Falling Into Muddied Water: A Look into Flash Flooding and Flood Response Systems
(Technical Paper)

Smart City or Surveillance City: Holding Smart Cities Accountable When it Comes to Privacy
(STS Paper)

A Thesis Prospectus
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Prospectus

Introduction

In 2014, flood damages totaled around $2.86 billion in the United States alone- with damages steadily increasing throughout the twentieth and twenty-first centuries (Saharia et al., 2017). Flooding and extreme rain events are often overlooked in importance especially when governments are budget planning. Rather than experience extreme financial burden, investing in flood prediction and prevention methods would minimize the cost of damages. Without the proper funding to have tools that can predict when flooding will occur, citizens cannot be notified of the potential weather hazard, therefore the likelihood of significant damage due to flooding is high. In order to mitigate the lack of flood preparedness, sensors which measure key metrics can be used to better estimate and inform citizens of an extreme weather event. The final technical deliverable will be implementing sensors to measure and find the correlation between soil moisture, rainfall, and water levels so that extreme weather events can be better predicted.

As the population in already densely populated cities begins to rise and global warming becomes an ever pressing issue, the idea of a "smart city" was conceived. A smart city is rooted in three aspects: sustainability, smartness (context aware economy), and inclusiveness (Arroub et al., 2016). Part of this ideal includes adding a few new features such as sensors and monitoring systems to collect information- allowing governments to better predict weather, monitor crime, and predict and correct issues before they arise. While implementing wireless sensors and devices may be beneficial in many ways, there may be an invasion of privacy when it comes to constantly monitoring and capturing information. While the main focus is on advancement of technology, it is essential to preserve the basic rights of humans and ensure that policy is being made to hold companies storing information accountable.

Technical

In order to improve flood response systems, sensors can be utilized to measure and predict when extreme flooding and rainfall might occur. Internet of Things (IoT), the concept of linking computers, sensors, and networks by means of the cloud, can be utilized to manage wireless sensors. Specifically within this project, The Things Network and long-range wide-area sensors (LoRaWAN) are used due to their effective performance in range and battery usage as opposed to other solutions like WiFi which take significant power and have a more limited range. A gateway is a device that connects The Things Network to the sensors within a certain geographical range. Gateways use a high powered network like cellular or WiFi to connect to The Things Network, while it uses low power networks like LoRaWAN to connect to the sensors- fully optimizing the power capacity of each. LoRaWAN allows longer range in areas with lower connectivity (Johnston et al., 2019). After sensor data is transmitted to The Things Network, it is then uploaded to a Google Cloud based storage solution for long term storage. In order to visualize the sensor data, an application called Grafana Cloud is used.

Currently, there are two gateways and four sensors deployed. With the help of the graduate advisor, the team will deploy another gateway on the roof of Rice Hall at the University of Virginia and deploy two additional sensors. The team will choose locations based on local watersheds and basins in order to best optimize the collection of data to benefit the UVa and local Charlottesville communities. In total there will be an ultrasonic, pressure, soil moisture, and weather sensor which team members will decide how to best utilize the data from each to create a comprehensive report on how to best predict flooding.

The first phase is that the systems team will evaluate how the current system is working in regards to cybersecurity, battery management, and UI/UX and look for ways that it could be

improved. They will then create a system map to visualize the entire IoT system used by the team at UVa. The second phase will be installing the gateway on top of Rice Hall as well as deploying the sensors with the help of the graduate advisor. The third phase will be completing analysis on the data collected and researching flood mitigation strategies that could be implemented. The final deliverable will be a report on the correlation between soil moisture, rainfall, and water levels and making actionable recommendations on how the UVa and surrounding Charlottesville communities can better prepare for floods based on the information gathered.

STS Topic

As cities begin to grow beyond their capacities, it is essential to learn how to mitigate poverty, crime, and environmental footprint. While the concept of a smart city promises sustainability, smart sensing, and lack of homelessness- it would require the implementation of cameras and sensors in order to monitor and collect data to make such predictions. Despite the fact that there are many benefits to installing these sensors, there may be significant consequences which might be easily overlooked- specifically the problem of human privacy.

