Tracking Humans Using a Distributed Array of Motorized Monocular Cameras.

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Abstract

By using our software you are able to minimize operator time by employing the power of a computer to automatically track humans moving within an area with a distributed monocular motorized camera array. Movement can then be represented on a historical perspective in which paths are highlighted; enabling the viewer to make informed placement decisions. Additionally, the system would minimize the learning curve for a distributed array of motorized cameras by maintaining field of view data for all cameras. The only operator would merely select an individual and be able to watch in real time as the system tracks and plots the path taken by that individual.

Target Audience:

The primary target of the application would be for surveillance for both security and athletic entertainment. Possible surveillance applications range from theft prevention systems used in retail environment to locating infant children at home. The system could also be optimized to track non-human objects such as motor vehicles.

Currently in a retail environment an operator would have to select a camera to manipulate and then using a joystick pan, tilt, or zoom (PTZ). Therefore the operator must be able to manipulate 3 ranges of motion simultaneously in order to track an individual. Then when the field of view becomes obstructed, he would have to manipulate another camera PTZ until the individual is located. The operator would not be able to overlay the path already taken by the individual. Nor would they be able to utilize all cameras simultaneously and efficiently.

Previous Work:

Motion tracking is a well developed area of computer vision. Current technology allows for real-time tracking and recognition of a person or object with a fixed camera. In fact one study choose to use many fixed cameras rather than a single motorized,

> *"A moving camera with a substantial degree of rotational freedom [2] increases the viewing angle to certain degree, however, it complicates the implementation by adding the motion estimation of both the viewing system and the subject of interest." [1]*

This is understandably true for most cases, but if the camera moves at a predictable velocity we could correct for PTZ movement prior to motion estimation. Although standardization with PTZ control protocols between manufactures has not been implemented; some success has been achieved with single motorized camera. Two possible methods explored for motion detection while PTZing have been the use of current pan/tilt information combined with focal length or 4 corresponding points in two different frames to compute their relationship.[4]

The earliest developments which used a distributed array of cameras were in the late 90's. Approaches have sense been developed for both an overlapping and non-overlapping array of fixed cameras. Little development has been made with motorized cameras in a distributed array; with the exception of a fixed camera paired with a motorized camera. That study focused on face tracking utilized a fixed camera to determine where best to position a motorized camera for a higher resolution close up.

Personal Experience:

Nick Jensen, a senior in computer engineering has significant experience with C++ and network security. He has worked with commercial detection and set up a LAN based personal video recorder for his parents.

Benjamin Smeenk is a senior in Computer Science. His previous experience is rather limited in actual projects, although he has done a fair amount of playing with little bits of code in different programming languages. These languages include C++, C#, Java, Javascript, HTML, UNIX(bash), Basic, DOS, Assembly, Matlab, OpenCV, and Scheme. Of these languages, he has only done projects in C++, C#, and Java, and the main parts of these projects were GUI based. He was involved in a group that made a scheduler using Java as the language of choice, and later was part of another group that made a task manager add-on for Microsoft Windows using C++ and C#.

We believe this can be done because although the exact method has not been used, many similar methods have been used in previous experiments. Also, the equipment and software available to use have been updated several times since most of the similar methods were used. For example, most of the previous attempts were done using fixed cameras, while we have access to ones that, while set in place, can be turned to face in different directions.

Approach:

With two cameras within sight of each other they would determine their position relative to each other. Once they have their positions determined, they can begin tracking. While tracking a moving object, the program will create an object containing the coordinates, and that object will be placed in a linked list. Data contained in the linked list can then be overlaid on the stationary background as depicted in Figure 1.

