Short Paper: Annotating Microblog Posts with Sensor Data for Emergency Reporting Applications

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Abstract. The explosion in user-generated content (on the Social Web) published from mobile devices has seen microblog platforms like Twitter grow exponentially. Twitter is a microblogging platform founded in 2006, which by October 2010 had roughly 175m users and as of June 2011, Twitter processed 200m posts per day. Twitter data has been utilised to predict/report natural disasters, civil unrest, and media topics. Smartphones and other mobile devices contain an array of sensors but are under-utilised on the Social Web. In this paper, we propose a method for annotating microblog posts with multi-sensor data by representing it with ontologies such as SSN and SIOC. We present an alignment of these ontologies and outline an enhanced Twitter client that would allow users to enter an emergency mode where all or most of the available sensor data would be published as annotations to the users post, allowing relief organisations to use any data relevant.

Keywords: SSN, Microblog, SIOC, Citizen, Sensors, Social Sensing

1 Introduction

The unprecedented 96% growth in smartphone sales[1] and in user numbers on social platforms like Twitter (572,000 new accounts created on March 12, 2011) demonstrate the growth in the use of the mobile web. As microblogging lends itself to instantaneous updates, data related to events occurring around the world is created before it can be reported on by more traditional media methods or even by blog or blog-like services. In parallel with this growth in mobile-based microblogging, mobile devices themselves have begun to incorporate increasing amounts of sensors for various purposes, ranging from detecting light levels when a phone is placed close to one's head to accelerometers that can detect orientation changes and movement in various directions.

[1] http://www.gartner.com/it/page.jsp?id=1466313

In this short paper, we look at using microblogging platforms as citizen sensing/reporting platforms by adding mobile sensor data to user posts and describing that data using the SSN (Semantic Sensor Network)[2] ontology and the SIOC (Semantically-Interlinked Online Communities)[3] ontology. In particular, we outline applications for emergency scenarios, where people can report on events using microblogging while automatically attaching all available sensor data from their mobile devices (in order to provide context to emergency reports). The structure of this paper is as follows. Section 2 will describe related work in this area along with a brief review of mobile sensors. We will describe the Twitter Annotations initiative in Section 3, and how it can be used for sensor data annotations. Section 4 will detail the alignments required between the social and sensor data ontologies SIOC and SSN. Section 5 will outline our proposed 'emergency mode' microblogging client that allows users to upload all available sensor data with a post to aid relief workers/government agencies. We will present conclusions in Section 6.

2 Related Work

Sheth uses the example of Twitter posts during the Mumbai terrorist attacks in November 2008 when Twitter updates and Flickr feeds by citizens using mobile devices reported observations of these events in real time[1].[4] Twitter data has been used in event/disaster reporting and prediction[2]. Tapia *et al.* examined the usage of Twitter to aid relief workers with information regarding disasters, and they saw one method of using "microblogged data as ambient or contextual data to enrich the information provided to the NGO at the time of disaster"[3]. Mobile devices contain many sensor formats that provide information such as location (through GPS or cell tower locations) to create/add context to microblog posts and status updates. Companies like Foursquare use this contextual data to create various geo-social gaming/marketing applications.

In relation to microblog posts, at present GPS adds location to the data of the post made, but in the field of multi-sensor context awareness, researchers are currently examining ways to augment devices with an awareness of their situation and environment to add contextual understanding through the use of combined sensor data. As Gellersen *et al.* asserts "Position is a static environment and does not capture dynamic aspects of a situation"[4], and this concept can be applied to most single sensor data, but with multi-sensor context awareness the diverse sensor readings are combined and then with processing situational awareness can be derived. Situation awareness is the observation of surrounding elements/events in relation to the user, this perception of the immediate environment lets humans derive meaning and aids in decision making.[5]

[2] http://www.w3.org/2005/Incubator/ssn/XGR-ssn/

[3] http://sioc-project.org/

[4] http://www.telegraph.co.uk/news/worldnews/asia/india/3530640/Mumbai-attacks-Twitter-and-Flickr-used-to-break-news-Bombay-India.html

