connector on the circuit. The circuit at left in the figure has connectors for nine lines bus, which includes power for motors. The circuit at right in the figure has connectors for a five-line bus.

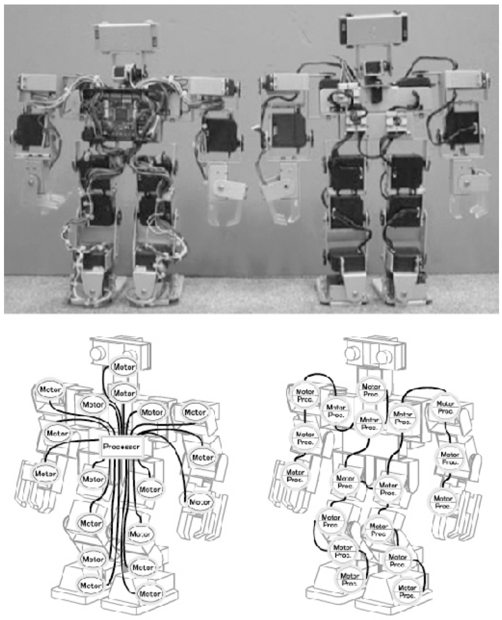


Fig. 12. Developed humanoid robot (left) built-In centralized approach, (right) device distributed approach.

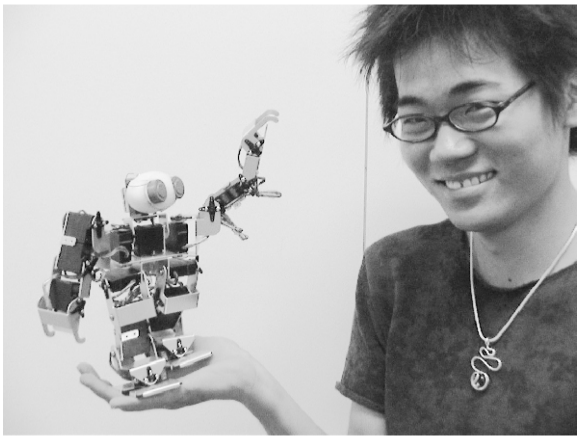


Fig. 13. 18 DOF Palm-Top Humanoid Robot: ChibiKaz.

4. Development of Small Humanoid Robot

4.1. 18 DOF Humanoid Robot: Kaz

The small humanoid robot Kaz was originally developed by the built-in centralized approach. This robot has 18 DOF, i.e., 4 DOF for each leg, 3 DOF for each arm, 1 DOF for each hand, and 2 DOF for the neck. The robot is 340 mm high and weighs 1.6 kg. To confirm the difference between the built-in centralized and device distributed approaches, we developed a humanoid robot based on the device distributed approach using developed intelligent servos, while other components are diverted from that of Kaz.

Figure 12 shows the difference between the robot based on the built-in centralized approach and that based

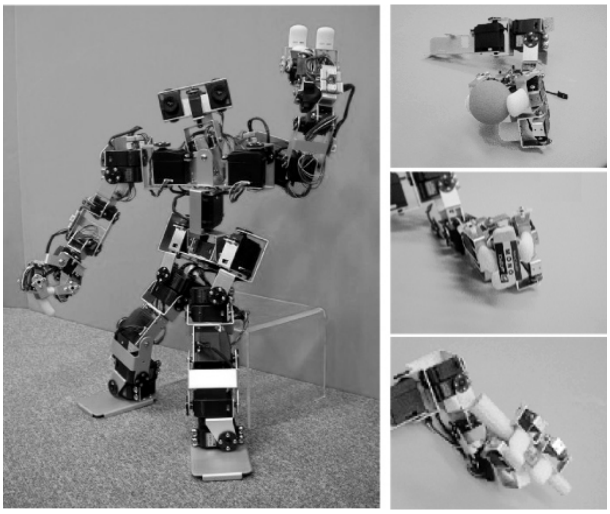


Fig. 14. 37 DOF small humanoid robot: Tot.

on the device distributed approach. Wiring of the built-in centralized robot is complicated, whereas that of the device distributed robot is simple.

4.2. Palm-Top Humanoid Robot: ChibiKaz

ChibiKaz is a small humanoid robot with 18 DOF as shown in **Fig. 13**. This robot consists of an S3102 small servo module that is 28.0 13.0 30.5 mm, making it small enough to put on a palm, whereas Kaz uses S9204, which is 40.5 20.0 37.5 mm.

Intelligent servos for S3102 servo modules enable development of small and compact humanoid robots. In development, the humanoid robot was developed without sensors, then an accelerometer sensor was attached to the robot. Adding this sensor involved only connecting the unit to the built-in serial bus, while all wiring cables for servo modules remained as is. Communication unit software was modified to add codes to receive data from the accelerometer sensor and transmit to serial connection to the brain PC, as described in section 3.5. Servo software need not be modified.

