Towards safe re-opening of campuses in a pandemic by using Geospatial Location based Tracking Management

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Abstract— **This position paper presents the argument for digital asset tracking and management of human assets within the physical University campus environment using Geospatial Information Systems (GIS) database visualization maps. The efforts of our study provide the unique contribution of being able to identify possible safe zones on campus for student and staff to meet while being mindful of COVID19 protocols. Though COVID19 is the specific use case, we purport that this methodology will be valid for future similar pandemics. The paper also highlights the unique challenges and opportunities of the pandemic use case based on our proof of concept study. These concerns are raised to motivate similar institutions needing to deal with related Geospatial asset tracking considerations within their own environments during this pandemic.**

Keywords— Geospatial, visualization, pandemic, safe

I. INTRODUCTION

Geographic Information System (GIS) data provide valuable information to the asset management organization [1]Pandemic planning has given scarce attention to how we track physical assets properly within geographic spaces like college and University campuses. Given the dense populations within these spaces, this is not advisable. Since pandemic mitigation measures have been enforced to slow the spread of COVID19, students have had to study online; as COVID19 spread is very favorable in campus spaces. The need to manage open spaces like class rooms, Wi-Fi hot spot congregation points, and the free flow of the student public within these zones is a growing concern.

This paper identifies precautionary activities that a university should urgently seek to implement given pandemic challenges. The role of management in establishing the necessary conditions for the safe re-opening of educational institutions is undeniable. Administrative teams need to build suitable safety bubbles. Unfortunately, how to successfully do this is still not well understood. To re-open the campus with respect of the face-to-face instruction will require a significant Geospatial digital and human asset tracking system be put in place with suitable site analysis studies that will account for how the educational institution can accomplish this, keep students and faculty safe, and get ahead of potential outbreaks; with proactive contact tracing.

Many Universities worldwide including our own have implemented blended learning for some programs to support business continuity. Notwithstanding what applies in Universities is also well established and true for many public and private organizations in general.

In our own University setting our very specific approach has been to model Geospatial ArcGIS Microsoft SQL 2016 databases of the entire campus class room and open space settings, Wi-Fi access points, and their proximities as parameters. These parameters are qualified by asset types and operations [1,2]. The collected data set generates archetypes of all the campus locations as digital hotspots visualized from a secure and encrypted SQL Server 2016 database with suitable audit tracking from our dedicated private cloud environment [2]. At present, the database snapshots represent discrete fixed location points campus wide with video imagery which have been meta-tagged for labeling and description. Dynamic tracking against these discrete points represents our next step and is the focus of ongoing work as we contemplate the move to larger cloud based databases like Oracle12c as well as storing data in NoSQL systems. Our current collected data set of discrete location points campus wide represents an early iteration of the proof of concept experiments to appreciate the

nuances of issues with respect to Geospatial database asset and inventory tracking

Capacity planning on our SQL server 2016 database is currently managed by a local private Microsoft azure cloud configuration [2]. The team in a subsequent phase will have to evaluate further database security options within the cloud based environments to ensure system stability.

At the centre of the Geospatial asset inventory and tracking strategy is the need for consistent security of these databases and this in itself requires an independent paper to fully address these concerns.

II. CHALLENGES

Geospatial location mapping and accuracy of buildings including coordinates has been heavily dependent on both primary and secondary data sources which still need some sanitization given our current efforts. Data source quality based on integrity checking [2], needs to be well established if we are to ensure suitable accuracy in our larger scale experimental results. Secondly, issues of security and privacy as a policy constraint on the geospatial data sets will need further careful review [3] by our research group as we seek to model the concerns and then to establish a suitable framework.

To date, this work assumes the need for a fully decentralized geospatial database asset tracking and inventory system of governance as our guided approach [3,4]. Against the background of this localization of control, this initiative assumes that we will need several mobile test users to share the telemetry data for aggregation purposes within our COVID19 safety bubble. We are still collecting the inventory of test mobile users as a part of this aggregation process. Inspection monitoring of when a safety bubble has been compromised still needs to be understood and how our data visualization dashboards can detect this and issue alerts. Arguably this latter challenge could spur its own opportunity and is subject of further discussion in Section III below and is motivated by works in [3].

