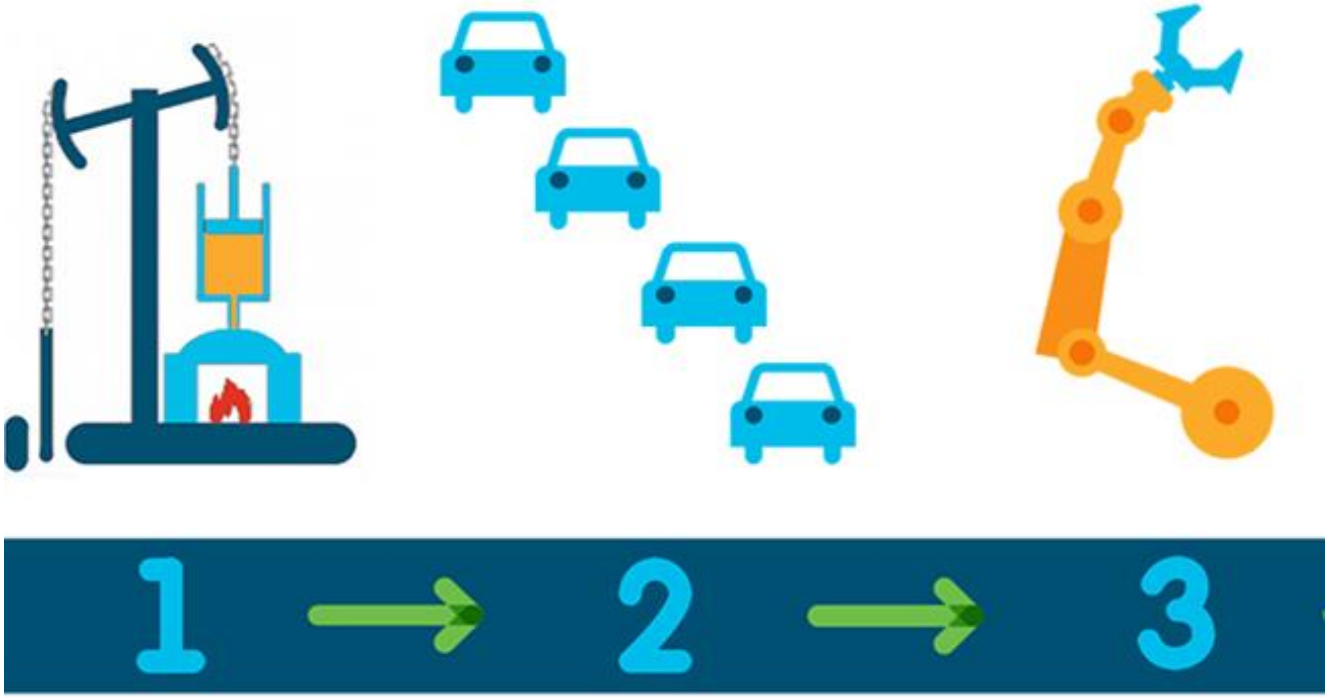
Condition Monitoring of Industrial Machines Using Cloud Communication

Anoush Sepehri
Summer Research Student
Fluid Power and Telerobotics Research Laboratory
University of Manitoba



Industry 1.0 Industry 2.0 Industry 3.0

Today: Industry 4.0

Cyber Physical systems

Internet of Things (IoT)

Automation

Smart Factories

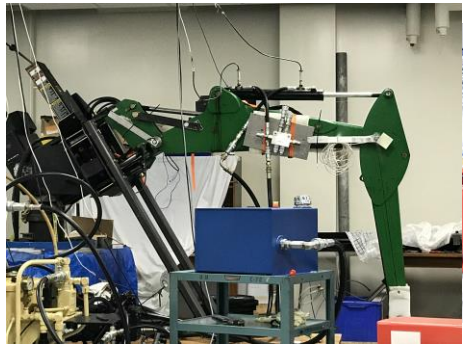
Big Data Analytics

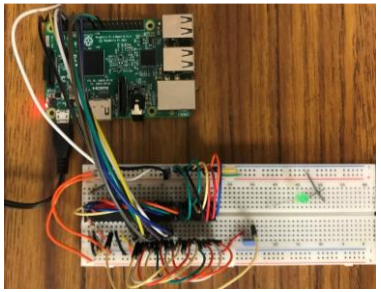
- Cloud Computing
- Predictive Manufacturing

