Probe Permeameter Machine

using MCC 118 and MCC 134 with Raspberry Pi®

Introduction

RO Scientific is a small engineering company as well as the MCC distributor in Romania and specializes in providing custom DAQ solutions. With expertise in both system design and software development, customers turn to them when commercially available solutions are either too expensive and/or do not fully suit their needs.

One such customer had a requirement for developing an automated permeameter machine. Accurate rock permeability measurements are critical for the oil and gas industry as the costly decision to drill in a particular spot heavily relies on such permeability measurements performed on prospective core samples.

The developed product is a fully automatic, dual steady/unsteady state, 2D predefined and arbitrary measurement pattern permeameter. The aim was to design a device capable of providing fast and reliable permeability measurements, with unprecedented accuracy and repeatability over large core samples.

The Challenge

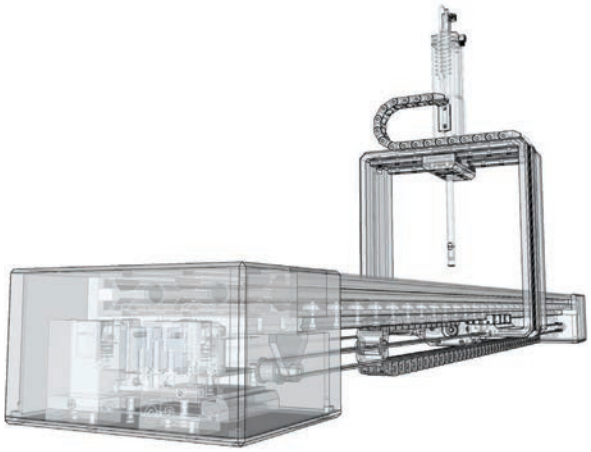
The process of measuring the permeability in core samples continues to be more like an art that lies on the talent and expertise of the technician that performs the measurement. The whole process is labor intensive and time consuming. RO Scientific's customer wanted to automate this process, as if it was performed by a human expert, and do so in fraction of the time.

The Solution

RO Scientific decided on the Raspberry Pi platform because they needed something as small as possible yet capable of providing enough computational power to perform some basic machine vision, do real time data acquisition and processing, and transfer the outcome via Wi-Fi to a remote interface. The MCC DAQ HATs were selected because of their ability to make accurate measurements at high speeds.

The completed machine consists of a high-resolution camera, an X-Y table, controllers, a Raspberry Pi 4, and the MCC 118 and MCC 134 DAQ HATs. The HATs measure four pressure sensors, one high-precision temperature sensor, and two thermocouples for measuring slow changing temperature measurements, like ambient temperature.

Data is sent via WiFi to a remote touch screen interface where the operator can view gas pressure, temperature, and flow data in real time.



The Probe Permeameter machine makes measurements in core samples using an X-Y control system with under one millimeter precision. A Raspberry Pi 4 board is at the heart of the solution, providing enough processing power for the machine vision and data acquisition and control functions.

The system was programmed using the open-source MCC Universal Library for Linux®. It was critical for RO Scientific be in full control of the software so they can deliver updates any time there is a change in the customer's needs.

Operation

Using a hi-res camera, the system scans the measurement table, determining the edges of the rock sample. A pneumatic actuator then lowers a probe to the sample surface and a gas (typically nitrogen) is injected into the rock sample. Pressure is measured at several points and temperature data is logged. Gas viscosity is determined. A fast-responding pressure sensor makes measurements at 10 kS/s, monitoring the pressure decay. From this pressure decay curve, in conjunction with the other pressure and temperature measurements, the sample permeability is calculated. This process is repeated in several locations within the sample.

Result

RO Scientific used the latest permeability measurement research and transposed the decision-making process into code. The outcome was a 90% decrease in the overall measurement time and the measurements proved to be as accurate as when performed by a human expert, and equally important, made the whole process repeatable.

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