Abstract

Mechatronic systems have been used in many industrial areas of daily life for several years. However, the discipline "mechatronics" is historically still in its early stage. Because of the strong development of information technology, future mechatronic systems will become more and more intelligent.

Nowadays the objective of the development is not only in the functional enhancement; the safety and reliability of the system is of increasing importance. In other words, modern intelligent mechatronic systems need to have the ability to self-diagnose their own health state and even self-healing. In that way, such systems can finally achieve full autonomous operation.

In this work, a concept for the assessment of the health of a relatively simple mechatronic system and its reliability-based control is explained using an example permanent magnet synchronous machine. For a holistic concept of diagnosis and control systems, a three-layer-design is used.

The diagnostic system includes monitoring, identification and prediction of faults. To predict the system condition, damage models of components are used. These damage models are based on the physical damage mechanisms and the statistical data of the components. The damage accumulation is calculated from the various stresses for example thermal, mechanical, chemical, electric, etc. Finally, the health state of the system is determined. Parallel to this, the fault monitoring and identification can be retained as basic safety functions. Particularly for stochastic events, a threshold monitoring reacts much faster than fault prediction. The compilation of fault monitoring, identification and prediction provides a complete description of the system’s health state. With this information, both the controller itself and the desired operating point are optimized. To use an adjustable fault-tolerant control, the controller is built on a model-based structure, possibly with adaptation. A robust passive controller is used as a basic controller in the whole control loop. The reliability-based control is the superior control loop. It works on the basis of the system’s health state and uses the method of fuzzy control. The maximum load of the system is adapted, so that the system health rate can be regulated in the normal range. The system is protected from itself in an intelligent way. As a result, the availability and reliability of the whole system are retained or even increased.