Agenda

1. Understanding Internet of Things (IoT)
2. Smart Sensors in Action
3. Benefits of Smart Sensors in Floodplain and Emergency Management
4. How the Federal Government Supports Smart Sensor Technology Development
5. Dam Safety Example: Hurricane Harvey
6. How Sensors Can Be Used to Improve Dam Safety
7. Considerations with Smart Sensors
Understanding Internet of Things (IoT)
IoT Devices

IoT devices measure a range of different items such as:

- Temperature/Moisture
- Water Levels, Flow, and Pressure
- Electricity
- Sound/Vibration

These devices are placed onto networks such as:

- Cellular
- WiFi
- Bluetooth

These devices can be used to make data informed decisions. Examples of smart devices already on the market include:

- Smart Speakers
- Parking Sensors
- Smart Thermostats
- Connected Cars
- Activity Tracker
Internet of Things (IoT) Market

**IoT Market**

Projected Market Revenue of IoT Worldwide: 2015-2021 (in billions of USD)

- 2015: $195 Billion
- 2017: $235 Billion
- 2020*: $470 Billion
- 2021*: $520 Billion

**Global Smart Sensor Market**

- 2018: $30.82 Billion
- 2024: $85.93 Billion

May 23, 2019
What are Smart Cities?

A smart city is a designation given to a city that uses different types of Internet of Things (IoT) sensors and devices to improve the quality and performance of urban services (i.e. energy, transportation, flooding). Smart cities put data and digital technology to work to make better decisions and improve the quality of life.
Growth of Smart Cities

Analysts expect a steady increase of smart city development around the world over the next seven years, with the total value of the global smart city market projected to exceed US$1 trillion by 2020 and US $2.5 trillion by 2025.

Source: "Smart Cities Market Analysis & Segment Forecast to 2025", Grand View Research, 2019
Smart Sensors in Action
How are Smart Sensors used?

Place IoT on City Infrastructure

Collect Data and Run Analytics

Take Action

Communicate with Stakeholders
Benefits of Smart Sensors in Floodplain and Emergency Management
Fire Response and Recovery

- To quickly identify victims, IoT sensors can be placed within homes and other structures to provide indoor positioning information.
- Smart city technologies will eventually allow first responders to view building floor plans, utilities layouts and underground maps to assist in case of a fire (Ex. Arkema Chemical Plant after Harvey).

Car Accident Management

- In a traffic accident, IoT sensors can be used to determine the exact location of the accident, as well as send data from the accident to alert first responders to a crash and provide them details of the accident.

Active Shooter Scenario

- IoT sensors can give first responders information on where gunshots have happened and where victims or potential suspects are located.
- According to R&D Magazine, one person dies for every 15 seconds a shooter is active and it takes two minutes on average for someone to call 911 and report a shooting.

Sensor detects gunshots, saving lives.

By Catherine Sleep, 16 March 2019

A gunshot was fired outside of Jamestown Middle School, forcing the school to go into lockdown. Thanks to the new sensor technology installed at the school, the gunshot was detected immediately, and dispatchers were called to the scene and arrived very quickly.

According to R&D Magazine, one person dies for every 15 seconds a shooter is active and it takes two minutes on average for someone to call 911 and report a shooting. Thanks to these sensors, first responders were dispatched immediately, saving lives in the process.
Flood Detection Sensors

Flood sensors can be used to send geo-targeted alerts and increase safety of a surrounding community in the event of flooded roads, waterways, and dams.

**Flooded Highways and Roads**
- Flood sensors can be installed on traffic lights and light poles to determine the amount of water on a road after a major storm or hurricane.
- This knowledge can be used to shut down a road if it is too dangerous to drive on. Additionally, IoT sensors could communicate with local government to send Geo-targeted alerts warning the surrounding area.

