Integration of Advanced Flood Warning Technologies

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Introduction

Flood Warning Overview

Programming and programmability

Communication protocols

Integration Examples
  ◦ Remote control operation
  ◦ Remote PTZ camera control
What is Flood Warning?

Making use of flood forecasting and real-time data to make decisions about warnings disseminated to emergency officials and the general public.

Well-established industry and protocols.

DATA COLLECTION
- Precipitation
- Atmospheric
- Surface Water
- Ground Water
- Water Quality

COMMUNICATION
- ALERT
- ALERT2
- OrbComm Satellite
- HughesNet Satellite
- Cellular
- 2-Way Radio

DATA MANAGEMENT
- NovaStar 5
- Open Source Database
- Hydrologic Forecasting
- Data Reporting

ALERTS & EMERGENCY RESPONSE
- Alarm Notification
- Web Access
- Smart Phone/Tablet
- Flood Response Planning
Programming with Python

Why use Python?

- Inherently open source
- High level language
- Large user base
- Easy to read
- Easy to learn
- Taught at university level
- ESRI geoprocessing accessible through Python
- There’s a module for that

```python
x = 2
y = 'Stage'
for number in range (0,10):
    print number

import socket
collection = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
self.cxn.connect(('10.0.0.105', 4200))
```

```python
from twitter import *
```
Python Purposes

Hydrologic and Real-Time Data Purposes
- Modeling IO support (e.g., FLO-2D, HEC-RAS, HEC-DSS, HEC-6)
- Data collection and mining
- Data processing and decision support
- Watchdog scripting
- Action / Controls
- Data display and dissemination
- ∞

```python
import phonenumbers as pn
try:
    x = pn.parse(self.mobilePhone.text(), 'US')
    if pn.is_valid_number(x):
        # do something important
```
Specific Python Examples

Spatial data display (*.shp, *.kml)

MRMS radar mining and display

Complex alarm conditions (multiple sensor conditions)

ALERT/ALERT2 Base station software

Web frameworks (e.g., Flask, Django)
Traditional Communication Protocols for Flood Warning

ALERT and ALERT2 provide robust means of data telemetry
  ◦ Independent, off-grid
  ◦ Low power
  ◦ Real-time
  ◦ Efficient VHF waveform propagation
  ◦ Reliable and proven technology – developed in the 1970’s

Advanced hardware configurations require advances in technology
  ◦ Low bandwidth
  ◦ Limitations for two-way application
  ◦ Security
Communication Protocols

ALERT / ALERT2
- **Pros**: compatibility with existing networks, off-grid, reliable, real-time
- **Cons**: requires existing network, low bandwidth, non-secure 2-way Connection

Digital Microwave Network
- **Pros**: high bandwidth, existing network
- **Cons**: requires existing network, proximity to network

Cellular
- **Pros**: high bandwidth, existing network, easy to set up
- **Cons**: Proximity to network, moderately expensive ($15 / month for 5 GB for Verizon static IP address)

Satellite
- **Pros**: Last line of defense, most likely to connect, easy to set up
- **Cons**: Expensive ($80 / Month for 5 Mb with static IP address), low bandwidth, inconsistent connection
Sierra Wireless GX450 Cellular Modem ($700)

Hughes 9502 BGAN Satellite Modem ($2,000)
Integration Examples

Remote IP Pan-Tilt-Zoom Camera with Stage / Precipitation sensing

Remote dam valve controls
Remote IP Camera and Stage/Precipitation Sensing

Ash Creek, Arizona

Perennial watercourse located in the Pinaleño Mountain Range

8 mi^2 drainage area

Rugged terrain and steep slopes ranging in elevation from 4,000 feet to > 10,000 feet

Vegetation ranging from high desert chaparral to Ponderosa Pines

Irrigation source for Cluff Ranch Lake AGFD Facility

Looking upstream at Mount Graham – 10,700’
2017 Arizona Fires

Frye Fire boundary

Caused by lightning strike on June 7, 2017
Burned 48,443 acres
90% contained by July 13th
Debris Flow Aftermath

Photos by Ann Youberg, AZGS, 8/2/2017, Swift Highway (SR366) at and near Wet Creek
Ash Creek Debris Flow Aftermath

Significant damage to water pipeline extending from irrigation diversion structure one mile downstream

Access roads up the creek were washed out and channels became highly incised

Arizona Game and Fish Department (AGFD) interested in gaging upstream of their facilities (Cluff Ranch) along Ash Creek

> 15 feet channel incision
Project Needs

Protection for AGFD facilities

Advanced notification of future flow events
- Precipitation / Stage
- Transmit via ALERT

Visual aid to assess future debris flows
- PTZ + IR camera
- Temporary, modular construction for camera system
- Repurpose existing unused hardware
- Long-term monitoring
Sensor Specifications

HSE Tipping Bucket

CSI Pressure Transducer – CS451

Bosch Autodome 5000 IR
- 1x – 36x zoom (8x digital)
- Infrared illumination
- IP66 enclosure
- Pan-Tilt-Zoom capabilities
- 64 gb on-board storage (microSD)
- Excellent user interfaces
  - Direct web hosting (port 80)
  - Desktop viewing
  - Desktop configuration
  - Mobile
- 3-year factory warranty
- $1,300
  - $7,000 total including support equipment
Camera System Components

- Cell Modem
- PoE Injector
- Relays
- CSI CR300 Datalogger
- 12VDC – 24VAC Inverter
- Fuse Holder
- Charge Controller
- Battery Bank
Camera System Specifications

Dual power options
- 48VDC PoE
- 24VAC

150W 12V solar panel

300 Ah battery bank

220mA cooling fan

Directional high-gain antenna

Power management logic handled by datalogger

Local WiFi
Camera Usability

Mobile Application (android and apple)

On-board website hosting (HTTP)
Sensor 627 (Ash Creek Stage) @ 02/14/18 20:17:43 a value of 0.10 feet / 1 hour ... rising rate of change larger than the alarm values set for this sensor.

Nighttime live viewing of event

Collected stage data during event
Remote Valve Controls

Chevelon Canyon Lake Dam
- Install remote access to principle outlet valves
  - Primary (18”) and Secondary (6”)
- Limited access
- Limited telemetry options
Remote Valve Controls

Existing facilities for valve operation
- Concrete enclosure
- Hand-operated hydraulic pump
- Non-operative rams
Improvements to Valve Ops

Provide remote control
Provide gaging at outlet control structure
Replace non-operational hydraulic rams at bottom of lake
Replace hand pump with electric motors
Utilize programmable microcontrollers to provide easy control
Hydraulic Ram Replacement

For 6” Valve

For 18” Valve
Control System Overview
2 – 80 A (12 VDC) Motors for redundancy

Pressure sensors
- Hydraulic fluid level
- Hydraulic pressure

4 hydraulic lines extend to bottom of lake
- 6” valve: Open / Close
- 18” valve: Open / Close

Fluid pressure directed by solenoid switches
Principle Outlet Gaging
Future Planning

Web-based application for valve controls
Weir at outlet for flow verification
Installing PT for lake level

Planned repeater installation at the Brookbank DPS (Department of Public Safety) network for ALERT communication.
Conclusions

Modern programming languages are intuitive and powerful
Communication protocols are becoming cheaper and easier to manage
Integration of these technologies is becoming easier and easier
No knowledge of rocket science required
Questions

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