Objective and Specific Aims

Objective: Simplify the process of data acquisition for fault detection and analysis to eliminate the need for manual condition monitoring

Specific Aims: Small and Portable modular device that can be retrofitted onto various industrial machines to monitor and send data in regard to its performance to the cloud
Data can be downloaded off the cloud from anywhere in the world for analysis





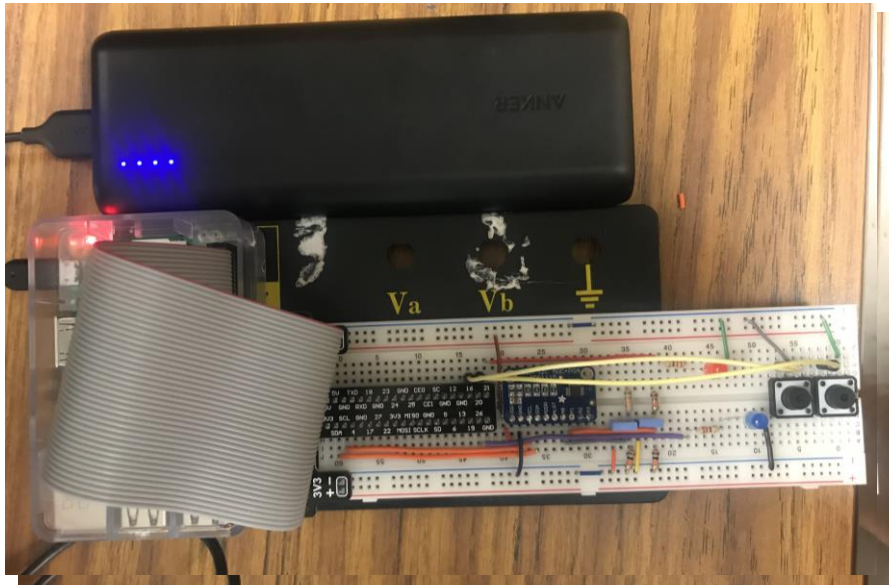
Hardware Development

Raspberry Pi B Model 3

Adafruit ADC 1115 PGA Chip

Anker Power Core 20100

Basic Electrical Components



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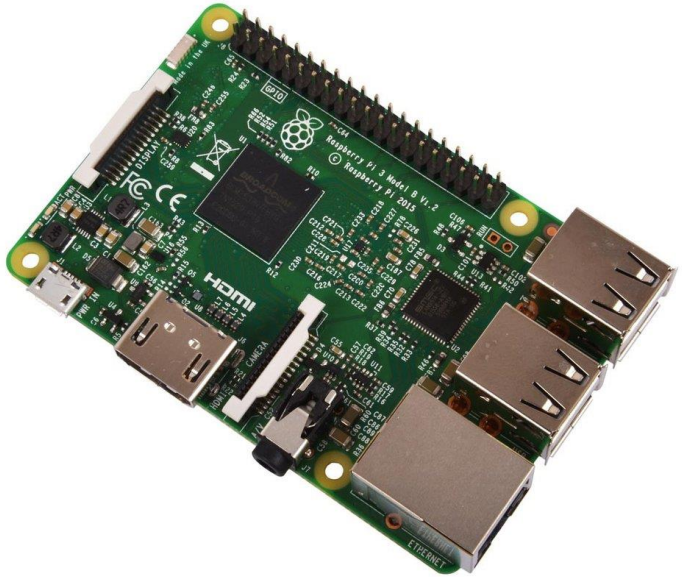

