Prof. Dr. İsmail Hakkı Altaş

RESEARCH STATEMENT

A General Overlook

I have my bachelor, BScE and PhD degrees all in electrical engineering. My PhD thesis was about developing control strategies for photovoltaic (PV) energy systems. I developed a PV cell simulation model, which I converted to a real time emulation model too. Then I tested PID and fuzzy logic controllers I designed in these simulation and emulation models of PV cells. I also developed a maximum power point tracking (MPPT) algorithm and applied my controllers for tracking the MPP. Design of controllable dc chopper as the interfacing device of the emulator to dc and ac loads was a part of my PhD thesis, as well. I applied my controllers to this dc chopper in order to transfer the maximum PV power to dc loads as well as one and three-phase ac loads. I published a quite number of journal articles and conference papers from the studies mentioned above. After completing my PhD, I continued my research as an academician in similar topics with the addition of new ones such as neural fuzzy systems, intelligent control, fuzzy decision-making, flexible ac transmission systems, distributed generation, smart grids and energy management. Lately I have my graduate students to study on topics mostly related to the problems in renewable integrated power distribution networks by employing intelligent controllers, fuzzy decision makers, soft computing based optimization and ANN based estimation. I have done 13 research project supported by TUBITAK (The Scientific and Technological Research Council of Türkiye), KTU BAP (Karadeniz Technical University Research Fund), The Ministry of Science and Industry (SANTEZ) and DOKAP (Eastern Black Sea Project Regional Development Administration). My 14th project funded by TUBITAK is still going on. It will be completed in 2025.

Current Research

I started my academic studies at Karadeniz Technical University (KTU) after getting the PhD degree abroad in 1993. My research has mainly focused on power systems, renewable energy systems and control systems. In time, both problems and solution methods have changed in these topics resulting in major changes in my research fields, as well. For example, with increasing PV and wind power installation in urban areas where power generation and consumption have become side by side, new stability, control, management and cyber security issues have raised. Therefore, my research topics have developed towards the followings, which are generally among the national priority topics that announced by The Scientific and Technological Research Council of Türkiye every year.

- Damping the oscillations in bus-bar voltages and frequencies,
- Frequency and voltage stability in distributed networks,
- Renewable energy systems
- Microgrids
- Energy management systems

- Day ahead forecasting of sun and wind conditions for energy generation and consumption management,
- Centralized or decentralized control of power components in distributed and smart power networks
- Cyber security of data flow used for both control and management of the smart electrical networks.
- Machine learning applications for day ahead weather forecasting, fault type and location estimation and power management problems.
- Integrating human decision-making processes into machines by fuzzy decision makers and fuzzy controllers.
- Developing intelligent methods for problem solving especially for robotized machines.

I established a research laboratory called *Intelligent Systems and Automation Lab (ISAL)* at KTU in 2004. Later, I established two more research groups and labs called *Power, Energy and Control (POWENCON)* and *Sustainable Energy Utilization Lab (SEUL)*.

Currently my PhD students are studying most of the topics listed above in the research labs POWENCON and SEUL.

Future Research

Energy sources have always been an important issue for all countries. The annual energy consumption per person is assumed an indication of development level for countries as GDP is. Therefore, my research areas will follow the problems in energy generation, transmission, distribution and consumption stages as the new alternative sources and solution methods needed. Besides, the power system has a very complicated structure that has many data to be collected, stored and used to solve current and future problems. As transmission speed and bandwidth of digital communication improve, the ability of collecting power system data become easier and more accurate. The collected data will be a key parameter in estimating future problems and developing new solutions to them.

Luckily, new heuristic and soft computing methods in data mining, machine learning and expert system applications have been developing very fast in the literature. The applications of these methods are going to be very important in order to operate power systems more efficiently and less interruptions. Therefore, my research pathway has been going toward the intelligent expert system methods in power and energy systems.

Other Potentials

Automatic control systems have been another research area for me. I have delivered lectures on Automatic Control Systems and completed some projects that related to robotic applications rather than power systems. I developed a generalized fuzzy logic controller (FLC) for both Matlab® and Simulink that is different than the one comes with fuzzy logic toolbox of Matlab®. I have used this model in many of my projects.

Therefore, both classical and intelligent controllers are parts of my research areas.