ShareCam: Shared Access to a Robotic Streaming Video Camera *

[Demonstration Proposal]

Dezhen Song
IEOR Department
University of California, Berkeley
CA 94720-1777, USA

Ken Goldberg
IEOR and EECS Departments
University of California, Berkeley
CA 94720-1777, USA

ABSTRACT

ShareCam is a robotic pan, tilt, and zoom streaming video camera controlled by simultaneous frame requests from remote users. Robotic webcameras are commercially available but currently restrict control to only one user at a time. ShareCam introduces a new interface that allows simultaneous control by many users. We will demonstrate the implemented system using a Java-based interface at the conference linked via the Internet to a camera on the UC Berkeley campus. We will also discuss system architecture and several new algorithms we've developed to compute optimal camera paramters based on user frame requests. ShareCam can be tested online at: www.tele-actor.net/sharecam/

Categories and Subject Descriptors

H.4.3 [**Information System Applications**]: Communication Applications

1. INTRODUCTION

Robotic webcameras with pan, tilt, and zoom controls are now commercially available and are being installed in hundreds of locations[1] around the world. In these systems, the camera parameters can be remotely adjusted by viewers via the Internet to observe details in the scene. Current control methods restrict control to one user at a time; users have to wait in a queue for their turn to operate the camera. We will demonstrate ShareCam, a new approach that eliminates the queue and allows many users to share control of the robotic camera simultaneously.

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[1]http://www.x-zone.canon.co.jp/WebView-E/index.htm

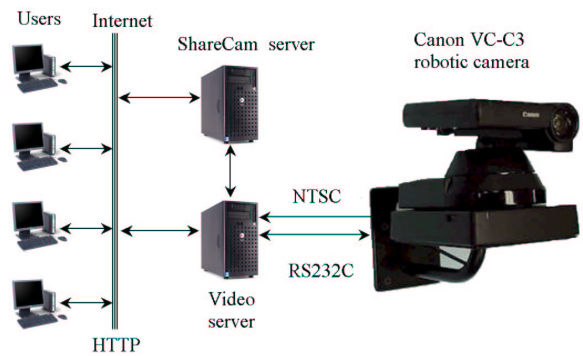

Figure 1: ShareCam System Architecture.

2. RELATED WORK

Kimber, Liu, Foote et al. describe a multi-user robot camera for videoconferencing in [5]. Similar to Sharecam, they formulate the robot parameter selection for multiple simultaneous users as an optimization problem based on position and area of overlap. To solve the problem, they propose an approximation based on the bounding boxes of all combinations of user frames. Our approach reduces running time from exponential to polynomial in the number of users and we provide formal bounds on the errors resulting from grid-based approximations.

As illustrated in Figure 1, Sharecam allows many users to simultaneously control a robotic streaming video camera. In the taxonomy proposed by Tanie et al. [1], ShareCam is a Multiple Operator Single Robot (MOSR) system. Sharecam is motivated by applications such as education, entertainment, and journalism, where groups of users desire simultaneous access to a single video camera.

As shown in figure 2, the Sharecam interface allows users to control a robot camera with 3 degrees of freedom.

One precedent of an online MOSR system is described in McDonald, Cannon and colleagues [6]. In [2] Goldberg and Chen analyze a formal model of collaborative control describe Internet-based MOSR system that averaged multiple human inputs to simultaneously control a single industrial robot arm. In [3] we propose the "Spatial Dynamic Voting"

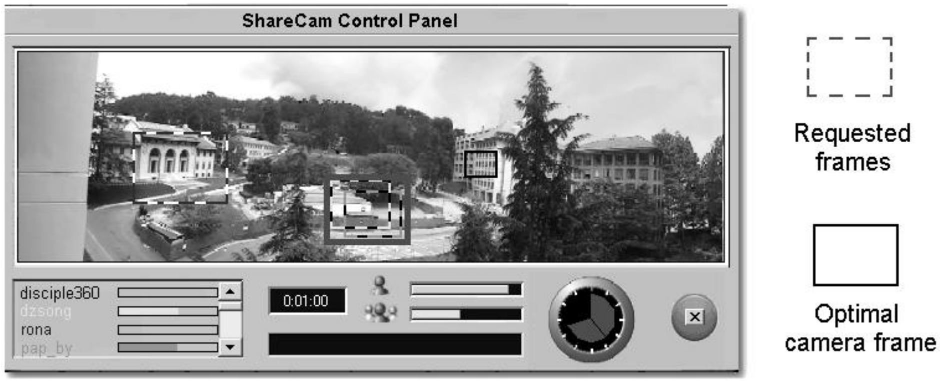

Figure 2: This figure illustrates ShareCam's Java-based user interface, which currently runs on most Windows based PCs. Users view two windows. One (not shown) displays a live video stream as captured by the robotic camera. The second window, illustrated here, contains the user interface. The panoramic image is a fixed photo of the camera's reachable range of view. The snapshot above shows 4 active users listed in the scrollable window at the left. Each user requests a camera frame by positioning a dashed rectangle over the panoramic image. Based on these requests, the algorithm computes an optimal camera frame (shown with solid rectangle), and servoes the camera accordingly to displays the resulting live video stream. The horizontal bars indicate levels of user satisfaction as described below.

(SDV) interface. The SDV collects, displays, and analyzes sets of spatial votes from multiple online operators using a Gaussian point clustering algorithm developed to guide the motion of a remote human "Tele-Actor".

An earlier paper [9], published in the Workshop on Algorithmic Foundations of Robotics, formulated the ShareCam problem geometrically and reported initial results on exact algorithms: for n users and m zoom levels, the exact algorithm runs in $O(n^2m)$ time. The latest research on the algorithm can be found at [4, 8]. A detailed description of interface, system architecture, and implementation can be found in [7].

3. SYSTEM ARCHITECTURE AND INTERFACE

As illustrated in Figure 1, the ShareCam system includes the camera and two servers that communicate with users via the Internet. Streaming video is captured at the camera server and streamed back to the remote users using a Java interface. User responses are collected at the ShareCam server and used to compute optimal camera positions, which are sent to camera server to control the camera.

As illustrated in figure 2, ShareCam's Java-based interface includes two image windows, one fixed for user input and the other a live streaming video image. The interface collects requested camera frames (specified as a desired rectangle) from n users, computes a single camera frame based on all inputs, and moves the camera accordingly.

Sharecam is available online at:
http://tele-actor.net/sharecam/

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