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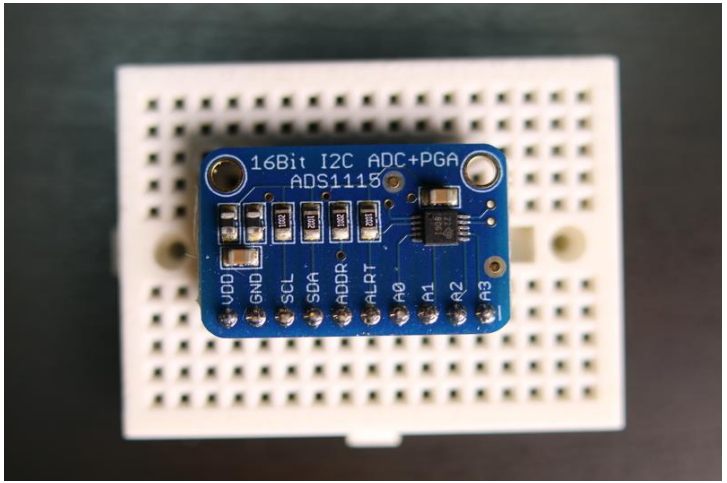

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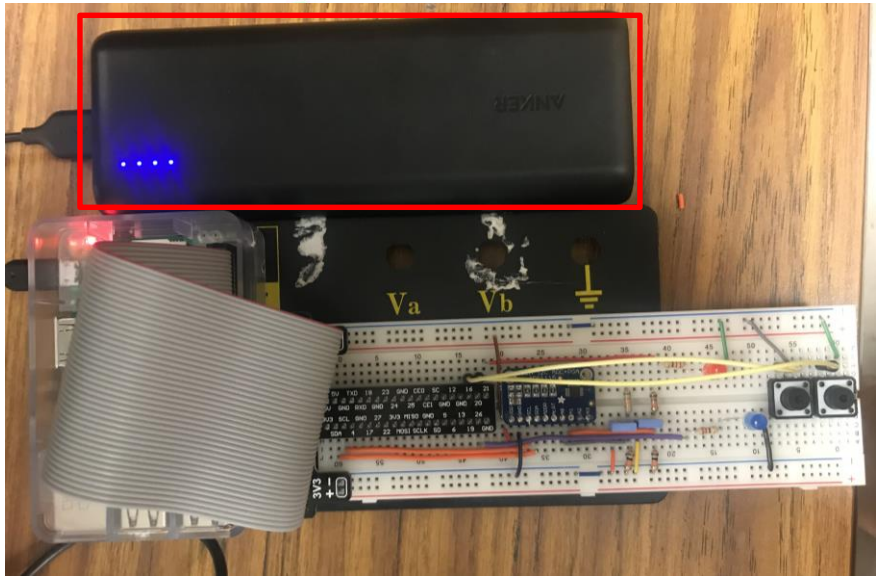

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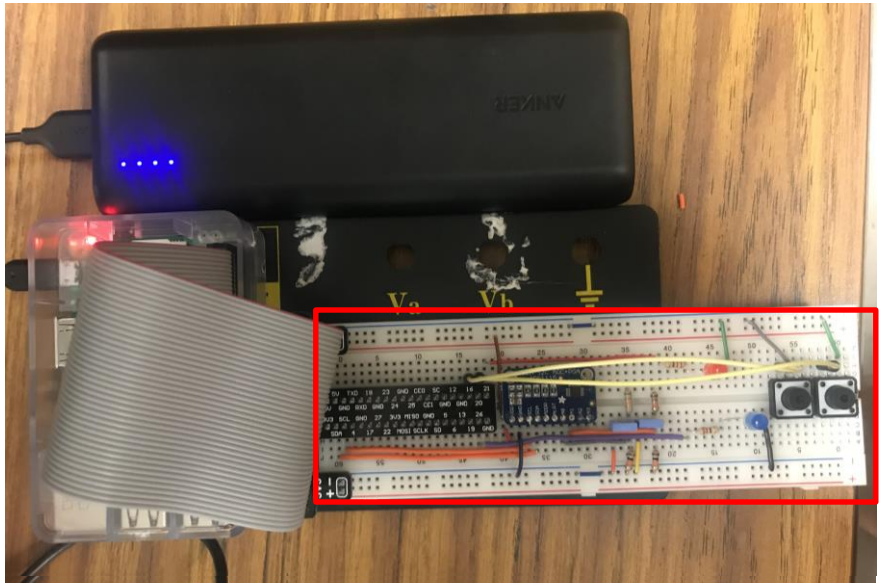


