Ulrich Kremer

Ulrich Kremer is a Professor in the Department of Computer Science at Rutgers University. He graduated with a Diplom in Informatik from the University of Bonn, Germany. He went on to receive a M.S. and Ph.D. in Computer Science from Rice University in 1993 and 1995, respectively. His research interests include compilation techniques and interactive programming environments for parallel systems, compiler support for power and energy management, programming models and optimizations for dynamic networks of resource constrained devices (e.g.: smart phones), and novel programming architectures for autonomous robots such as autonomous underwater vehicles. Dr. Kremer received an NSF CAREER award for his work on compiler-directed low power and energy optimizations.

A New Programming Architecture for the SLOCUM Autonomous Underwater Vehicle

Autonomous underwater vehicles (AUVs) have evolved from mainly experimental platforms to increasingly reliable systems used for a variety of scientific, commercial, and military applications. The Slocum glider is a commercially available, buoyancy-driven, battery operated AUV. Instead of using a propeller, a buoyancy-driven vehicle achieves forward propulsion by changing its buoyancy resulting in a sawtooth-shaped flight path. Due to this energy efficient mode of propulsion, gliders are the platform of choice for oceanographic research that needs a continuous sensing presence in the world's oceans, allowing individual AUV deployments lasting several months. Slocum gliders have been used to study the impact of global warming, ocean phenomena such as toxic algae blooms, or environmental disasters such as the oil spill as the result of the 2010 Deepwater Horizon accident in the Gulf of Mexico.

In this talk, I will discuss our multi-year, NSF funded effort to make the Slocum glider a more effective research platform for oceanographers to use. We have extended the existing system by a new programming architecture consisting of advanced computing components and new programming abstractions, where energy consumption is a first-order concern. The new programming architecture includes simulation tools for mission design and debugging, on-board and off-board path planning capabilities, an on-board power measurement infrastructure for sensor payloads and motors, and a tool for glider pilot training. This work has been mainly driven by the needs of actual glider pilots and oceanographers, and has been tested under field conditions through deployments in the Atlantic Ocean off the coast of New Jersey. I believe that many of the lessons learned in the context of battery-operated AUVs can be applied to other energy-constrained systems as well such as smart phones, where sensing, actuation, communication, and computation activities have to be managed based on different user needs and available battery life.