Synthesized Emotions of People in the Crowd

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***Abstract*—This paper was originally submitted to Xinova as a response to a Request for Invention (RFI) focusing on new Decision and Response Techniques for Security Applications. This paper describes a method for quickly assessing crowd sentiment.**

In more detail, this describes how to highlight important anomalies in images presented of crowds, and identify people that display different emotions than those around them in a way that reduces operational overload.

I. Abstract

SECURITY command and control personnel must continuously analyze vast amounts of data in order to take actionable decisions. Only a small percentage of the data to be analyzed actually contains important information for the decision process; the rest is irrelevant to that process and is both a distraction to the decision maker and makes the decision maker tired faster. As such, it is important to devise tools that will present decision makers with the right information at the right time. In particular, we present a solution to the problem of reducing the amount of video information presented at each point in time while highlighting potentially important anomalies in the images presented. In particular, we present a solution for identifying people that display different emotions than the majority of the crowd surrounding them. This would allow security command personnel to identify persons of interest in the crowd and decide on further actions.

II. Summary of the invention

We present a solution to the problem of reducing the amount of data with low-information content that is presented to command and control personnel during their decision making process. In particular, our solution reduces the video content presented and synthesizes higher amounts of information on the same video screen by highlighting potentially important anomalies in the images presented.

The solution introduced below identifies people that display different emotions compared to the majority of the crowd surrounding them. This will allow security command personnel to quickly identify persons of Interest in the crowd and decide on further actions.

In summary, our method analyzed automatically in a video feed every person's facial expression, compares it to the facial expressions of nearby people, and produces a synthesized image depicting a reduced number of representative types of facial expressions depicting people's state of mind in an image.

III. Detailed Explanation

During the process of ensuring security for public events, the security command center personnel is continuously presented with large numbers of video feeds showing the crowd behavior, and it is asked to analyze, in real time, the mood and actions of members of the crowd in order to quickly identify potentially dangerous behaviors and situations and intervene to prevent possible incidents.

This process quickly leads to information overload for the command center personnel, and therefore any means of reducing the amount of low-content information to be displayed while increasing the density of displayed information will be especially valuable.

When analyzing real-time video feeds showing the people in the crowd at large events, it is important for security personnel to understand the mood of the crowd and any anomalies that may show up. This is very hard to do just by looking at hundreds or thousands of faces in every image, and it is also very tiring for the person analyzing these images.

We propose a solution to this problem by automatically analyzing the faces of the people in video feeds and depicting only representative facial expressions for groups of people in the same vicinity.

This method reduces the video content presented and synthesizes large amounts of information on the same video screen making it easier to identify potentially important anomalies in the images presented.

The method recommends building (i) a facial expression recognition system, (ii) a database of facial expressions,

and (iii) an avatar associated with each category of facial expressions in the database.

For each video feed, we:

1. First apply a high-level image analysis filter that isolates people from the rest of the image

2. For each person, analyze their face and, using the facial expression recognition system (there are a number of such systems available today), classify their facial expression into one of the categories stored in the database

3. Identify the set of people situated next (or close) to each other that have the same facial expression

4. Replace each such set of people in the image with an image of the avatar depicting their facial expression

5. After this step, the image will show a small number of avatars that depict the facial expression of the people in the crowd

6. The size of each avatar will be directly proportional to a combination of (i) the number of people showing the same emotion, and (ii) the "gravity" of the emotion. For example, happy emotions will have low gravity numbers while scared or angry expressions will have high gravity numbers. So a large happy crowd will have a relatively small avatar on the screen, compared with a small angry set of people; a large angry set of people will have a much larger avatar. In addition, different avatars will be represented with different colors (for example only: red for angry, orange for scared, green for happy, etc.).

As an example, take the following picture showing a mostly happy crowd:

Fig. 1. Generally happy crowd

The system analyzes every face in the crowd and determines that all but two of them express sentiments of happiness. The two different expressions are circled below:

Fig. 2. Possible expression anomalies

In particular, one person is indifferent and the other is angry. As a consequence, the system replaces all the happy faces with a few happy avatars and singles out the indifferent and the angry expressions, for example as follows:

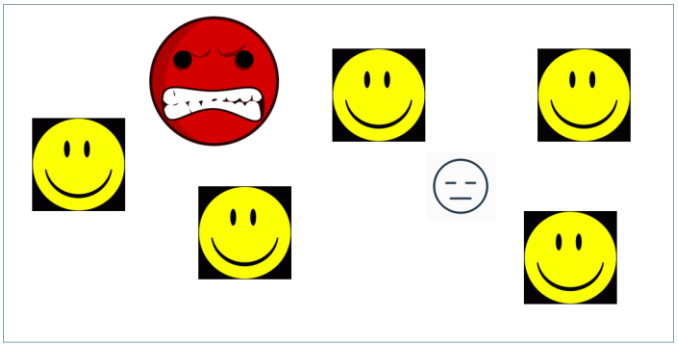

Fig. 3. Create weighted avatars to display possible threat level

All the happy faces were replaced with a few yellow happy avatars, the indifferent face was singled out but not colored and the angry face was also singled out but magnified and colored in red for emphasis. This last image makes it much easier for a control person to understand the mood of the people in the crowd and to identify potential persons of interest that may justify further review.

The operator can then request the original image and analyze the angry person in the real context, then potentially instruct field personnel for further surveillance as appropriate.

An extension of this method is to add to the facial expression analysis mentioned above an additional step of analyzing body expressions of people in the crowd. This

can be used to augment the analysis of faces, and is especially useful in cases where faces are not completely visible (may be obstructed by objects or people in the image) but body posture can convey similar information that can be then processed and display in the same manner as described above for faces.

IV. Conclusion

The method proposed here will reduce the load on command center operators and analysts by automatically identifying the mood of people in the crowd and highlighting the ones that have potentially suspicious behavior, bringing them to the analysts' attention, and reducing the information overload from normal video feeds that would need to be observed at all times. It can:

- Assist security personal and security systems in identifying people that display different emotions compared to the majority of the crowd surrounding them

- Focus security command personnel on persons of interest in the crowd, based on their detected states of minds, and decide on further actions

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