Software Development

Python 3.6

Two different Scripts

- One ran on modular Device
- One ran on laptop/desktop

Script 1: Run on Raspberry Pi

Parameters: Total Sampling Length, Number of Signals to read

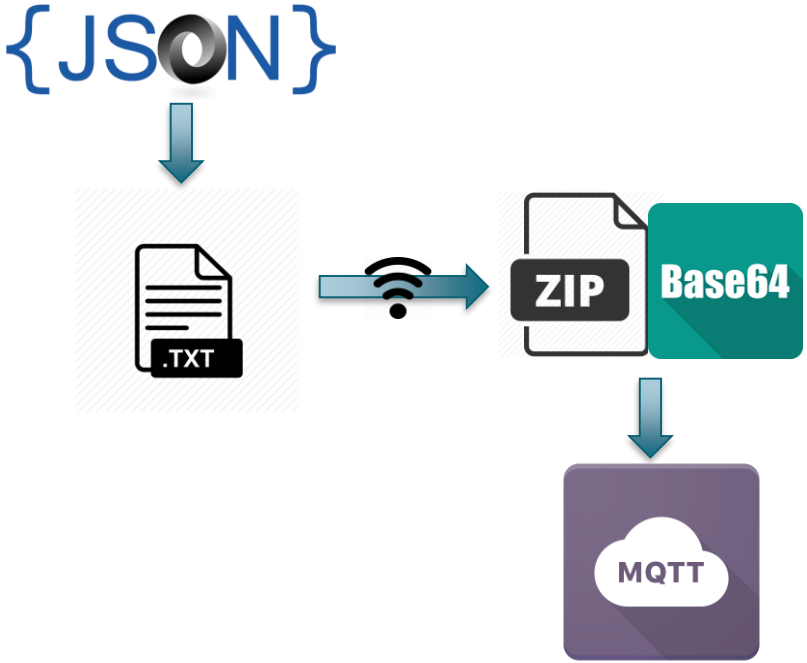
Samples data at 100 Hz for up to 5 minutes

