OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Robotics and Energetic Systems Group

Enabling Robotic Operations in High-Temperature Environments

The Next Generation of Fire-Fighting, Rescue, and Maintenance Robots

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Technology Need

High lift capacity for remote operations is needed for high-temperature environments. Hydraulics are the traditional actuation of choice for high payload applications due to higher power to volume and power to weight ratios than electric actuation. There are significant controls issues associated with using hydraulics in a high-temperature environment. Oak Ridge National Laboratory (ORNL) is working to address these issues, thereby providing a capability that currently does not exist.

Sample Application: Remote Boiler Repair

Leaks in boilers at fossil power plants cause an average unavailability of 5%. As leaks develop in the boiler, their severity is monitored based on water loss through the system. If possible, leak repair is delayed until a scheduled shutdown to avoid unnecessary costs and lost production. After shutdown, temperatures decrease quickly to approximately 600°F. At this point the thermal inertia of the boiler becomes the dominant phenomenon. At the end of the cool down period which could be more than 8 hours, the boiler is still uncomfortably warm, but human access is possible. The boiler leak is then repaired by a welder hanging from cables in a boson's chair. These outages can result in up to $1M in loss of production per event depending on the size of the unit.

ORNL Approach

ORNL has conducted research into remote operation in high-temperature environments. The focus of this research has been the enabling controls capability to facilitate high-temperature operations. Testing and analysis has resulted in a novel robotic device that has been tested at up to 700°F, with results indicating that temperatures of 1,000°F or greater are possible. This novel robotic device demonstrated that dexterous manipulation associated with tasks such as handling and welding of pipes and associated mobility is indeed possible. Instead of waiting for a high-temperature environment to cool down, maintenance operations could be performed remotely, resulting in significant savings in production costs and improvement in overall plant availability.

High-temperature manipulation test stand.

Application Areas

This approach is applicable to areas that are too hot for human operation or where there is potential cost savings in avoiding having to cool the environment before human entry. Such areas include boiler repair, industrial melters, radioactive waste storage, fire-fighting, first-responders, and rescue robots.

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