Energy-Autonomous Sensor Node for Intelligent Infrastructure
Thorsten Hehn, Benjamin Lang, Daniel Schillinger

Overall Project
• Automatisiertes und vernetztes Fahren in der Logistik am Testfeld Friedrichshafen (ALFRIED)
• Objective: To develop the basis for a connected, digitally controlled mobility system, with a particular focus on inner-city goods traffic
• Mobility system
  • Intelligent vehicles
  • Intelligent infrastructure
  • Digital data platform
  • Smart city control center

Multimodal Energy Harvesting System
Energy Sources
• Light (direct, indirect)
• Wind
• Battery Pack
Energy Converter
• Photovoltaic panels
• Electromagnetic wind turbine
Maximum Power Point Tracking (MPPT)
• Custom design, as not commercially available

Photovoltaics
Challenges
• Different radiation intensities on different partial surfaces
• Systemically different operating point per side
• Site-related differences within a side
• Vegetation or snow
• Local soiling, shadows
Implemented solutions
• White solar panels from SOLAXESS on three sides 7.5 W max. in total
• Separate MPPT per panel

Power Management & Battery Pack
Challenges
• High power requirement due to sensors
• Operation at -20°C to 80°C
• Lithium plating at high charging current and low temperatures
• Design for delineator shape
Implemented solutions
• LiFePO4 temperature-resistant, long service life > 1000 cycles
• Fuel gauge avoids lithium plating and increases service life

Energy Forecast
Motivation
• Energy prediction for scheduling the sensor on time
Challenges
• Angle of incidence
• Shading curves
• Diffuse and direct irradiation
• Weather influences
Goal
• Comparison and evaluation of the existing and our extended algorithms for energy forecast

Conclusions
• Photovoltaics promising up to 10 Wp, wind generators of this size/location only show low energy yield < 1 W
• Energy consumption of the UWB sensors several 10 W
→ Supply gap (‘energy starving’)
• MPPT not commercially available for broad power spectrum
→ Custom design
• ProEnergy is currently implemented for power prediction, FPPE_extended planned for future iterations
• Performance tests in real traffic are still pending

funded by
Bundesministerium für Bildung und Wissenschaft