ANNEXURE - II

Person Tally using Streaming Video

Checked By:		Date: 26/06/2004
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1. **Introduction**

The aim of "Person Tally using Streaming Video" is to provide the functionality of counting the no. of persons moving in and out of a doorway being monitored by an Analog Camera connected to a Video Server Transmitter, and thereafter the video being made available on the machine where the application is running.

1.1 Purpose and Scope

This document is meant to list down all the functionalities provided by the software. It would serve as a guide for the users and would help in optimizing the Motion Detection process for a particular location. The document also mentions the basic idea behind the software as well as possibilities for it's further development.

1.2 Product and Environment

Product Name: Person Tally Using Streaming Video

Purpose: To help in security surveillance in an indoor environment. It can also be used to detect any kind of motion at any location. The software also provides a variety of visualizations of the motion detection process to help the user adjust the various motion detection parameters for the location as well as to verify the results.

Environment: The programming for the Software has been done in Java, with the use of the additional API of Java Media Framework (JMF) for processing of the video.

1.3 Acronyms

API	: Application Program Interface
CIF	: Common Intermediate Format (352X288)
IP	: Internet Protocol
J2SDK	: Java 2 Standard Development Kit
JMF	: Java Media Framework
RGB	: Red Green Blue
VST	: Video Server Transmitter

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1.4 References

J2SDK API   java.sun.com/j2se/1.4.2/docs/api/

JMF API   java.sun.com/products/java-media/jmf/index.jsp

'K Means Clustering' Algorithm:

http://cne.gmu.edu/modules/dau/stat/clustgalgs/clust5_bdy.html

2. Overview

2.1 Product Perspective

The product is an independent entity in itself and does not require to be connected or part of a larger software or be a subsystem to any other software. It also does not need any Media Player for any processing or visualization functionalities.

2.2 User Characteristics

User Groups Include:

- Security Departments of Corporate Houses.
- Defense, Police or other organizations with movement restrictions.
- Departmental Stores

The program by nature is decentralized and runs on individual computers. The scope of an administrator is not required, which means that there is no classification of the users and all users shall be same for the software.

Any person with the elementary knowledge of using a computer can be a user of the product.

2.3 Restrictions

(a) The process for counting the persons assumes an overhead vision of the location. So, the camera for the surveillance needs to be mounted accordingly.

(b) For good results, resolution of the video input should be 4CIF or higher.

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(c) The Settings file for a particular location is given a name according to the name of the file. So, care should be taken to avoid settings being overwritten.

3. Data and Databases

The product does not make a use of any database. The product stores the Detection Settings as set by the user for the different locations in different read-only files in a subfolder-'Settings'.

4. Product Functions

4.1 Functionalities

(a) The Main function of the software is to count the number of persons crossing a Doorway being monitored by a camera. It can even keep track of persons moving in as well as those moving out of the door, with the directions being specified by the user.

(b) The product also displays the 'Variation Frame' video to the user wherein all the movements are shown in White colour, while the static background is shown in Black. This would allow the user to set the Threshold for detection of motion to reduce the noise in the processed video.

(c) The user can see the 'Motion Rectangle' i.e. the rectangle in the video frame outside which no motion takes place. This helps to verify that the Threshold setting is giving the desired results.

(d) The user can also see the 'Moving Objects' wherein the various moving objects are tracked individually. These objects would be later considered for the count and checked for crossing the doorway. So, the user may adjust their size through the Distance parameter in the Detection Setting to have a correct count.

(e) Other runtime facilities include the positioning of the door and setting up of the 'Area of Interest', which would be region inside the video frame, wherein all the Motion Detection tasks would be carried out.

4.2 User Interface

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Following features have been provided to get the input from the user as well as to show the desired output on the media panel on the main window of the application.

4.2.1 File Operations

(a) Open: Opening files on the local machine for viewing or detection of motion. The user shall be able to navigate through the entire computer and all the files, but by default only standard video files would be visible to him.

(b) Open URL: Opening files on a remote machine on the network or to stream the video from any streaming website. In case of a remote PC on the network, the string comprising the IP of the machine and the address on the file should be prefixed with "file://".

(c) Exit: Exits the software to the system.

4.2.2 View Options

(a) Video: Shows the video track of the selected video on the main panel. If the file also contains an audio track, same is also played. This is the default selection when the application is started, but allows the user to come back to this mode after any of the modes given under are selected. The person count stops on the selection of this mode.

(b) Variation Frame: Shows a processed video to the user wherein all the movements in the original video are shown in White colour, while the static background is shown in Black. Once again, the person count would stop on the selection of this mode.

(c) Motion Rectangle: Shows the original video to the user with a rectangle overlaid. The rectangle changes its shape accordingly to enclose the region outside which no motion takes place.

(d) Moving Objects: Shows the original video to the user with many red rectangles overlaid. They enclose the individual objects moving within the frame. The rectangles are drawn only while the objects are in motion.

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(e) Control: Allows the user to Play/Pause or jump forward or backward on the track as well as to control the volume if an audio track is also contained.

4.2.3 Count Operations

(a) Start: Starts counting the no. of persons crossing the doorway in either direction, and the result is displayed on the main panel in a text field marked as 'Person Count'.

(b) Reset: Stops the counting processes and resets all the result displays on the main panel to 0.

