Online ground temperature and soil moisture monitoring of a shallow geothermal system with non-conventional components

Ludwin Duran[1], Darius Mottaghy[1], Ulf Hermann[2] and Rolf Groß[3]

[1]FH Aachen University of Applied Sciences, Faculty of Energy Technology, Jülich, Germany
[2]Solar-Institute Jülich of FH Aachen, Solar-Campus Jülich, Germany
[3]FH Aachen University of Applied Sciences, Faculty of Civil Engineering, Aachen, Germany

EGU General Assembly, 2020

Motivation

▶ Internet of things

▶ Data Mining

▶ Exploration of the impact of the soil temperature and moisture in other soil properties

▶ Better understanding of thermal behavior of shallow geothermal systems in the unsaturated zone.

Motivation

1. Ice storage
2. Plate heat exchangers
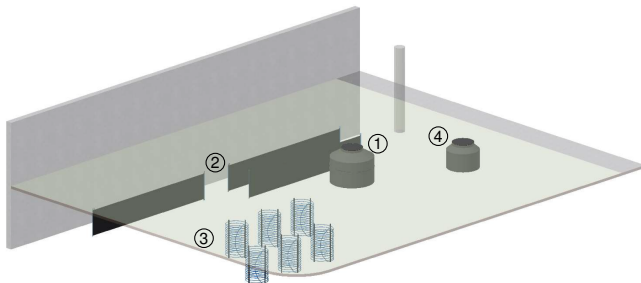3. Helix coils
4. Distribution shaft
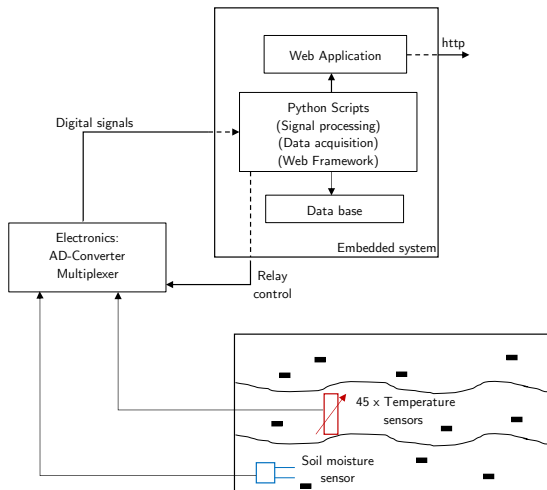

Figure 1: Shallow geothermal installation [4]

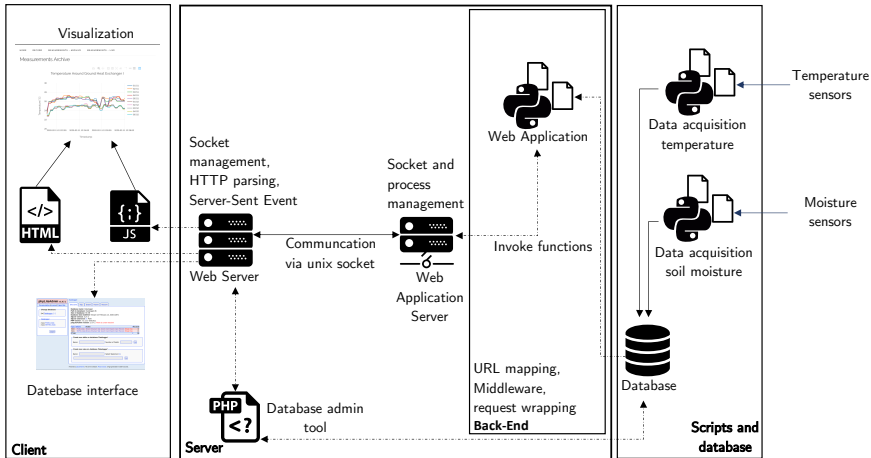# Design

Figure 2: Base design

Design

Implementation

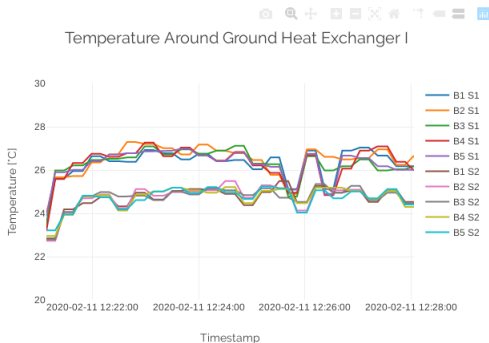▶ Web Application for online and offline visualization of the sensor measurements.

