Thesis Project Portfolio

Hydrologic Modeling and System Optimization for IoT Flood Management

(Technical Report)

Smart City or Surveillance City: Holding Smart Cities Accountable When it Comes to Privacy

(STS Research Paper)

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Lily Malinowski

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Department of Systems and Information Engineering

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Executive Summary

The relationship between Internet of Things (IoT), or sensor networks, and human privacy are very closely intertwined. Sensors relate directly to data collection- an ever-existing problem within social media apps or online web browsing. The issue with data collection is that it is often done without the user knowing and people aren't aware of how much information they are readily giving out and how that data is further used or sold without their knowledge. Smart cities or the concept of installing sensors to predict dangerous events in the same vein doesn't consider how to get informed consent of citizens to collect significant data and fails to consider human privacy in the implementation of a solution for a significant societal problem. So, when considering the technical aspects of sensors, it is also important to consider if they are used and implemented, how it directly impacts human privacy.

For the technical report, a project on IoT sensors in the context of flooding was conducted. Flooding and extreme rain events will be a top climate hazard for Charlottesville by 2050, according to a study made by Lopes and Tilman (2020) on the local effects of climate change. The increasing frequency and severity of storms due to climate change is magnifying these flooding impacts. The Internet of Things (IoT) revolution promises more ubiquitous sensing capabilities. When applied to water systems, IoT has the potential to increase insights into how hydrologic systems respond to extreme rainfall events, aiding in emergency management efforts before and during extreme weather events. For the technical project, ultrasonic, soil moisture, weather sensors were deployed using an IoT network. After collecting data from the sensors, it was used to forecast water levels with the hope of applying to flood management decision makers. First, a hydrologic model for a watershed in Charlottesville was created and ArcGIS was utilized to obtain parameters for the model from geospatial datasets

such as elevation, soils, land use, and land cover. Real-time 6hr rainfall precipitation forecast data from NOAA using Python. Parameters obtained from ArcGIS, the 6hr rainfall precipitation data, and values from water sensors can be combined to create the hydrologic model in HEC-HMS. To explore IoT and systems integration, determine the battery life of the IoT water sensor devices, and analyzed the relationship between various parameters affecting battery life including the sampling rate and spreading factor. The team was also able to fully deploy new sensors around UVA grounds and integrate them into the IoT network and model.

Imagine a world in which everywhere one looked was a piece of technology monitoring, recording, collecting information about them- that is the reality of a "smart city". While smart cities haven't been fully implemented yet, they may be an accurate depiction of a potential future implementation of technology. Human privacy is an ongoing issue even in today's society with just the rise of smartphones and wearable technologies. While these devices provide great convenience, it is important to survey opinions about how the use of this technology may violate privacy if it is to be further implemented later in a smart city-like solution. Using wicked problem framing, the sociotechnical project aims to prove that while some might view human privacy as a wicked problem, there still must be action taken upon it. Privacy is an issue that affects everyone and if permanently implemented throughout society with no bounds, the technology will be inescapable. While wicked problems are deemed unsolvable, an effort must be made to tame the problem of privacy in order to hold governments and technology companies accountable in preserving a basic human right.

In completing the technical physical application of Internet of Things and LoraWAN sensors simultaneously with the sociotechnical application of analyzing how the overuse of technology in a smart city context violates human privacy directly relates the concept to the

potential method of implementation. Oftentimes, concepts to solve large societal problems are conceived but all of the potential consequences aren't fully considered. The benefit of completing these projects simultaneously is the ability to see both the concept in a broad context of how it would impact society and exploring current developing technologies which could later lead to the implementation of the concept. Engineers are tasked fully with the innovation, the implementations and functionality of the technology, while never fully asked to consider the moral implications. When considering IoT and the way it can be used to allow networks of computers to communicate more efficiently and with less human intervention, the solution appears to have no negative outcomes. However, when considering the sociotechnical problem of how devices which regularly monitor and collect data it becomes more apparent that there are significant potential violations of implementing this previously thought promising technology.