Detection of Public Incident by Filming Characteristics without Violating Privacy

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***Abstract*—This paper was originally submitted to Xinova as a response to a Request for Invention (RFI) on new event monitoring methods. In this paper, a method to provide fast detection of possible public incident that would allow for a fast response during a large scale incident is proposed.**

In more detail, this solution analyzes behavioral characteristics of crowd taking photos/videos (before, during and after) of a possible incident by considering the rough location, direction of focus, and distribution of the crowd, and their cellphones' location attributes, in a way that protects the privacy of the users.

I. Problems

FAST detection of public incident and fast response to such incident are both crucial when handling situation like a large scale accident or an attack. Covering a place or an incident with multiple social cameras has been studied and mentioned in this RFI. However, the means the government can take prior to such events usually are limited considering privacy (legal) issues. For example, it'd be very difficult to assume the government would be allowed for mass accessing users' cell phone cameras or their photo albums freely on a general basis, not to mention that the size of the data combined would also render the solution unpractical. But, to some extent, general government access to characteristics of people using their cell phones conducting certain types of activities, e.g. taking photos etc., might be allowed in face of potential danger.

II. Summary of the Invention

The proposed method is to quickly detect possible public incidents by analyzing behavioral characteristics of crowd taking photos/videos in face of (before, during and after) a possible incident, without knowing the contents of the photos or videos thus protecting privacy. This is done by considering the rough location and distribution of the crowd, their cellphone's embedded inertia sensor readings during photo/video shooting, and the 'flip rate' when an accident/incident happens.

III. How is This Invention Made and Used

Photo/Video shooting behavioral analysis of crowds when facing danger.

Location and spread of crowd

The general location and spread of crowd can be obtained by statistics provided by local telecom operators or by other more accurate means, e.g. Apple's positioning service. Overall there are no technical difficulties in doing this and government might be granted the right of touching these data when the public are in danger. Since it is not the emphasis of this proposed solution it is omitted.

The 'Flip' effect

The unexpected incident, no matter an accident or an attack, has its unique psychological impact on crowds in the vicinity because of its ugly but stimulating nature. People usually feel shocked or horrified if involved. The impact to photo/video shooting behaviour and the resulting output in such a situation might suggest a way for fast detection of anomaly.

Studying the video clips in similar situations on video websites we find this 'Flip' effect. Just like flipping a coin, an unexpected incident has a similar effect to crowds' photo/video shooting behaviours.

1) When an incident happens during a video/photo shooting, the cell phone user, especially when close to the epicenter of the incident, tends to stop shooting, or dramatically change his shooting behaviour, e.g. quickly pointing his cell phone camera towards the direction where the incident is happening, if he's not too close.
2) Meanwhile other users not that close by and not on video/photo shooting tend to take out their smart phones and start shooting.

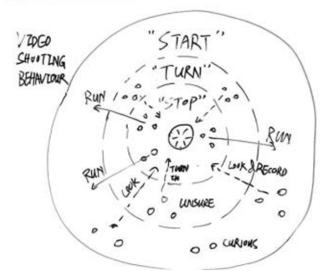

Fig. 1. Shooting behavior during an incident

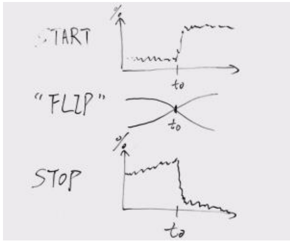

Fig. 2. Flip effect

*Hand trembling or other physiological indic*es

Because of the adrenaline rush, people experiencing an unexpected incident would also have other changes in behavioral characteristics, among which trembling is one of the most frequently observed phenomenon. Today's or future cell phones are and sure will be all equipped with inertia sensors which are able to measure this 'trembling', like a background noise level. It is directly linked to the psychological impact a person embraces when experiencing an incident and we can safely assume the pattern of the ' trembling' (or other physiological signal future cell phone sensors can pick up) changes along the course and is detectable.

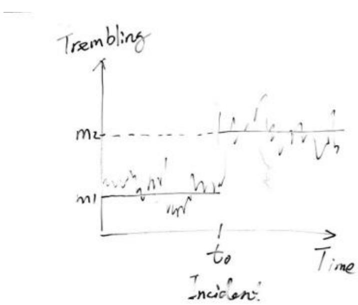

Fig. 3. Trembling effect

Incident Detection

By considering all the 3 mentioned factors together, we can come up with the below event detection function:

P(M,T) = Incident_Fast_Screening (Distribution_of_Crowds(M,T), Significance_of_Flip(M, T), Physiological_Indices(M, T));

In which M stands for the crowds, T stands for time, Distribution_of_Crowds(), Significance_of_Flip() and Physiological_Indices() are 3 functions of M and T and stand for crowds spatial distribution along with time, significance level of a 'Flip' and significance level of physiological indices change respectively. The Incident_Fast_Screening() is a function of telling whether and to what degree a pre-defined or dynamically adjusted threshold has been reached, of which the output stands for or is positively correlated to the probability of a possible incident which is happening among a certain group of people around some interested location.

For example, the M is a vector consisting of multiple records of IDs, in which an ID can be a serial number of a sim card, a phone number, or anything unique and traceable. T stands for time. Distribution_of_Crowds updates an array consisting multiple records of [id, position(x, y, z), t], in which position can be acquired by GPS reporting or other means given the geo resolution needed, showing the spatial and temporal distribution of crowds. Significance_of_Flip firstly divides M into Mi by geo grid of which the granularity or scale is generated via experience and can be continuously finetuned by historical events, providing necessary level of overlapping to avoid cutting one incident in two, then calculates the significance of 'flip' of each Mi along with time. The detection of significance of a 'flip' can be by evaluating the product of two derivatives of percentage changing curves of 'start' and 'stops/changes' of Mi along with time. If granularity or scale is set properly a significant negative change of the product would be observed depending on the threshold or 'alarming level' an agency needs. Similarly Physiological_Indices generates and updates an array consisting multiple records of [Mi, physio_index(a,b,c, …), t], in which physio_index contains various physiological data available to current or future cell phones, including but not limited to hand trembling, heart rate, blood pressure, etc., which can be used to track nervous or excitement level of Mi. If the physiological changes are positively correlated to the significance of the 'flip' mentioned above, a possible incident would be reported by the Incident_Fast_Screening with its geo coordinate, time, scale, confidence level, etc., without violating privacy of individual users.

The temporal and spatial resolution of the method depends on the data it can get and it will evolve itself by mapping its output to real world incidents after they happened, thus eventually reaching a lower level of false positive.

IV. Conclusion

As summarization, the proposed method provides a quick way to detect possible public incidents that would allow for more targeted and actionable responses. It can analyse behavioral characteristics of crowd taking photos/videos using attributes of the cellphones in the crowd, all while protecting the privacy of the users in the vicinity of the incident(s).

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