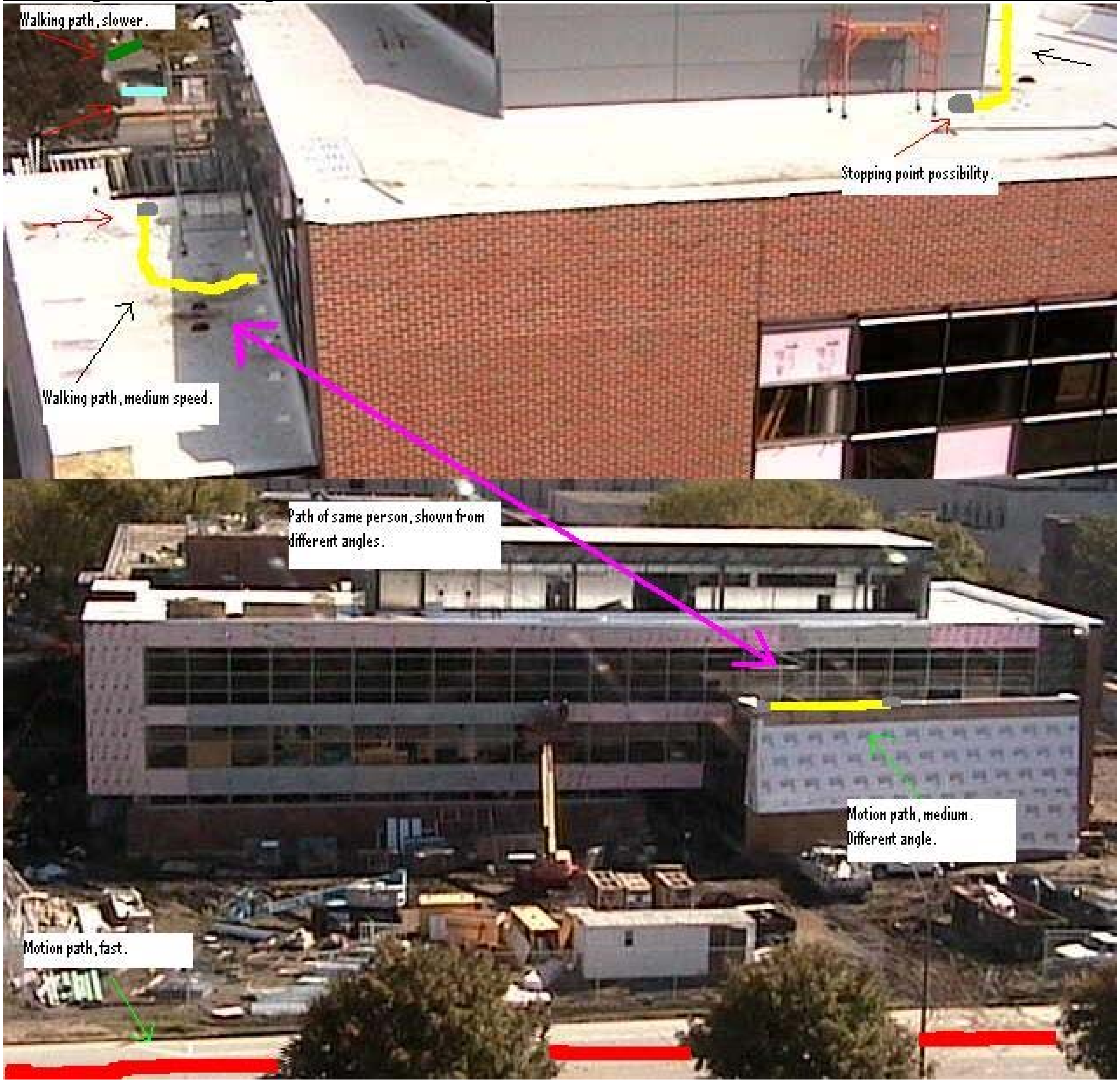

Figure 1 Proposed tracking output

Equipment to be used:

Our solution will utilize existing motorized network cameras on the ISU campus. The software will be written to run on any computer connected to the internet.

Algorithms:

Algorithms for background filtering can be categorized into three groups: Adaptive & subtraction, region based tracking and tracking using shape information. Adaptive background generation and subtraction is done by taking the Gaussian distribution for each pixel and building a static background which is done by stationary cameras. The moving object is then subtraction from the background. Tracking using shape information requires a database of known shape models and the placement of a shape near the target for accurate tracking. Region based tracking is similar to tracking by shape information since they both require initialization steps to accurately track an object.

Citations:

1. Q. Cai and J.K. Aggarwal, “Tracking Human Motion Using Multiple Cameras,” *Proc. Int"l Conf. Pattern Recognition,* pp. 68-72, Vienna, Austria, Aug. 1996.
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3. Proceedings of the 13th International Conference on Pattern Recognition 1996, 25-29 Aug 1996, Volume: 3, On page(s): 68-72 vol.3
4. S. Kang, J. Paik, A. Koschan, B. Abidi, and M. A. Abidi, "Real-time video tracking using PTZ cameras," Proc. of SPIE 6th International Conference on Quality Control by Artificial Vision, Vol. 5132, pp. 103-111, Gatlinburg, TN, May 2003.