(c) Directional: Enables the directional count. If the person counter is started after selecting this option, the software keeps the track of persons moving in as well as those moving out of the door, with the directions being specified by the user. The result of directional motion as well as the cumulative motion is shown on the main window in appropriate text fields. The user can turn this option off by clicking on this menu again.

4.2.4 Settings

(a) Detection Settings: Opens a new Window to adjust detection parameters.

(b) Area of Interest: After selecting this option, the user can select the area in which he/she wants to restrict the processing and results by drawing a rectangle on the video frame while keeping the mouse left-clicked. Only a selection in the downward and towards the right on the panel is allowed, an error message is displayed otherwise. The user can turn this option off by clicking on this menu again.

4.2.5 About Window

(a) Software: Intimates the user about the main function of the user.

(b) Developers: Intimates the user about the names of the developers.

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4.2.6 Detection Settings

    (a) Threshold: The user can adjust the slider to set the threshold value of motion detection. This would adjust the noise in the processed video, and the impact could be visibly seen through the Variation Frame.

    (b) Smoothness: The user can adjust the slider to set the size (in pixels) of the region whose pixel values would be averaged during the processing. This allows for the removal of local effects e.g. flickering. A bigger dimension of the region would reduce the computations on the price of the granularity.

    (c) Distance: The user can adjust the perpendicular distance of the persons from the camera. Their size would be computed accordingly and the identification and counting would depend on it.

    (d) Position: Allows the user to set the position of the doorway on the main panel, which is shown by a pointer on the main window. Any person crossing the location would be considered for a count.

    (e) Select Direction: The user can mark the direction to be considered as movement inside the door by clicking along one of the two arrows shown in this window.

    (f) Done: Closes the Detection Settings window.

    (g) Save: Saves the current settings of all the attributes above in a read only file in a subfolder 'Settings'. The Settings file for a particular location is given a name according to the name of the file.

5. Architectural Design

The processing involves generating a Variation Frame and all the further processing including the person count is done on the basis of it.

5.1 Philosophy of Solution

    (a) The main problem for the software is to track individual moving objects in the video. After a particular video is chosen, a predefined codec is applied on it, which splits it into frames in real time. The

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algorithm takes the difference between the averaged RGB values for all the pixels for two consecutive frames.

(b) The pixel for which this difference is greater than a particular threshold, as set by the user for the location, is considered to be in 'motion'. Those with a difference greater than the threshold are set to white while others are set to black to reduce the error in further processing.

(c) With the size of the person and the no. of pixels which have underwent motion already known, the initialization step of 'k-means Clustering' Algorithm is applied. In the subsequent steps, the pixels are grouped into cluster and their centroids are found. These results can be used to view the moving objects or for counting.

5.2 Software Architecture

The software makes use of the following six classes

(a) **PersonTally.java:** It is the entry point of the software. It extends Motion.java and passes the control to it. It also defines the action listeners for all the user interfaces. It loads the settings saved for a particular location on the selection of a file.

(b) **Motion.java:** This class constructs the entire GUI, applies all the pre-checking for the tracks in the video file before initiating the software. On successful checking, it applies the codec on it as developed in MotionDetection.java

(c) **MotionDetection.java:** This generates the array containing the difference in pixel values of consecutive frames. This can be used to generate the Variation Frame. It also draws the Motion Rectangle as per the choice of the user. When person counting is enabled, it passes the control to Persons.java.

(d) **Persons.java:** It applies the 'k-Means Clustering' algorithm, to find the centroids of individual movements and draw the rectangles as per the choice of the users. It also reflects the results of person count on the main window.

(e) **DetectionSettings.java:** This class generates a window to allow the users to adjust the various motion detection parameters.

(f) **About.java:** Intimates the user about the software.

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6. Interfaces

6.1 Hardware Interface

A web based VST connected to the camera on the Network would be required if the processing and the count has to be done in real time from the remote location. The absolute path from where the video is being streamed should also be known. Any other peripheral is not required.

6.2 Software Interface

The software being programmed in Java needs J2SDK while for the media processing and viewing, JMF needs to be installed on the workstation running it. The software is Platform independent.

6.3 Communication Interface

Network connectivity between the workstation and the VST is required for grabbing the video.

7. Other Requirements

7.1 Security, Recovery and Usability

The product would be robust enough to detect a video failure for reasons like network or power failure. It would also not allow non-video files to be considered for processing.

7.2 Maintainability

The various parameters for motion detection can be changed on fly as well as saved for future use for respective locations. Thus the user does not need to reconfigure the settings each time the application is run.

7.3 Transferability/Portability

The program being written in Java is platform/OS independent.

8. Remarks

8.1 Guidelines

  (a) The threshold should be set as high as possible to reduce the effects of noise and reduce the overall processing.
  (b) The direction in and out should not be changed on the fly.

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(c) Switching to variation frame should be avoided to have a proper count once the count is started.

(d) In case of a local file, the video would have to be played again from the control component after the selection of the Area of Interest.

8.2 The software has been developed as Phase I of the project: Traffic Applications using Digital Video**.**

9. **Ideas for Future Development**
   (a) The angle of the camera could be allowed to change.
   (b) Pattern matching to identify a person outline.
   (c) Use of customized DSP chips for motion detection.
   (d) The log of passers by can be maintained in a database.
   (e) There can be an animation showing the handshaking in the GUI.
   (f) Tutorial

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