

**CAMBRIDGE RESEARCH LABORATORY** Technical Report Series

R

Δ

Digital Equipment Corporation has four research facilities: the Systems Research Center and the Western Research Laboratory, both in Palo Alto, California; the Paris Research Laboratory, in Paris; and the Cambridge Research Laboratory, in Cambridge, Massachusetts.

The Cambridge laboratory became operational in 1988 and is located at One Kendall Square, near MIT. CRL engages in computing research to extend the state of the computing art in areas likely to be important to Digital and its customers in future years. CRL's main focus is applications technology; that is, the creation of knowledge and tools useful for the preparation of important classes of applications.

CRL Technical Reports can be ordered by electronic mail. To receive instructions, send a message to one of the following addresses, with the word **help** in the Subject line:

On Digital's EASYnet: On the Internet: CRL::TECHREPORTS techreports@crl.dec.com

This work may not be copied or reproduced for any commercial purpose. Permission to copy without payment is granted for non-profit educational and research purposes provided all such copies include a notice that such copying is by permission of the Cambridge Research Lab of Digital Equipment Corporation, an acknowledgment of the authors to the work, and all applicable portions of the copyright notice.

The Digital logo is a trademark of Digital Equipment Corporation.



Cambridge Research Laboratory One Kendall Square Cambridge, Massachusetts 02139

## Image Mosaicing for Tele-Reality

## Applications

Richard Szeliski Digital Equipment Corporation Cambridge Research Lab

CRL 94/2

May, 1994

#### Abstract

While a large number of virtual reality applications, such as fluid flow analysis and molecular modeling, deal with simulated data, many newer applications attempt to recreate true reality as convincingly as possible. Building detailed models for such applications, which we call *tele-reality*, is a major bottleneck holding back their deployment. In this paper, we present techniques for automatically deriving realistic 2-D scenes and 3-D texture-mapped models from video sequences, which can help overcome this bottleneck. The fundamental technique we use is *image mosaicing*, i.e., the automatic alignment of multiple images into larger aggregates which are then used to represent portions of a 3-D scene. We begin with the easiest problems, those of flat scene and panoramic scene mosaicing, and progress to more complicated scenes, culminating in full 3-D models. We also present a number of novel applications based on tele-reality technology.

**Keywords:** image mosaics, image registration, image compositing, planar scenes, panoramic scenes, 3-D scene recovery, motion estimation, structure from motion, virtual reality, tele-reality. ©Digital Equipment Corporation 1994. All rights reserved.

#### **DOCKET A L A R M** Find authenticated court documents without watermarks at <u>docketalarm.com</u>. TESLA, INC.

#### Contents

## Contents

1	Intro	duction	l	
2	Rela	ted work	2	
3	Basi	e imaging equations	3	
4	Planar image mosaicing		5	
	4.1	Local image registration	5	
	4.2	Global image registration	3	
	4.3	Results	8	
5	Pano	pramic image mosaicing	9	
	5.1	Results	1	
6	Scenes with arbitrary depth		1	
	6.1	Formulation	3	
	6.2	Results	4	
7	Full	3-D model recovery	4	
8	App	ications	3	
	8.1	Planar mosaicing applications	8	
	8.2	3-D model building applications	9	
	8.3	End-user applications	9	
9	Disc	Discussion		
10	Con	clusions	2	
A	2-D projective transformations			

# DOCKET



## Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## **Real-Time Litigation Alerts**



Keep your litigation team up-to-date with **real-time** alerts and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

### **Advanced Docket Research**



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## **Analytics At Your Fingertips**



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

#### API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

#### LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

#### **FINANCIAL INSTITUTIONS**

Litigation and bankruptcy checks for companies and debtors.

#### **E-DISCOVERY AND LEGAL VENDORS**

Sync your system to PACER to automate legal marketing.

