

FUNDING PROGRAM FOR NEXT GENERATION WORLD-LEADING RESEARCHERS

Project Title: A Study on Embedded Processor Architectures and OS-based Power Management Techniques for Environmental Energy-based Systems

Name: Tohru ISHIHARA

Institution: Kyoto University

1. Background of research

Computer systems are now used everywhere in the world especially in developed countries and dissipate significant amount of energy. Population of IT users in developing countries is also rapidly increasing, which will increase world wide energy dissipation and may cause global fossil fuel crisis in future. Up to the present, a number of studies have been done for reducing the energy consumption in the computer systems. However, the growth of the IT user population in the world is faster than the energy reduction of the computer systems, and therefore more drastic change in the research strategy is needed for reducing the fossil fuel dissipation.

2. Research objectives

The goal of this project is to develop an embedded computer system which works stably with environmental energy only. The environmental energy represents sustainable energy obtained from external sources like solar power, thermal energy, wind energy, salinity gradients, and kinetic energy. Therefore, the direct research goal of the project is not reducing the energy consumption of the computer systems, but developing a mechanism for maximizing quality of services provided by the computer systems with the limited and unstable energy sources.

3. Research characteristics (incl. originality and creativity)

Traditionally, the following two themes have been studied separately in different research fields;

- (1) Maximizing energy efficiency in harvesting and transporting the environmental energy,
- (2) Minimizing energy dissipation in a computer system by controlling it according to behavior of applications.

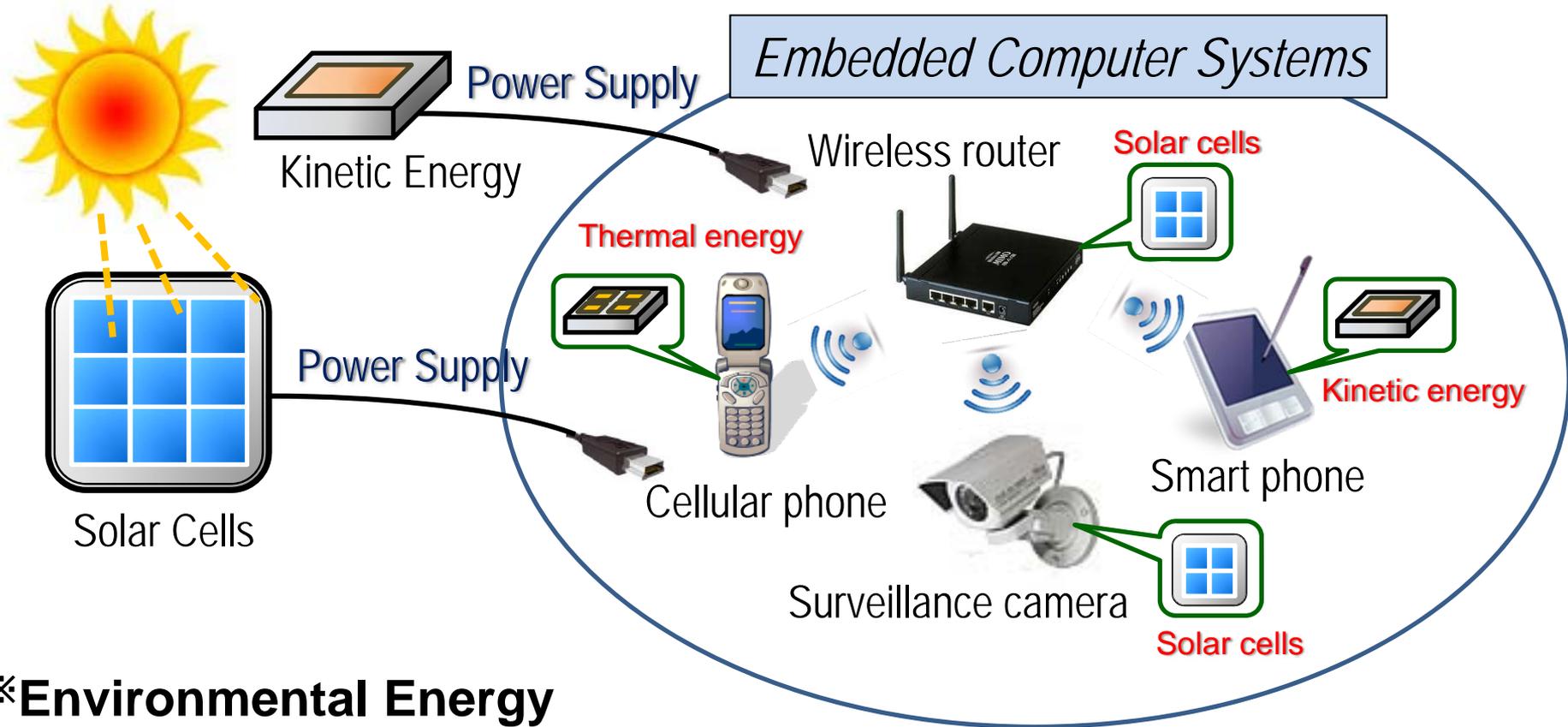
The key of our research is targeting above two themes simultaneously and aiming at obtaining synergetic effects among different research fields; control theory, electrical engineering and computer science.

4. Anticipated effects and future applications of research

The environmental energy based system being developed in this project helps growth of information society in the world including developed and developing countries without increasing fossil fuel dissipation. Specifically, introducing the information society into the developing countries helps improve their quality of life and will accelerate economic growth in such countries. Since the embedded computer technology has been Japan's strong suit, the project might also help Japanese industry initiates green IT innovation in the world.

Research Goal

Develop a mechanism for embedded computer systems which work stably with *environmental energy only



*Environmental Energy

- Sustainable and reusable without any fossil fuel dissipation at run time
- × Unstable output power and voltage (Sophisticated management needed)



Our Goal

- Develop energy management methods for
- * an efficient use of environmental energy
- * seamless services by computer systems

Key idea

Collaboration among different research fields;
control theory, electrical engineering and computer science

Control for efficient
energy harvesting

- * Energy generator
Max. Power Point Tracking
Serial/parallel optimization
- * Energy storage
Charge/discharge optimization
Serial/parallel optimization

Energy management
for computer systems

- * Processor systems
Job scheduling
Processor power management
- * I/O devices
Output image quality control
LCD back-light control

Co-optimization

Spread Embedded Green Computing Technologies Everywhere
Assist Developing Countries and Initiate World Wide Green IT Innovation