Challenges and Approaches for Real-Time Data Quality Evaluation

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Overview

- Brief Introduction to Primodal
- Primodal Monitoring Stations/Networks
- Real-Time Data Quality Evaluation
- Discussion for the Future
Introducing Primodal

Primodal Inc.
- Based in Hamilton, ON.
- Dedicated WWTP modelling firm
- Primary consulting firm
- Projects around the world including:
  - Locally as well as US, UK, Greece, Hungary, Israel

Primodal Systems Inc.
- Based in Hamilton, ON.
- Technology firm
- Monitoring equipment developer & manufacturer

Monitoring the Future: Advancing Water Monitoring Network Design
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Introducing Primodal

Wastewater Treatment Expertise

- Process Engineering & Modelling
  - from development to application,
  - as clients and modellers,
  - as academics, and consultants
Wastewater Treatment Expertise

- Process Engineering & Modelling
  - from development to application,
  - as clients and modellers,
  - as academics, and consultants

- COMMON THEME → Data Evaluation
  – the need for accurate and representative data
Process Understanding & Modelling

The Potential
- User-friendly software
- Limitless applications
- Whole-system modelling

The Pitfalls
- Model Prediction Accuracy
- Communication
- Expertise
- Model Maintenance
- Data Quality

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Primodal Systems
Data Acquisition
Identified Issues: Continuous Monitoring

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water’s edge
- advancements with digital sensor technology
- portability of system
Monitoring Station Development (RSM30)

- 2-year RSM30 Development Effort
  - private company / university collaborative effort
  - custom software development
  - sensor manufacturer independent

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Advancing Water Monitoring Network Design

Primodal Systems Inc.

Laval University

ifak

Three (3) Prototypes

System Requirements

Software Engineering

User Experience & Testing

RSM30
Monitoring the Future: Advancing Water Monitoring Network Design
Network Features

- BaseStation
  - Fieldbus configured
  - Local data storage and data analysis
  - Local RAID data protection
  - Real-time data analysis

- Central Server
  - Connection to multiple stations
  - Supervisory control

- Remote communication
  - TCP/IP – based
  - Wireless, ethernet, GSM, …
Primodal Monitoring Stations

 Std Configuration

- std AC power
- multiple sensors
- industrial computer
- fieldbus
- logger
- climate control

Prototype #1

Monitoring the Future:
Advancing Water Monitoring Network Design
Primodal Monitoring Stations

- Installed at Quebec City WWTP
- measuring primary effluent

Monitoring the Future: Advancing Water Monitoring Network Design
Installed at Water’s Edge St. Charles River

– measuring river quality parameters
Primodal Monitoring Stations

- Installed at Water’s Edge St. Charles River

– measuring river quality parameters
PrecisionNow: Two Stage Approach

- **BaseStation**
  - water’s edge
PrecisionNow: Two Stage Approach

- **BaseStation**
  - water’s edge

- **Central Server**
  - office location
  - advanced data analysis
  - connection to multiple BaseStations
Primodal Monitoring Stations

- BaseStation
  - measurement channels
  - visualisation

Monitoring the Future: Advancing Water Monitoring Network Design
Primodal Monitoring Stations

- **BaseStation**
  - measurement channels
  - visualisation
  - meta-data storage ....

user-input qualitative information (i.e. recalibration, event logs, weather, sensor faults...)

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www.primodal.com
Primodal Monitoring Stations

- **BaseStation**
  - measurement channels
  - visualisation
  - meta-data storage ....
  - customisable, user-definable data modules

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**RSM30 at the Water’s Edge**

- PrecisionNow software
- raw data logger
- intelligence at the water’s edge
  - storage of meta data
  - storage of log data
  - real-time data quality analysis
  - error identification, alarm triggering
  - signaling (events)
  - storage of analysis data
  - storage of primary data
Central Server
- connection to multiple stations
Central Server

- connection to multiple stations
- station details
Central Server

- connection to multiple stations
- station details
- visualisation & data modules
Data from Quebec City WWTP

- Hach Lange (pH)
Data from Quebec City WWTP

– Hach Lange (TSS)
Data from Quebec City: St Charles River

- Conductivity raw data

Noise, Natural Cycle or Event?
Data from Quebec City: St Charles River

– Conductivity data after LowPass Filter
Data from Quebec City: St Charles River

- MeS probe: TSS data after LowPass Filter

Real Events or Sensor Issues?
Data from Quebec City: St Charles River

- Conductivity vs MeS (data after LowPass Filter)

- no alarm

Confirmation of real events as picked up by other measurements
Data from Quebec City: St Charles River

- DO probe: Temperature

Real Event or Sensor Issue?
Data from Quebec City: St Charles River
– DO probe: Temperature, Rate of Change

Monitoring the Future: Advancing Water Monitoring Network Design
Data from Quebec City: St Charles River

– DO probe: Temperature, Standard Deviation

Still Unknown…
Primodal Monitoring Station Data Modules

- **Data from Quebec City: St Charles River**

  - Comparison of Temperature Signals
  - DO vs Conductivity Probes

  ![Graph showing temperature and conductivity data]

  **More Evidence, Redundant Sensor Signals…**
Data from Quebec City: St Charles River

– Comparison of Temperature Signals

- DO vs pH Probes
Data from Quebec City: St Charles River

- Comparison of Temperature Signals
- Conductivity vs pH Probes
- alarm triggered

Trends: drift detection
- Algorithms more sensitive to trends
- Trend clear, 0.5°C over 2 months
Summary

- Identified Issues: RSM30 Solutions
  - volume of data → data stored, simplified, filtered

Monitoring the Future:
Advancing Water Monitoring Network Design
Summary

Identified Issues: RSM30 Solutions

- volume of data
- data graveyards → real-time analysis to identify and trigger alarm situations, generate datasets of ‘clean’ data
Summary

Identified Issues: RSM30 Solutions

- volume of data
- data graveyards
- post-processing effort → automated data analysis for initial sanity check and to minimise calibration problems, identify trends, offsets .... as the data is stored
Summary

➢ **Identified Issues:** RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling  → trend, problem analysis to identify sensor problems and enable timely dispatch of technicians when problems present themselves

*Monitoring the Future: Advancing Water Monitoring Network Design*
Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water’s edge

→ data storage and visualisation included in the station itself, giving technicians access to historical, log, measurement data to better maintain sensors and stations
Summary

Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water’s edge
- advancements with digital sensor technology
  - profibus based sensor connections allow two-way communication with digital sensors and use of advanced sensor features
Summary

Identified Issues: RSM30 Solutions

- volume of data
- creation of data graveyards
- post-processing effort
- maintenance scheduling
- information available to field technician at water’s edge
- advancements with digital sensor technology
- portability of system → small, light form factor allows station to be moved, new sensors configured, new analyses incorporated…
Moving Forward

• More field deployments
• More system design feedback
• Integrate user feedback into interface
• More remote communication options
• Data module development
  - out-of-bounds → multi-variant regression analysis
  - SNR → more advanced time-series analysis
Thank-you