4.3. 37 DOF Humanoid Robot: Tot

Figure 14 shows a small humanoid robot with 37 DOF, i.e., 6 DOF for each leg and arm, 3 DOF for neck, 2 DOF for the torso, and 4 DOF for hand.

The robot is 430 mm high and weighs 2.1 kg. This development shows that intelligent devices based robot design can build a humanoid robot with a number of DOFs.

5. Conclusions

This paper described the design and implementation of robot system with bus wired intelligent devices, with each device having a processor. This architecture realizes a robot system with simplicity and expandability, which is able to adapt to modified configurations such as adding additional devices, without significant changes in existing software and hardware configurations.

We developed intelligent servos and intelligent sensors as prototypes of intelligent devices, and built small humanoid robots to confirm that intelligent servos realize a wiring saving robot and a many DOF robot, adding additional devices easily.

There are limitations on our developed system. Since we use an SM bus for a communication bus that enables only up to 127 devices, so, in practice, there still exists a restriction on the number of devices in the system. Another limitation is that only one module can communicate at the same time, so more devices in the system require more communication time for one cycle, and this reduces the response of the entire system. Our developed humanoid robots uses 20-30 units; in this configuration, they can communicate with all modules at 20 Hz, which is sufficient for our small humanoid robot.

Although several improvements are required for our developed prototype, we believe the device distributed approach we proposed realizes a robot with many sensors and actuators with simple expandability of software, wiring, and hardware.

References:

[1] S. Kagami, K. Okada, M. Kabasawa, Y. Matsumoto, A. Konno and M. Inaba, H. Inoue, "A Vision-based Legged Robot as a Research Platform Proc. of International Conference on Intelligent Robots and Systems (IROS'98)", pp. 235–240, 1998.

[2] K. Nishiwaki, T. Sugihara, S. Kagami, F. Kanehiro, M. Inaba, H. Inoue, "Design and Development of Research Platform for Perception-Action Integration in Humanoid Robot : H6", Proc. of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS'00), pp. 1559–1564, 2000.

[3] H. Inoue, S. Tachi et al., "HRP: Humanoid robotics project of MITI", Proceedings of the First IEEE-RAS International Conference on Humanoid Robots, Cambridge, MA, September 2000.

[4] T. Shibata, Y. Matsumoto, T. Kuwahara, M. Inaba, H. Inoue, "Hyper Scooter: a Mobile Robot Sharing Visual Information with a Human", In Proc. of IEEE Int. Conf. on Robotics and Automation (ICRA'95), pp. 1074-1079, 1995.

[5] S. Yuta, S. Suzuki, S. Iida, "Implementation of a small size experimental selfcontained autonomous robot: sensors, vehicle control and description of sensor behavior", Proceedings of 2nd International Symposium on Experimental Robotics, pp. 25–27, 1991.

[6] M. Inaba, "Remote-brained humanoid project", Advanced Robotics, Vol. 11, No. 6, pp. 605-620, 1997.

[7] M. Fujita, K. Kageyama, "An Open Architecture for Robot Entertainment", Proc. of Int. Conf. on Autonomous Agents, pp. 435-442, 1997.

[8] N. Yamasaki, "Design and implementation of responsive processor for parallel/distributed control and its development environments," Journal of Robotics and Mechatronics, vol. 13, pp. 125-133, 9 2001.

[9] K. Koyasako, I. Mizuuchi, M. Inaba, H. Inoue, "Development of

Small Processor Modules for the On-Body LAN of a Full-Body Robot Proceedings of the 15th Annual Conference of RSJ", pp. 1021-1022, 1997. (in Japanese)

[10] T. Furuta, Y. Okumura, T. Tawara, H. Kitano, morph, "A Small-size Humanoid Platform for Behavior Coordination Research Humanoids 2001", Waseda Univ., Nov pp. 22-24, 2001.

[11] E. F. Fukushima, K. Takita, S. Hirose, T. Nakamura, "Development of a High Speed Serial I/O for Robot Control", Proceedings of '01 Robotics and Mechatronics, pp 1A-A1, 2001. (In Japanese)

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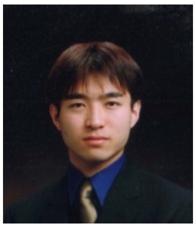

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Main Works:
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Main Works:
"A Platform for Robotics Research based on the Remote-Brained Robot Approach", The International Journal of Robotics Research, vol.19, No. 10, pp 933-954, (2000)

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Main Works:
"Vision-based Remote Operating System for Humanoid using Manipulation Database", 20th Annual Symposium of Robotics-Mechatronics, 3C23, (2002)

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