Stores Data has JSON formatted .txt files

Compress using Gzip and encode with Base64

Send data using MQTT protocol

If no wireless connection established, data is stored until connected

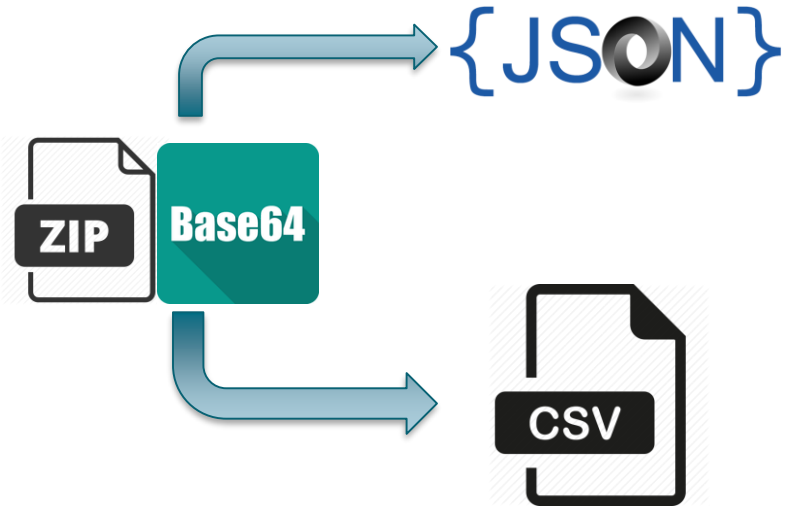


Script 2: Run on Desktop Console

After downloading compressed file off the cloud

Decompress the data and decode

Convert and output the file into JSON and CSV

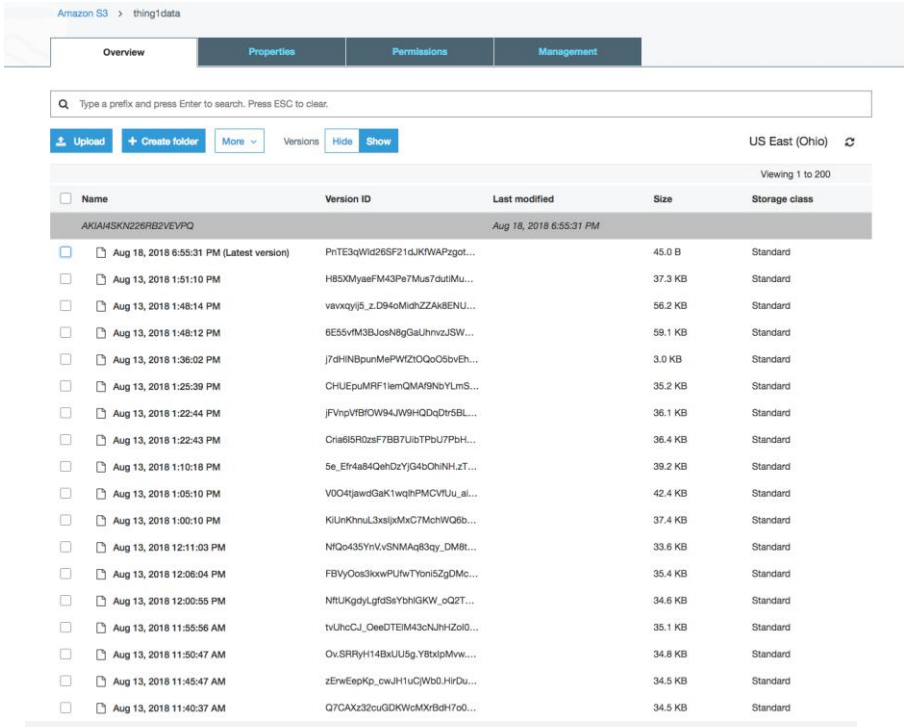


Cloud Server

Amazon IoT Core for initial reception of data

Data is transferred to Amazon S3 for storage

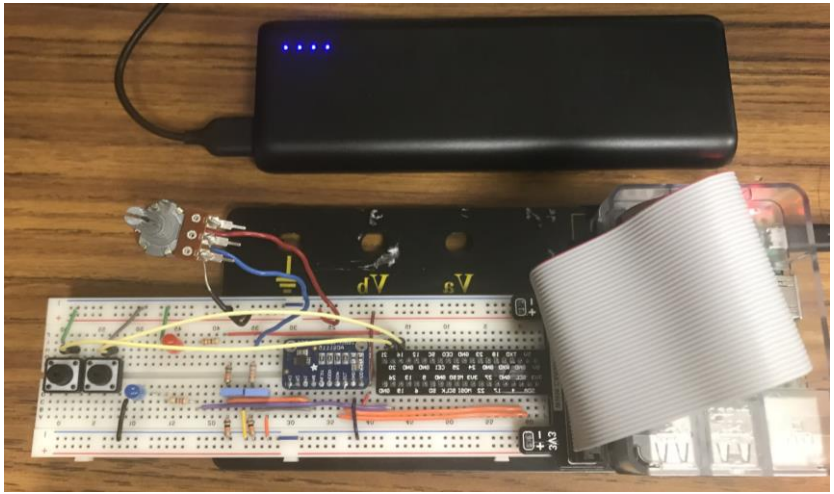
Can be downloaded and decompressed to use in analytical programs such as Excel or Matlab