Another independent but related concern is the need to build interdisciplinary skillsets within the area of both Computer Science and GIS. The limitation is really a function of the Computing curriculum not adequately addressing GIS-based competencies as is our observation within our campus environment. Where our colleagues and students within the Faculty of the Built Environment do have knowledge and skills in GIS particularly from the perspective of land surveying, and urban town planning and logistics, the gap is that the skill sets does not exist in any one team to work on projects of this particular scale. The counter-argument here is that the perceived challenge is in fact an opportunity where interdisciplinary teams between computer science and the Faculty of the Built Environment could work together to build out the GIS teams required in fulfilling the needs of this project for completeness.

III. OPPORTUNITIES

A decentralized model of using mobile phones to assist the Geospatial database human asset tracking within the campus safety zones may be the most plausible option. Today, we could safely assume that everyone has a smart phone within a University environment, or almost everyone when we think of it anecdotally. In short, mobile phones today are pervasive.

To adequately model safety zones in Geospatial campus environments like ours, the mobile phone could be used to provide location predictions without necessarily compromising the security and privacy of the personal data of the student and/or staff users operating within the Geospatial safety zone bubble. The use of federated learning approaches [3,4] to train locally on a user's mobile device while they operate within a Geospatial safety zone bubble could provide real time data analytics to the University system administrators of the activities within the Geospatial campus safety bubble zone. Notably these safety zones are assumed to be sterile with managed human interactions and strict protocols based on COVID19 to enter and leave these physical zones. We assume the emergent area of Federated learning which applies a machine learning approach to spatial location inventory and asset tracking. The approach helps to minimize false positives about spatial locations related to bad actors and adversaries that could compromise the Geospatial safety zones picked up by database visualization dashboards within our ArcGIS environment. Marrying security, privacy, breach detection, and tracing will require innovative solutions.

As a part of good practice of any spatial location prediction analysis environment, the assumption here is that our Geospatial database would have large training data sets from which the GPS coordinates collected from students and staff mobile phones about a location, buildings within that location, people within that location and any other asset type can be aggregated, and collected as uploads to the Geospatial database environments albeit within a local or data cloud environment.

Hence when Federated learning is applied to the aggregated Geospatial database environment, suitable blockchain level security techniques on non-sensitive data using consensus can be used to ensure against rates of data change about spatial locations and what is happening in real time within these locations.

In essence, if the entire Geospatial aggregated database environments are to be established, a location prediction model with suitable levels of accuracy to discern in real time the activities of the actors i.e. staff and students that move through this environment and capture that as a part of the data visualization dashboards. More specifically, the ability to track and determine data changes based on a user's mobile GPS coordinates would mean that the data could be fed into a neural network and trained with time as a function of the final system prototype that manages these COVID19 safety zones on the campus.

Clearly from the discussions so far raised in this pape these concerns are definitely not trivial. Hence, comprehensive policies and operational procedures around handling the

Geospatial database system environment for supporting COVID19 like human asset tracking should consider:

I. Mapping the campus locations processes within the University and implementing the Geospatial digital assets inventory and the priority of these spatial assets as a catalogue. This we are already doing.

II. Setup an aggregated de-centralized Geospatial database environment modelled based on user centric security and privacy say with blockchain consensus. This is still work to be done.

III. Ensure that location change within the Geospatial network based on asset movement is harnessed using Federated learning techniques and trained as neural networks to predict patterns of behaviour within the COVID19 campus safety zones.

IV. CONCLUSION

This position paper argued the need for developing a COVID19 Geospatial inventory human asset tracking and management system for University campus environments. The points presented in this paper argue well for managed Geospatial safety zones for the free flow of human and other asset inventory across physical building spaces on campus. The paper by contribution supported an exploratory argument of the challenges and the opportunities of modelling these campus wide safety zones. We posit the need for aggregated Geospatial databases with local user control and security operated from that user's mobile device as a deliberate approach in tracking human and other assets within COVID19 campus safety bubbles.

The research directions are promising given the arguments of using Federated learning techniques to handle location data change within the Geospatial databases environment. We are mindful that at a policy level a suitable framework for handling the Geospatial database environment within the University has to be anchored in correctly mapping campus locations, ensure suitable data aggregation for the spatial database based on localized database security, and harnessing the power of Federated machine learning using neural networks to accurately discern the campus COVID19 safety bubble locations. By extension we believe our approach can be applied across other institutions both in the public and private sector to harness similar site studies and results.

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