**Flooded Waterways**
- IoT sensors can be installed on rivers and waterways to detect rising levels and determine when it may overflow.
- IoT sensors could communicate with other IoT devices (smart speakers) or with local government to alert an area of a flash flood and to avoid roadways and to flood proof your home.
- Sensors can also be used to measure the water quality.

**Dam Safety**
- IoT sensor data can be used to inform dam releases, monitor pressure and rate of fill in order to prevent them from overflowing, as well as to make sure they are properly maintained and structurally sound.
How the Federal Government Supports Smart Sensor Technology Development
FEMA Mitigation Planning

FEMA Strategic Plan

Strategic Goal #1: Build a Culture of Preparedness

• Incentivize investments that reduce risk, including pre-disaster mitigation, and reduce disaster costs at all levels.

Hazard Mitigation Grants

• FEMA’s Federal Insurance and Mitigation Administration (FIMA) seeks to increase pre-disaster mitigation investments through DRRA implementation.
• Section 1234 feedback via ideascale.
Evigia Systems

- Developing a new type of sensor that is self-powered, stand alone, rapidly deployed, and low cost.
- Will give you real time environmental data (i.e. air pressure, water level, water temperature).
- Linked to cellular and cloud, doing analytics in the cloud.

Progeny Systems

- Flood sensors are in alpha beta stage.
- Have deliver flood sensors to 5 localities.
- Data is going to the localities.
  - Question is: How are they using this data?
- Primary communication for the sensor is cellular.
  - Impact of 5G?
Importance of Dam Safety
Hurricane Harvey
Barker and Addicks Reservoir

- During Hurricane Harvey water levels reached record level of 99 feet at Barker and 105 feet at Addicks (At one point, the dams water levels were raising more than half a foot per hour).

- In order to prevent a spillover of the dam, the Army Corps of Engineers released water through the dam gates, which lead to additional flooding.

- To complicate any evacuation efforts, several major roadways that run through both reservoirs were underwater.

The Washington Post

Houston dam spills over for the first time in history, overwhelmed by Harvey rainfall

By Emily Wax-Thibodeaux, Alex Horton, and Amy Wang 29 August 2017

One of two major flood-control reservoirs in the Houston area began spilling over for the first time in history, despite efforts to prevent such “uncontrolled” overflow the day before, officials said.

The U.S. Army Corps of Engineers confirmed Tuesday morning that water was spilling from the north end of the Addicks Reservoir, which has been overwhelmed by extreme rainfall from Hurricane Harvey. Officials said they expect the Barker Reservoir, to the south of Addicks, to begin overflowing similarly at some point soon.

A Harris County Flood Control District meteorologist said the overflow from the reservoirs would eventually flow into downtown Houston.

The reservoirs, which flank Interstate 10 on the west side of Houston, feed into the Buffalo Bayou and are surrounded by parks and residential areas. Water levels in the two reservoirs had already reached record levels Monday evening, measuring 105 feet at Addicks and 99 feet at Barker.
Hurricane Harvey: Barker and Addicks Reservoir

Sunday, August 26th: Evacuation Notices Issued
Evacuation Notices were given for residents around the reservoirs.

Monday, August 27th: Release Water from Reservoirs
The Corps planned Monday to release water at 4,000 cubic feet per second from each reservoir over a six- to 10-hour period. By midmorning Monday, streets and houses in some surrounding neighborhoods had already begun flooding.

Tuesday, August 28th: Rescue Mission
On Tuesday afternoon, helicopters and boats roamed the upscale subdivisions southwest of the Barker Reservoir, attempting rescues of families.
Could Sensors Have Mitigated Impact of Hurricane Harvey?

Thursday, August 17th
Harvey begins as a slow moving tropical storm in the Gulf of Mexico.

Friday, August 18th
City of Houston uses sensor technology to assess current dam levels and determine how much rain the dam can withstand if a hurricane occurs.

Thursday, August 24th
Harvey becomes a Category 1 hurricane.

Use of Sensor Tech to Mitigate Impact of Hurricane

Based on data from sensor technology, water is released from dams under controlled conditions.

