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APPLICATION OF DISTRIBUTED CONTROL SYSTEM SUBJECT TO RESOURCE LIMITATION FOR HEATER CONTROL EQUIPMENT TO PUBLIC INFRASTRUCTURE SYSTEM

Abstract

This paper proposes a novel power supply management system aiming to manage risks caused by unexpected defects in public infrastructure systems are lacking in the conventional power supply systems. Conventional power systems are fragile in two aspects: utilizing supply-based decision model and weak robustness property. A local electrical company in Japan that uses the conventional system went into severe shortage of electrical power and implemented planned outage due to the collapse of Fukushima plant and created huge loss of industrial opportunities. Our approach to solve this type of problem is to apply the distributed control subject to resource limitation used in a spacecraft that are mostly operated under limited power environment. The power supply management system was originally developed at JAXA to manage the risk of electric power scarce due to excess access from each device. The main idea is to decrease the peak amount of limited power in a spacecraft by changing in switching time based on demand-response from each device. For realization, the system features "decentralized system" and "priority setting" on each device. The decentralized system, in which each device has its own controller and changes information each other, contributes to the robustness of the system since a defect of the controller does not affect other parts of the system while the limited power is allocated based on the priority level of each device. Experiments were taken for heater control equipment to demonstrate the practical performance of the novel power system. In the experiments, we prepared six devices with heater controllers which received duty signals, and set the target temperature for each of the devices. We initiated the experiments by providing sufficient power and checked if all the devices were fully working, and then decreased the power supply to observe the behavior of the temperatures under limited resource. As a result, all of the devices met the temperature requirements even under short energy supply. To quantitatively evaluate the benefits of the new system when applied to public infrastructure systems, we have arranged multiple small electrical trains (HO gauge) whose electrical power provision system is basically the same as the real one. Presently, the distributed control system is being implemented to the small train system, to show whether similar results as the heater control case are also achieved. In conclusion, we will present the newly constructed power system and elaborate its ramifications together with the experimental results.