[5] http://en.wikipedia.org/wiki/Situation_awareness

Table 1. Mobile Sensing Types

Sensor Types	**Sensor Return Values**
Accelerometer	Acceleration along X, Y, Z axes (m/s^2)
Gyroscope	Angular speed along X, Y, Z axes measured in radians/second
Magnetic Field	Magnetic field in X, Y, Z axes measured in micro-Tesla μT
Orientation	Angle measurement along X, Y, Z axes in degrees
Proximity	Distance (cm)
NFC	A short-range wireless technology
GPS	Returns location if available (longitude and latitude)
Camera	Captures still images and video
Microphone	Allows for capture of audio
Compass	Standard directional compass values
Light	Light intensity in Lumens

Table 1 shows a non-exhaustive list of common mobile device sensors and their expected return values. Apple, Google, Nokia, and Microsoft have developed APIs in their mobile operating systems to allow access to these sensors, which allow developers to use sensor data in their applications. Sensor APIs allow application developers access to sensor readings to aid in user experience but also to allow for the collection of context data [5]. The structure for attaching sensor readings to microblog posts can take the format of Twitter annotations, which we will describe in the next section, or SSN-annotated SIOC posts for semantically-enhanced applications as we will describe later on.

3 Twitter Annotations

Twitter Annotations is an initiative from Twitter that allows additional structured metadata to be attached to tweets, going beyond the geotemporal annotations normally found in social media content. While the annotation or metadata is structured, it is open to the user or developer to decide what additional information is attached to the microblog post. There is an overall limit of 512 bytes for the metadata payload, but this may be expanded as usage increases.

As an example in JSON, data about a movie described in a tweet could be attached to the tweet using the annotation {"movie":{"title":"The Guard"}}, indicating that the title of the movie is "The Guard". The guidelines for Twitter Annotations state that the goal is to "bring more structured data to tweets to allow for better discovery of data and richer interactions."[6] In the sphere of citizen sensing, Twitter annotations can be seen as a way to standardise an emerging field of supplementing microblog posts with sensor data and, as with any area, standardisation is important. Figure 1 illustrates two examples of annotations in the Twitter Annotations JSON format. The first example describes a digital compass sensor in an Android mobile device that returns direction in degrees, and the second describes data returned from a three-axis accelerometer.

[6] `http://dev.twitter.com/pages/annotations_overview`

In this work, the Twitter Annotations format will be used for adding sensor/ multi-sensor data to tweets using the Twitter Annotations API, and will inspire how we attach sensor data (represented using the SSN ontology) to tweets, blog posts and other microblog posts described via SIOC.

Sample compass annotation (Android):
[{“AndroidCompass":{"DirectionDegrees":"83"}}]

Sample accelerometer annotation (Android) with values for X, Y, Z:
[{"AndroidAccel":{"XAcc":"0.00","YAcc":"3.00","ZAcc":"9.00"}}]

Fig. 1. Annotation Examples

4 Aligning the SIOC and SSN ontologies

SIOC allows the semantic interlinking of content items from forums, blogs and other social websites, and aims to enable the integration of online community information[6]. SIOC provides a Semantic Web ontology for representing rich data from the Social Web using the Resource Description Framework (RDF). By describing the social data contained within online communities (powered by blogs, wikis, and forums) using semantic technologies, SIOC enables this data to become a “Social Web of Data”[7].

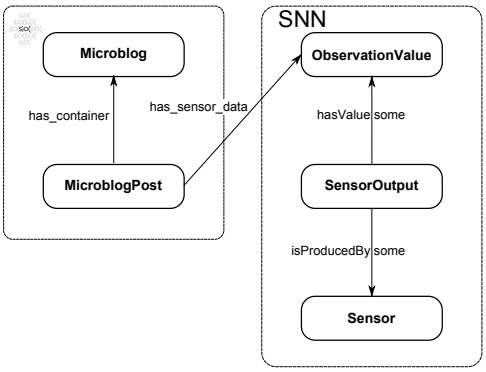

Fig. 2. Aligning the SSN Ontology with the SIOC Ontology

SIOC was originally written to describe web-based discussion on blogs and message boards, but with the SIOC Types module this has been expanded to include items like Microblog and MicroblogPost. SIOC has received significant

adoption in commercial and open-source software applications[7]: it has been adopted in the core of Drupal 7 and around 100 applications use SIOC.