Figure 4: Visualization of stored measurements [1]

Implementation

► An open source, web-based database admin tool was implemented in order to have remote access to the measurements stored in the database. The user can easily download the data for further processing.

Figure 5: Exporting using the database admin tool [1]

Future Scope

▶ **Effects on other soil properties**: The soil temperature and moisture affect other soil properties, e.g. thermal conductivity and specific heat capacity. The embedded system allow us the generate new data from the measurements, this can be done via correlation or using well-known relation formulas between soil properties.

Future Scope

The aim is to improve our understanding of the thermal processes in unsaturated soils and hence their influence on the performance of the installation components.
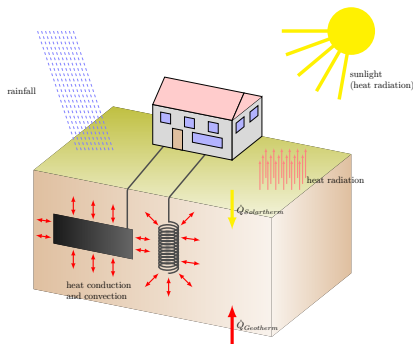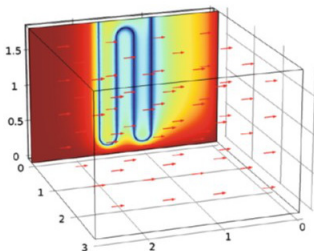

Figure 6: Soil Physical Processes [4]

Future Scope

▶ **Validation of simulations**: We plan to set up numerical models in order to compare measured and simulated data, thus enhancing the reliability. Furthermore, the results can be generalized and transferred, so similar geothermal installation can be optimally designed.

Kürten, S., Mottaghy, D. & Ziegler, M. (2015,16)
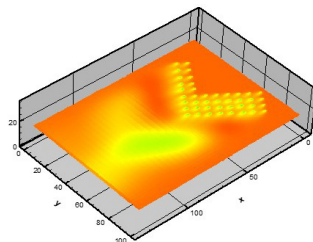
Mottaghy, D. & Dijkshoorn, L. (2012)

Figure 7: Performed simulations [2], [3]

Future Scope

▶ **Energy efficiency**: With a better understanding of the heat transport process around the ground heat exchangers, it will be possible to improve the quantitative design and therefore optimize the performance of the installation.

The geothermal energy gained from the system could be improved by predicting the necessary inlet temperatures of the heat pump for cooling and heating operation. Together with the operational parameters of the heat pump, it is possible to display the current thermal power.

References I

[1] L. Duran, D. Mottaghy, and R. Spiegelberg. *Aufbau und Realisierung einer Messapparatur zur Visualisierung von Temperatur- und Bodenfeuchtemessdaten einer oberflächennahen Geothermieanlage*. Master Thesis, FH Aachen, 2020.

[2] S. Kürten, D. Mottaghy, and M. Ziegler. "A new model for the description of the heat transfer for plane thermo-active geotechnical systems based on thermal resistances". In: *Acta Geotechnica* (2015).

[3] S. Kürten, D. Mottaghy, and M. Ziegler. "Design of plane energy geostructures based on laboratory tests and numerical modelling". In: *Energy and Buildings* (2015).

References II

[4] M. Langen, D. Mottaghy, and M. Lanz. *Entwicklung von Simulationswerkzeugen in Matlab zur Untersuchung der thermischen Wechselwirkungen zwischen verschiedenen Erdwärmeübertragern in einer Geothermieanlage*. Bachelor Thesis, FH Aachen, 2018.