Case Study 1

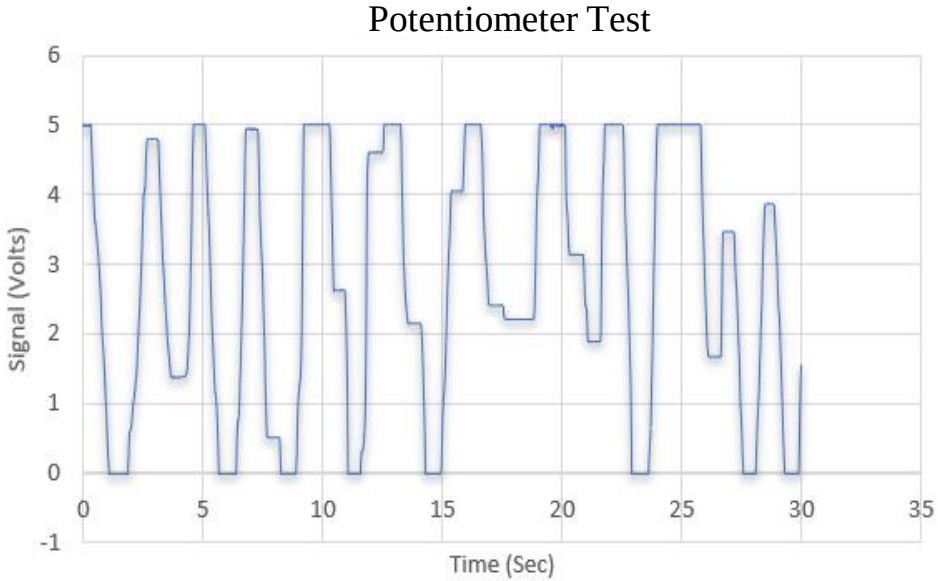
Use a rotary potentiometer to create a varying signal for the modular device to read

Proof of concept that the modular device can sample, store, and send accurate data to the cloud for retrieval



Data sampled at 100 Hz for 30 seconds

Data was successfully sampled, sent to the cloud, and retrieved



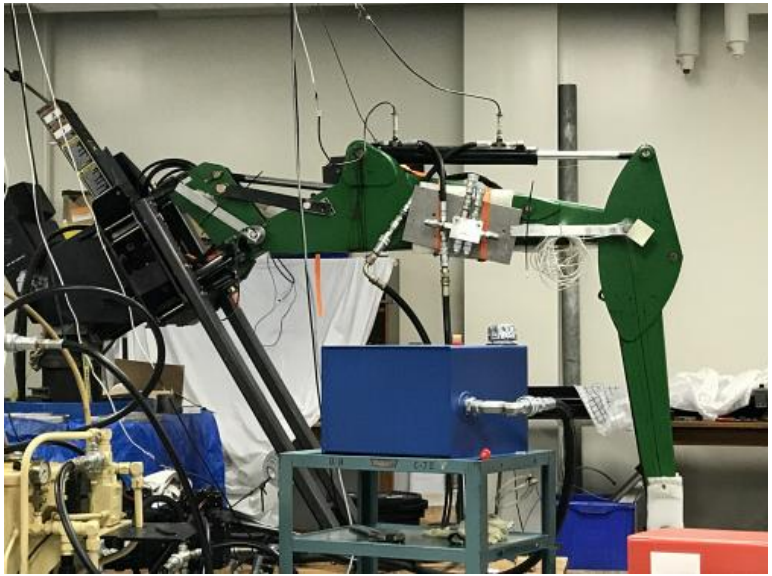
Case Study 2

Implement the modular device onto the Laboratory Based Backhoe Machine

Monitoring pressure data in hydraulic cylinders is important for internal leakage detection

