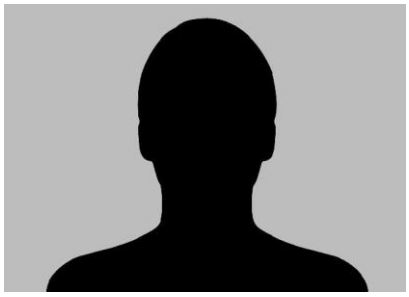
Zurich University
of Applied Sciences

School of
Engineering

InES Institute of
Embedded Systems

Generic title to be precisely given later: Autarkic system related research work



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At the Urban Water Observatory in Fehraltorf, the EAWAG uses battery powered sensor nodes to monitor overflow events on combined sewer tanks. They measure and transmit the current waste water level in periods of 2 to 5 minutes. Operating these sensor nodes requires replacing the batteries regularly and thus raises maintenance costs. Monitoring tanks at a bigger scale with an extended sensor network further increases maintenance costs.

To improve economical operation of such an extended network, the use of an energy harvesting based system is investigated in this work. In addition, suitable forms of environmental energies near sewer tanks are examined. The goal is to replace the batteries by a harvester and thus reducing the costs of maintenance.

Based on literature various forms of energies are assessed and three concepts for harvesting electrical energy near combined sewer tanks were created. The concepts show suitable positions for harvesters and power availability. To find an optimal combination of harvester and converter, the resulting power and the expected yearly energy of each combination is calculated based on various measurement results. To form a prototype, all of the selected system components were assembled on PCB. Based on results, the selected SM531 in combination with SPV1050 and BQ25570 will presumably harvest between 10 and 36 kJ of electric energy. Both combinations can cover all of the considered application scenarios and similar measurement and transmission intervals can be achieved. For the TEG, two mounting structures (PVC and 3D-printed) were created to enable converting the temperature difference between sewage water and canal wall on the TEG. Despite the temperature difference reaching up to 6 K, rms open loop voltages of only 4.88 to 11.6 mV on the TEG were measured with both structures. Using the current second iteration, a 40x40 mm TEG and the EM8900 boost converter, the combination is expected to harvest 65 J per year. This energy is not sufficient to power the system due to the required yearly energy of 141 J during standby. If the rms open loop voltage on the TEG can be increased to 20 mV, the system will likely be able to harvest 1 kJ and thus can cover more application scenarios.

A prototype configured for solar cells enables the energy autarkic operation to monitor overflow events on combined sewerage tanks. Further measurements are needed to validate system performance and usability for different application scenarios.

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