Friday, August 25th
Hurricane Harvey makes landfall in Texas.

Friday, August 25th
Hurricane Harvey makes landfall in Texas.

Saturday, August 26th
Despite torrential downpour, due to proper planning thanks to smart sensors, the Barker and Addicks Reservoir did not need to have water released, saving millions of dollars in damages.

Sensors determine where roads are flooded and shut down the roads, sending out geo-targeted alerts, communicating to other IoT devices (i.e. Alexa), and communicating with GPS to inform the surrounding area to avoid certain roads and bridges.

Sensors Impact saving lives and money
How Sensors Can Be Used to Improve Dam Safety
Sensors in Dam Safety**
**All stats via damsafety.org

The number of **high-hazard** potential dams, meaning their failure could lead to loss of life.

The number of **significant-hazard** potential dams, meaning their failure could lead to severe economic impact.

The **average age** of the 90,580 dams in the country.

ASCE estimates that it would take an investment of more than **$25 billion** to address dam deficiencies for Corps-owned dams.

“In order to improve public safety and resilience, the risk and consequences of dam failure must be lowered... Dam failures not only risk public safety, they also can cost our economy millions of dollars in damages. Failure is not just limited to damage to the dam itself... When a dam fails, resources must be devoted to the prevention and treatment of public health risks as well as the resulting structural consequences.” –ASCE 2017 Infrastructure Report Card
Improved Communication

- **Geo-Targeted Alerts**
  - Sensors detect when a dam is going to overflow, sends communications to local government and emergency response team, and they send out mass communications via phone/email to those in the impacted area.

- **IoT to IoT**
  - Sensors detect when a dam is going to overflow, send a signal to other IoT devices like smart speakers (Alexa, Google Home) which will verbally provide you with an alert that you are in a high risk area of flooding.

- **IoT to GPS**
  - Sensor detects that a dam has overflowed, impacting surrounding roads, and sends signal to GPS to redirect you away from the flooding.
Build Resiliency

Maintain Structure of Dams

- Sensors can continuously evaluate the structure of a Dam to ensure it does not become a high-hazard or significant-hazard dam.

Mitigation Planning (Continuous Improvement)

- Better plan to prevent worst-case scenarios (Ex. Barker and Addicks).
- Each disaster poses its own risk and own unique circumstances for learning.
- Analyze and use data to make better decisions when future disasters occur.

Development of Emergency Action Plans (EAPs)

- Sensors linked to computers that could quickly trigger Emergency Action Plans (EAPs) based on sensor findings.
Improved Safety

Water Levels

- If the water level raises above a threshold, it alerts surrounding area that they should evacuate.
- If water raises above the maximum threshold, dam owners need to release water from Dam or else it will capsize.

Water Quality

- There are also sensors for water quality that measure the ongoing health of the waterways, but if a hurricane—or the stagnant water left in its aftermath—brings about waterborne diseases (as happened during Hurricane Katrina) the sensors can measure that too.

Save Lives

- By knowing when a Dam will capsize, you save lives by not allowing it to break or by releasing water and alerting the surrounding area.
Considerations with Smart Sensors
Adopting Sensors into your Floodplain Management

**Business System Integration**
- Connect sensor technology to existing IT and business systems so that data collected by a sensor is not lost.
- Key Considerations for Smart Sensor Use
  - Maintenance
  - Cybersecurity
  - Weather Impact
  - Cost

**Training**
- Provide subject matter expertise on sensor technology and using sensors in emergency management.

**Data Processing**
- Generation of products (e.g., 3D models).

**Data Integration**
- Integrate data generated by sensors with outside data sets.

**Data Management**
- Follow information technology best practices when managing data, in order to provide data confidentiality, integrity, and availability.

**Program/Project Management**
- Contract regulation/management.
- Conduct field verification.
- Ensure guidance with any government restrictions.
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