Leave the modular device monitoring the Backhoe Machine for 24 hours

Compare off the cloud data vs. Onsite data for proof of accuracy

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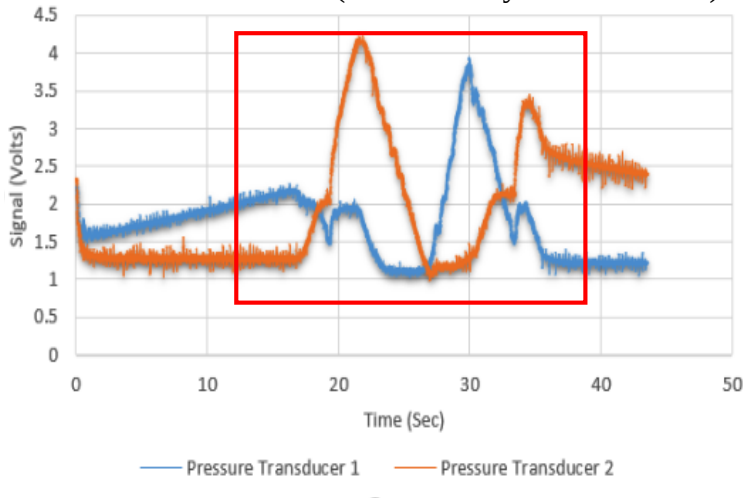
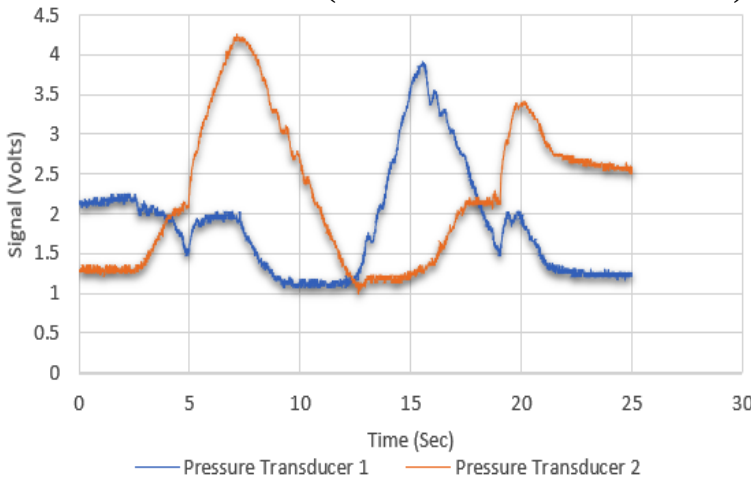
Backhoe Machine (Data Directly from Machine)



Backhoe Machine (Data Retrieved from the Cloud)



Internal Leakage and Fault detection Analysis can be conducted on this data

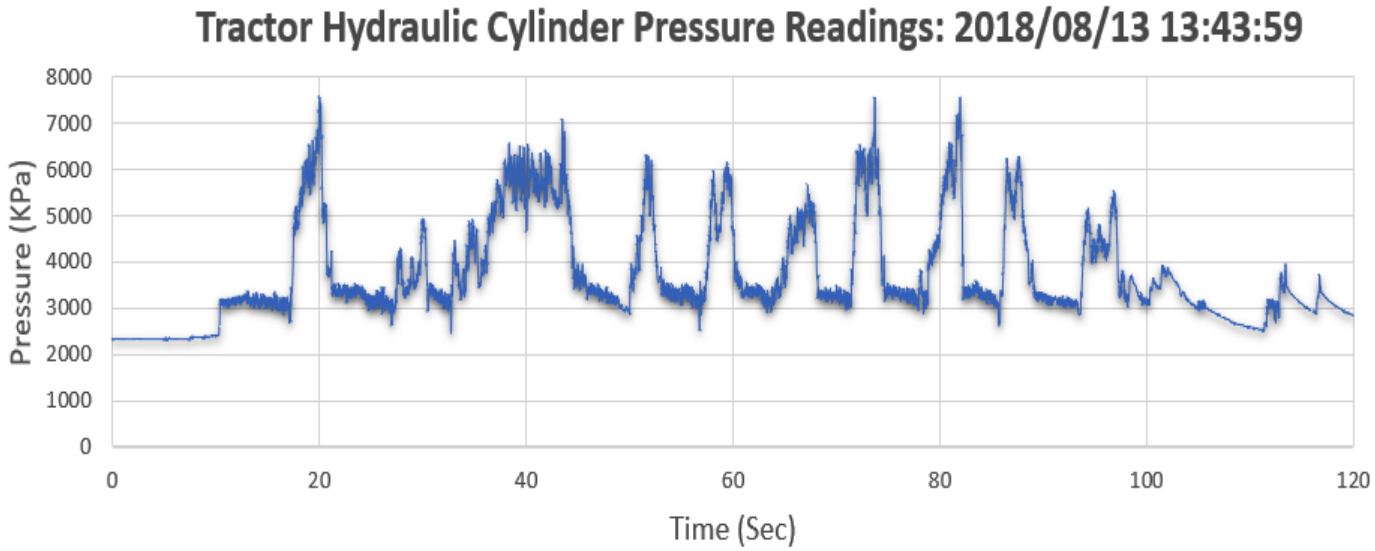
Data is of the sample level of accuracy as previous DAQ methods

