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A Packet-based Energy Management System for Multi-legged Walking Robots

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Abstract—Recent years, packet-based energy management systems attract attention as a new technology. In order to demonstrate such systems in the real world, we are interested in applying a packet-based energy management system to a multi-legged walking robot actuated by multiple motors. This paper reports our results on the hardware implementation and an experimental result.

1. Introduction

Power packets are formatted units of electricity, containing power and information on delivery. It is known to be a new concept of electric power supply and is expected as a future technology.

For power packets and systems implementing them, several results have been obtained so far (see [1] and references therein). On the other hand, although the power packets are expected to be applied to autonomous robots, there is no result on hardware development and experiment.

In this paper, we report on hardware development of a packet-based energy management system for an autonomous multi-legged walking robot and an experimental result. These results demonstrate the feasibility of the concept of power packets and the effectiveness in the real world.

2. Concept of a Packet-based Energy Management System

The concept of our packet-based energy management system is shown in Fig. 1. The aim of this system is to supply a power packet, i.e., intermittent power, to n loads for achieving a desired task in the whole system. In this system, a power packet can be sent to a single load in each time step.

The power dispatching procedure is as follows. First, each packet receiver estimates the required amount of power for the corresponding load and sends a request to the power router. Next, the power router determines the destination of the power packet and sends a request to the power. Then the power sends the energy to the power router, and the router supplies it to the distination.

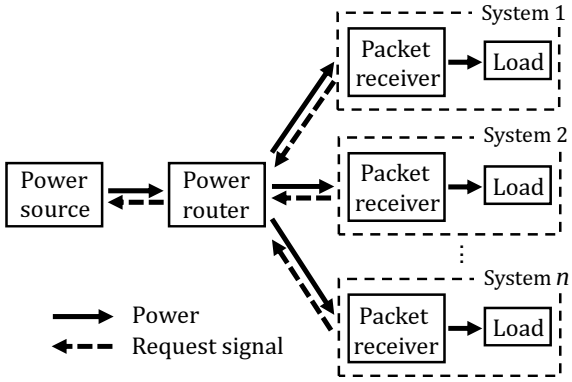

Fig. 1: Packet-based energy management system

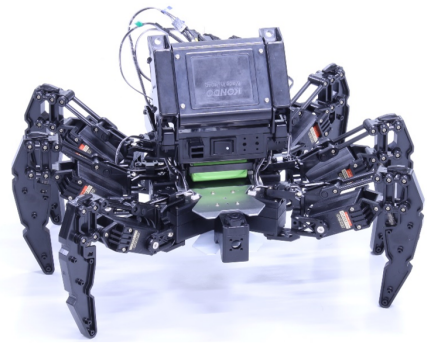

Fig. 2: Multi-legged walking robot (Kondo Kagaku Co., Ltd.)

3. Development of a Packet-based Energy Management System for Multi-legged Walking Robots

We have developed a packet-based energy management system for a multi-legged walking robot [2] (Kondo Kagaku Co., Ltd.). This robot has 6 legs and each leg equips 2 motors. These motors are servo motors whose max speed is 0.14s/60 °. In order to achieve walking, we need to send power packets to the 12 motors in an appropriate manner on the basis of the predictions of power demand. In the following subsections, we explain the packet receivers and the power router for the walking robot.

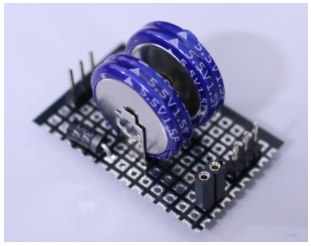

Fig. 3: Packet receiver

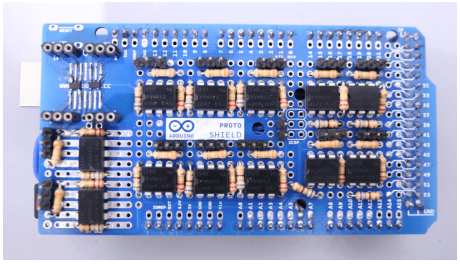

Fig. 4: Power router

3.1. Packet Receiver

The packet receiver is shown in Fig. 3. This is mainly composed of a capacitor and a diode. This receiver generates a request signal based on the terminal voltage of the capacitor. If a power packet is provided from the power router, this receiver saves power packet in the capacitor and supplies power to the corresponding motor.

3.2. Power Router

The power router is implemented by Arduino Mega 2560 [3] and Photo MOS Switch [4], as shown in Fig. 4. The router receives a request signal from the packet receivers, and selects a receiver which needs power the most. Next, the router actually sends a power packet to the destination.

4. Experimental Result

We have confirmed that the robot walks at the speed of approximately 0.04 m/s. Fig. 5 shows the snapshots of the walking.

5. Conclusion

We have developed a packet-based energy management system for a multi-legged walking robot, and demonstrated its performance. One of the important future topics is to develop a more efficient method to dispatch power packets.

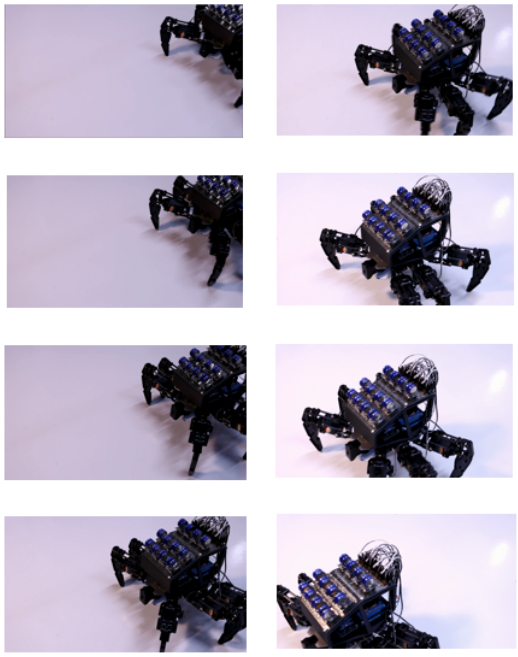

Fig. 5: Snapshots of the walking

Acknowledgments

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References

[1] T. Takuno, M. Koyama and T. Hikihara, “In-Home Power Distribution Systems by Circuit Switching and Power Packet Dispatching.” The 1st IEEE International Conference on Smart Grid Communications, pp. 427–430, 2010

[2] http://kondo-robot.com/product/kmr-m6-ver-2

[3] https://www.arduino.cc/en/Main/ArduinoBoard Mega2560

[4] http://www.irf.com/product-info/datasheets/ data/pvn012.pdf