81% of U.S. adults feel they have little to no control over data that companies collect about them (Atske, 2019). Based on the survey, it is apparent that even without constant surveillance and monitoring in every public location that there are considerate concerns in regards to personal privacy when just owning a cellular device or computer. Scaling this up in the context of a smart city where public spaces such as parks, libraries, workplaces, would all have cameras and sensors which recognize who enters and leaves and would gather invasive metrics about them without their consent. Technological innovation has advanced beyond the privacy policies and laws which should be holding companies accountable (Privacy &

Technology, 2022). When the government has access to citizens' digital footprints, which consists of any digital actions completed by an individual including but not limited to: web searches, purchases, facial recognition, then rights such as freedom of speech and equality are essentially void. Therefore, exploring the topic of human privacy is essential to maintaining basic civil liberties.

The Wicked Problem and Technological Fix can be coupled together to analyze how human privacy is a problem that heavily involves the intersection of society and technology. A wicked problem is a social or cultural problem that is difficult or impossible to solve due to its complex nature (Seager, Selinger, & Wiek, 2012). Data privacy is a wicked problem- one must consider not only the solution but also the "trade-offs and dynamics of technological, legal, and human factors" (Alaqra, A. S., 2018). Looking at data privacy through the wicked problem lens may reveal complex relationships not previously known. Technological fix is the framework which aims to address whether or not technology should be used to fix given problems. By utilizing this idea, the hope is to answer "Does fixing a problem with technology help the problem or simply direct the focus?" (Newberry). While smart cities promise to implement smart sensing, I hope to highlight the potential consequences of attempting to fix the lack of information by having an excess of information. Instead of fixing the problem at hand, it appears to create more problems- how should the data be stored and managed? How will the excess data be deleted after?

Some critics believe that categorizing a problem as a "wicked problem" and differentiating it from other problems as unsolvable is unrealistic- that regardless of the problem people will try to solve it (Turnbull & Hoppe, 2019). Within the paper, I acknowledge that

regardless of the fact that a problem is considered wicked or not, there must be action taken and a solution proposed.

Methodologies

Research Question: How does the implementation of smart cities specifically installing sensors to capture and gather information violate human privacy? How are citizens responding to that potential violation of privacy? To answer my research question, I first plan to lay groundwork by detailing the rise of smart cities and how the implementation of sensors and other devices violate human privacy. I will then be utilizing policy analysis to gather information about the types of policy that currently exist to regulate and protect privacy within the US. I plan to gather sources about policy ordering them in chronological order- because the order and dates might be interesting when compared to the timeline of the creation and innovation of the smart city. I also think that it would be interesting to do some discourse analysis to research some non-traditional sources such as social media to see what younger generations may think given that they grew up in the now "digital age". The project will be limited to privacy laws that have been made in regard to technological recording or monitoring only- those not involving technology will be excluded. For key words, I plan to search the words "privacy" and "privacy law regarding sensors or cameras" in order to find a majority of the sources.

Conclusion

The paper covers the impending need of better flood preparedness systems as well as the implementation of sensors in smart cities and how that might potentially jeopardize human privacy. In terms of the technical project, the team's final deliverables will be to create a system map to help visualize the connections between the entire IoT system (consisting of sensors, gateways, and cloud based storage systems) and second find the correlation between soil

moisture, water level, and rainfall to make recommendations on how the UVa and Charlottesville communities can better their flood preparedness systems.

When considering the implementation of smart cities, the paper also considers the sociotechnical consequences of implementing technology essentially ingraining it into the functionality of a city- which might change many aspects of society with a specific focus on human privacy. By analyzing the problem through various frameworks, the hope is to reveal potential consequences of implementing a smart city and ensuring that there are policies to hold key leaders and technology companies accountable for providing basic human privacy. The research done about the current policy which is enacted in the US will provide a baseline for current laws and identify gaps where future potential policy should be created.

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