Case Study 3

Implement the modular device onto an Agricultural Farming Tractor

Monitoring Device was ran for over three hours monitoring pressure of steering hydraulic cylinder

Pressure transducer attached to hydraulic cylinder on the underside



Internal Leakage and Fault detection Analysis can be conducted on this data

Modular Device is able to withstand robust environments is a viable option for data acquisition

Benefits

Eliminate the need for manual condition monitoring

Many machines can be retrofitted to send data to a common server

Data can be retrieved from anywhere in the world

Fault diagnosis methods can be conducted on the data

Modular Device can be used to sample and store data for long spans of time to collect large amounts of information

Future Possibilities

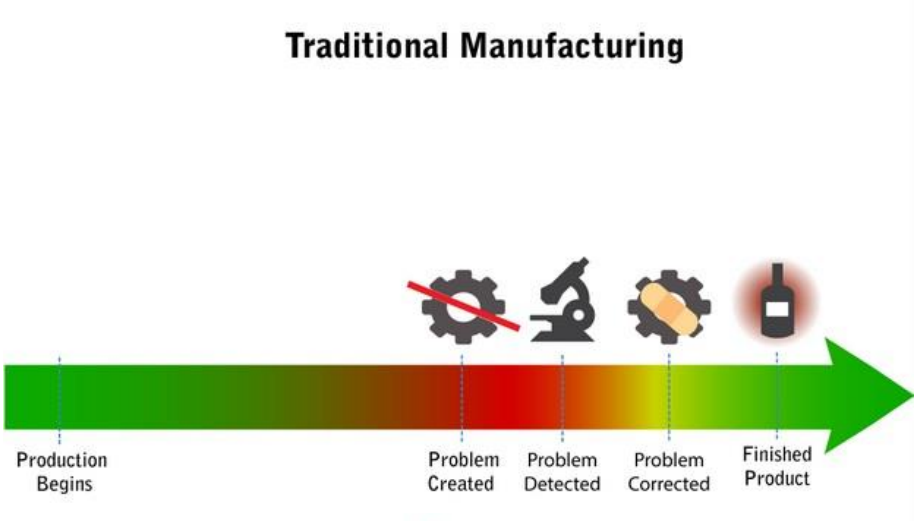
Modular device can sample large amounts of data over large periods of time

Data along with machine history and machine workload can be used to determine the state of the machine

Most optimal time to conduct maintenance can be determined prior to any breakdown

Eliminates long downtimes

Increase efficiency and reduce costs



Conclusion

Based on the ideas within the Industry 4.0 framework

Modular device eliminates the need for manual condition

Three case studies were conducted to demonstrate the monitoring device

Accurate data can be acquired and sent to the cloud to be retrieved from anywhere in the world

Modular device can be a critical component to predictive manufacturing/maintenance

Acknowledgments

I would like to thank:

Dr. John Chu
Dr. Ehsan Jalayeri
Mr. Guangan Ren
Mr. Shawn Shaerer
Dr. David Kuhn
Fluid Power and Telerobotics Research Laboratory