SECURE for Student Success

Undergraduate Research Program

Civil Engineering and Construction Management

Research Duration:	Summer 2025 (June – August 2025)
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Title of Project:	**Testing and Improving Low-Cost Electrical Resistivity Tomography (ERT) System**

Goals and Objectives: The objective of this project is to design, manufacture, test, and validate small-scale geophysics instruments. This project will develop small-scale instruments with off-the shelf CPU boards and circuit boards, design of specialized boards, and use of commercial circuit boards such as Arduino. While these systems will be tested on small-scale systems (bench-scale or local on-campus system), these systems can be refined and used in future field-based research projects.

Arduino is a brand of open-source microcontroller boards with their own processor and memory. Arduino boards are commonly referred to as I/O devices due to their ability to simultaneously act as input devices (i.e. receiving, detecting or measuring electronic signals or voltage levels) and output devices (i.e. sending electronic signals or varying output voltage

levels). The I/O capability allows the Arduino microcontrollers to communicate with some electronic devices such as environmental sensors, data loggers, cameras, and other sensors or electronic components. Such components can be controlled or programmed using Arduino code. The Arduino programming language is based on C/C++ that is accessed via a user-friendly integrated development environment (IDE). Peripherals such as microSD card shields and real-time clocks can be connected via breadboards and jumper wires (soldered or unsoldered), while bespoke printed circuit boards (PCBs) can be used to simplify construction and minimize connectivity issues such as loose wiring or poor soldering.

The specific objective of this project is to test and improve the Arduino-based electrical resistivity tomography (ERT) system developed by the undergraduate research group in the summer of 2024. ERT is a geophysical technique for imaging sub-surface structures using electrical resistivity measurements made at the surface. The general method of ERT constitutes of a current induced in the ground using two current electrodes, and measuring the electrical potential drop using two other electrodes. ERT can be used to map geologic variations including: soil lithology (e.g., clay versus gravel), presence of ground water, fracture zones, variations in soil saturation, areas of increased salinity or, in some cases, ground water contamination. ERT is often the best option for mapping cavities such as caves, karst and/or evaporite dissolution sinkholes. **Note**: Students in the SfS2 2024 Summer Research Program developed, built, and coded an ERT system that takes one measurement at a time, and any additional measurements (in space, e.g., different electrical terminals) need to made manually. For the 2025 Summer Research Program, students will make improvements on the system by (**1**) improving the accuracy of the 2024 system; (**2**) testing the 2024/2025 system in different environmental conditions, (**3**) developing a system that does multiple automatic measurements (as opposed to a single manual measurement).

Expectations: Interested student(s) must have some familiarity with electronic components, e.g., Arduino boards, circuit boards, and other electronic components. Basic to advanced knowledge of C/C++ or other coding language. Students who do not possess coding or electronics skills, should demonstrate a willingness and ability to learn quickly.

Outcomes: The expected outcome of this project is a fully functional laboratory-scale Arduino-based experimental ERT system. The final system will have been designed, constructed, and tested under different environmental conditions (using small-scale experiments). For this 2025 Summer Research Program students will work and improve the system developed by students from the 2024 Summer Research Program by **developing, building, coding, and testing an automatic switch board integrated into the Arduino-based ERT system**. This improved system will allow for the testing and configuration using multiple electrodes, without having to manually change/move or connect and disconnect cables.