Figure 2 outlines our method for annotating microblog posts with sensor/multi-sensor data by representing it with ontologies such as SSN and SIOC. The property *has_sensor_data* will join *sioct:MicroblogPost* to *ssn:ObervationValue*. We proprose to create a SIOC Sensors (siocs) module to include this and future related properties. The sioct:MicroblogPost itself can have one or more ObservationValue(s). Figure 3 is an example of a microblog post with orientation sensor data attached. We define an *AndroidOrientation* sensor that has a defined *SensorOutput* that has value *OriObservationValue* a subclass of *ObservationValue* and has three properties *hasXQuantityValue*, *hasYQuantityValue*, and *hasZQuantityValue*, defined in a Citizen Sensors ontology (cs).

```
<sioct:MicroblogPost rdf:about="http://joebloggs.example.com/microblog/2622">
        <ssn:SensorOutput rdf:about="http://example.com/OriSensorOutput?sensor_id=1&amp;time=1313768104">
          <hasValue rdf:resource="http://example.com/OriObservationValue?sensor_id=1&amp;time=1313768104"/>
          <isProducedBy rdf:resource="http://example.com/AndroidOrientation?sensor_id=1"/>
        </ssn:SensorOutput>
        <ssn:Sensor rdf:about="http://example.com/AndroidOrientation?sensor_id=1"/>
        <sioc:content>Help!</sioc:content>
        <siocs:has_sensor_data>
                <cs:OriObservationValue rdf:about="http://example.com/OriObservationValue?sensor_id=1&amp;time=1313768104">
                  <cs:hasXQuantityValue rdf:datatype="&xsd;float">0.00</cs:hasXQuantityValue>
                  <cs:hasYQuantityValue rdf:datatype="&xsd;float">3.00</cs:hasYQuantityValue>
                  <cs:hasZQuantityValue rdf:datatype="&xsd;float">9.00</cs:hasZQuantityValue>
                </cs:OriObservationValue>
        </siocs:has_sensor_data>
</sioct:MicroblogPost>
```

Fig. 3. RDF Example: Android Orientation Sensor Annotation

5 Scenario

We will now describe a scenario whereby data from multiple sensors can be attached to microblog posts using the aforementioned alignments to aid in emergency scenarios. We are currently developing a semantic microblogging client for the Android platform that implements both Twitter Annotations and SSN-annotated SIOC posts for emergency reporting with sensor data.

In an emergency, the user could employ the semantic microblogging client and activate the emergency mode that would allow the application to annotate any available sensor data to their post (including photos). The available sensor readings could help emergency workers by attaching the direction the user is facing, noise levels in the surrounding area, light levels, direction of movement, and any other available data to the post. If GPS is unavailable, then from these sensors and the information extracted from the microblog post (place names or points of interest) an estimated location along a directional line could be calculated. In situations where a snapshot of data is not relevant, attaching aggregated

[7] `http://sioc-project.org/applications`

values/lists of values describing changes in activity, compass direction, and noise levels over time might better communicate the user's situation. Furthermore, the microblog post contents and the annotated sensor readings could aid emergency teams with reports including direction and lighting conditions.

6 Conclusion

By combining the Social Web and sensors, applications can provide an extension of social activities through sensors, as user activity is modelled by both voluntary user input and sensor data annotated to the posts. In this paper, we describe how this will be implemented using web standards like the SIOC onotology and by aligning SIOC with the SSN ontology to both describe users' posts semantically and attach contextual sensor data to the post through metadata annotations. We have described a scenario that uses this combined SIOC-SSN representation, based on a semantic microblogging client currently being developed for mobile devices that will enable emergency reporting functionality.

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