ILLINOIS INSTITUTE OF TECHNOLOGY

Mechanical, Materials And Aerospace Engineering Department

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Distributed Sensor Systems for Large-Scale Control Applications

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Distributed sensor systems have tremendous potential advantages for many future engineering applications, from micro-electro-mechanical systems (MEMS) to large-scale mechanical/ aerospace systems. This talk presents the applications of the distributed sensor systems for large-scale control applications. In the first part of the talk, we discuss the problem of controlling the radiated noise from vibrating underwater vehicles. The approach proposed to implement the distributed sensor systems for the underwater vehicle problem is to cover the outer surface of the vehicle with a large number of sensor/actuator pairs, and to design feedback control systems to reduce the radiated noise. The control methodology developed for this problem has two different architectures. The first one is the assembly of local decentralized controllers, which are implemented for each sensor/actuator pair to reduce its vibration level. The second one is a global centralized controller, which coordinates the action of local controllers and minimizes the radiated acoustic power. The results of the numerical studies and experimental work, as well as the sensor networks and control system implementation issues, are presented.

In the second part of the talk, we discuss the development of distributed slow-down warning systems for safe automobiles using satellite navigation (GPS) and wireless communication technologies. The motivation for this new system is that the brake-light dependent warning system, which is used by most cars these days, is not often efficient in preventing multiple-car collisions. We propose that many pile-up crashes can be avoided if vehicles can transmit a warning signal whenever facing a hazard, and receive the warning signal, analyze it, and warn drivers if necessary. With such a system, information of a slowdown warning is propagated to all cars equipped with the warning system, thus allowing sufficient time for the car drivers to react appropriately. We formulate this problem as a distributed sensor network with decentralized control system, in which a human driver is a part of the plant. Through numerical simulations and experimental road tests involving several cars, we have shown that highway safety can be improved significantly, even when only a small subset of the vehicles are equipped with the warning system. We discuss how this concept can be generalized to other distributed sensor systems.