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Smart government framework with geo-crowdsourcing and social media analysis☆

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HIGHLIGHTS

- Proposes map-based reporting for government-related activities based on geo-crowdsourced data.
- Proposes mindmap-based reporting for social media analysis.
- Evaluates smart city frameworks, geo-crowdsourcing and social media analysis applications.

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ABSTRACT

Smart government utilizes data to improve services provided to the citizen. Smart city may benefit from citizen engagement through crowdsourcing and social media. This paper proposes a city event's prediction with map-based visualization utilizing crowdsourced geodata collected from citizen's report. Data is aggregated according to geo-position and used to predict next day's event. Mindmap-based visualization utilizing social media processed with topic modeling and topic similarity calculation is also proposed in this work. Proof-of-concept application and proposed system's processing time is evaluated to prove the feasibility of the system. Proposed system utilizes geo-crowdsourcing for event prediction visualization for government instead of direct services to citizen. Proposed social media visualization use topic modeling specifically created for short text which is appropriate for social media data.

1. Introduction

A smart city employs a combination of data collection, processing, and disseminating technologies to encourage application innovation and to promote the overall quality of life for its citizens that include utilities, health, transportation, entertainment and government services [1]. Technology (system and infrastructure), people (citizen engagement), and institution (government and organizations) are the central components for a smart city [2].

A smart city government manages and implements policies through ICTs and stakeholder collaboration [3]. Smart governments also utilize data to improve their services for the well-being of the community through citizen engagement and policies codevelopment [4].

The objective of this paper is to propose smart government framework with citizen engagement. One of the ways to achieve citizen engagement in a smart city is through crowdsourcing. OSM (OpenStreetMap) is example of a VGI (Volunteered Geographic Information) project which utilizes crowdsourced geodata for creating open map database. The OSM project also has potential of 3D VGI geo-crowdsourcing [5].

Research on the usage of geo-crowdsourcing via mobile data collection by indigenous people is conducted by [6]. People can provide location-based information using radio button, icon, camera capture, and audio recording to facilitate ecotourism asset mapping.

Smartphone-based sensing and crowdsourcing technique to detect the road surface conditions is presented in ([7]. The system may detect anomaly in roads such as potholes and bumps. An incentive mechanism for geographic crowdsensing is proposed in [8]. The system accommodates requesters (quality requirement), participants (quality provision), and crowdsourcing platform. The system can reduce requester's expenses and ensure fairness of allocation.

☆ This work is an extended and revised version of our conference paper that was presented in ICGHIT 2018.

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The system proposed in this paper uses geo-crowdsourcing to collect occurrences of accidents, crimes, broken public facilities, etc. so that officers can solve the problems and governments can create policies relevant to the citizens' needs.

Another way to achieve citizen engagement is through social media data utilization. Research on social media analytics for urban smart tourism ecosystems in [9] used kernel density estimation and latent Dirichlet allocation analysis to capture spatial patterns within the city related to users and environmental engagement. These patterns can be used for value creation for smart urban tourism.

Social media has lot of potential for analyzing city elements to provide insights to government. Social media data is also relatively easy to capture in real time. However, unstructured nature of social media data makes it difficult to analyze [10]. We propose social media analysis using mindmap-based visualization. Data from Twitter tweets are collected to analyze topics relevant with citizen's opinions.

SentenTree [11] is a social media content visualization technique which display word co-occurrence within same sentence. SentenTree may help people gain key concepts in social media text. Our proposed system works in the topic correlation instead of word co-occurrence which enables better concept abstraction. TopicNets [12] is a visualization technique using statistical topic models for large text corpora. TopicNets may help people with filtering and searching for large documents. Our proposed system uses method specifically created for short text preprocessing which is more suitable for social media data.

The main contributions of this paper are the following.

1. Proposal of map-based reporting for various government-related activities based on real-time and past smartphone geo-crowdsourced data.
2. Proposal of mindmap-based reporting for social media analysis.
3. Evaluation of some smart city frameworks, geo-crowdsourcing applications, and social media analysis applications.

The remainder of the paper is organized as follows. Section 2 begins with related work. Section 3 continues with proposed system. We continue with proof-of-concept application and system performance evaluation in Section 4. Finally, we conclude with future directions in Section 5.

2. Related work

Our proposed system consists of geo-crowdsourcing and social media analysis, therefore papers related to each module are also discussed.

2.1. Related smart city framework

CityPulse [13] is a smart city framework that supports smart city service creation based on Internet of Things data and social media (i.e. Twitter) data streams. The framework's goal is to enable cross-domain data integration.

IES Cities [14] is a smart city framework that utilizes Open Government Data and sensor networks. The goal of this framework is to ease the generation of citizen-centric apps that exploit data in various domains.

Smart city's IoT network architecture, its security challenges and Efficient Algorithm for Media-based Surveillance System (EAMSuS) for smart city framework is proposed in [15]. The system's efficacy in terms of users' privacy, media security, and sensor node memory requirements are shown through experimental analysis.

Government affairs service platform utilizing 3D GIS (Geographical Information System) and cloud computing is proposed in [16]. The paper shows various services' possibility (urban disaster and environmental protection, intelligent transportation, etc.) and various required technology and data. The paper still does not present relevant algorithms, implementation, and evaluation (should be available in their next work).

Different with frameworks mentioned before, our proposed framework is focused on visualization utilizing geo-crowdsourcing data (smartphone sensor) and social media analysis for city-related events.

2.2. Related geo-crowdsourcing application

Research on travel planning and personalized routing services on smart city transportation is conducted in [17]. The system utilizes OpenStreetMap, official bus availability data, and crowdsourcing of users' mobile devices (sensors and user feedback) to compute personalized path.

Similar to that, public transportation journey planner created using CityPulse framework was proposed in [18]. The application provides route recommendations and incident notifications for the citizens who travel by bus through bus arrival real-time information and incidents reported by citizens.

There are also various GIS (Geographic Information System) applications which are specialized for geo-spatial data analysis, and visualization. However, our proposed framework is an end-to-end system which includes geo-crowdsourcing data collection, analysis, and map-based visualization module.

2.3. Related social media analysis application

SensePlace3 is a geovisual analytics framework that provide overview and detail analysis of social media data using place-relevant information from tweets [19]. Our proposed system focuses on topic-based visualization for social media analysis instead of place-based visualization.

SentenTree, a social media content visualization technique is presented in [11]. SentenTree output is node-link diagram where nodes are words and links indicate word co-occurrence within same sentence may help people to gain a rapid understanding of key concepts and opinions in social media text. Our proposed system used topic modeling and topic similarity to preprocess the data instead of frequency co-occurrence.

TopicNets, a visual and interactive analysis of large text corpora using statistical topic models is proposed in [12]. Instead of full-fledged visualization with filtering and searching for large documents, our work focuses on mindmap-based visualization using GSDMM (Gibbs Sampling for Dirichlet Multinomial Mixture model) algorithm [20] specifically created for short text clustering.

3. Proposed system

3.1. Architecture

Table 1 shows the system components of the proposed system in terms of three smart city components (data acquisition, data processing, and data dissemination) as described in [1]. Fig. 1 shows the relationship between the actors and proposed system. Citizens and officers will collect data for geo-crowdsourcing application. Citizen's data from social media can be fetched and saved in a database. The government can manage data (especially master data) in databases and view reports through a web dashboard. Data communication with database will be done through CRUD (Create Read Update Delete) API in the server.