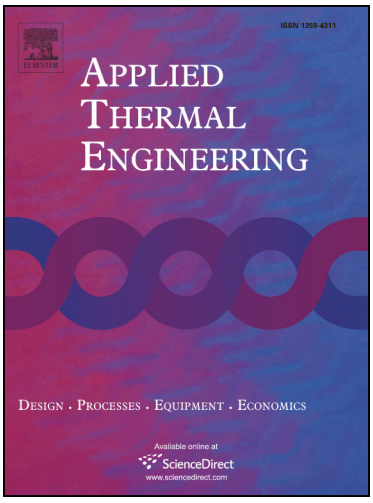

A Review on Thermal Management Methods for Robots

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A Review on Thermal Management Methods for Robots

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Abstract

In this study, various thermal management systems, which are designed for robotic systems, have been investigated. The robots are such a structure that consists of numerous different electronic components and devices. Such electronic parts have an operating temperature that directly effects the performance of the robot. Therefore, thermal management systems should be studied and designed carefully to meet the ideal working temperature of each component in the robot. In that case, thermal management systems for robotics system have been studied; challenges and future directions have been examined into two group: active and passive thermal management. Furthermore, thermal management methods of heat skins, heat spreaders, heat pipes, thermal interface materials (TIMs), phase change materials (PCMs), insulation materials, heater units, forced air and liquid systems and thermo-electric modules are studied in detail. The thermal resistance, performance effectiveness and COP values of different thermal management systems have been compared in this study to evaluate their performance in robotic systems. According to the literature results, the COP values of active thermal management systems vary between 0.21 and 2.32, while the performance effectiveness values of passive thermal management methods change from 0.1 to 0.98.

Keywords: Thermal management, efficiency, heating, cooling, robots, electronic components.

1. INTRODUCTION

With the development of computer technologies, robots and their applications are gradually becoming a part of our life. Robots are able to perform tasks that are not or partly possible for humans. They may be implemented in many different applications such as medical, military, nuclear rescue, space missions and mining applications. However, robotic systems are complicated system consisting of mechanical and electrical subsystems. Some of the subsystems are not capable of running in hash environment (e.g., low/high temperature, high humidity), especially electronic and electrical subsystems. Therefore, an adaptive thermal management of robotic system is required which can be intelligently adjusted depending on the ambient conditions. A wide range of thermal management systems have been developed and improved in other applications, however, it is short of in depth analysis and development in robotic applications. Therefore, this paper aims to review cutting-edge thermal management technologies, and provide guideline and instruction of developing a thermal management system for robotic systems.

As it has been mentioned above, a practical robotic system should be able to be implemented in real world environments with both low and high temperatures. Because of the working conditions, robots should be designed to adapt to the environment where the robot will be operated. Every electronic component has a range of operating temperatures. Therefore, it is crucial to design a system that can maintain the temperature in a certain range so that none of the electronic components will be failed. According to U.S. Air Force estimation, over 55% of