PULKIT PARIKH

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OBJECTIVE

To make an outstanding contribution to a quality research product/service

WORK EXPERIENCE

DESIGNATION	ORGANIZATION	WORK AREAS	WORK DURATION
Research Consultant	**HP Labs India**	Image Processing, Computer Vision	**1.5+ years** [March 2007 - Present]
Research Assistant	**ADE, DRDO** and IIIT Hyderabad	Computer Vision, Processing of Aerial Data	1 year + 10 months [April 2005 - Jan 2007]
Trainee	**IIT Delhi**	Visualization	6 months

INTERNATIONAL PUBLICATIONS

Motion Constraints for Video Mosaicing - Appeared in **IET VIE**, 2006

Enhanced Video Mosaicing using Camera Motion Properties - Appeared in **IEEE WMVC**, 2007

PaperDiff: A Script Independent Automatic Method for Finding the Text Differences between Two Printed Document Images – Appeared in **DAS**, 2008

I have also co-authored two internal publications at HP Labs worldwide.

EDUCATION

DEGREE	INSTITUTE/BOARD	PASSOUT	PERCENTAGE
MS by Research [**Computer Vision**] Thesis Advisor: Dr C. V. Jawahar	IIIT, Hyderabad	Jan 2007	9.42 CGPA
BE in Information Technology	Nirma Institute of Technology, Ahmedabad	July 2003	70
Senior Secondary	DBHSS, Gujarat Board	1999	88 (PCM: 94)
Secondary	DBHSS, Gujarat Board	1997	91

AREAS of INTEREST

Computer Vision, Image Processing, Pattern Recognition, Computational Geometry

MAJOR PROJECTS (detailed in the annexure)

- **Low Complexity Skew Correction –** as part of my work at *HP Labs*
- **Automatic Document Image Clean-up –** as part of my work at *HP Labs*
- **Robust Registration for Video Mosaicing Using Camera Motion Properties**
- **Geo-registration** – Project done for *ADE, DRDO*
- **Derivation of Motion Constraints on Homographies**

- **Video Mosaicing Toolkit** – Developed for *ADE, DRDO*
- **A Novel Quality Measure for Mosaics**
- **Camera Pose Estimation using a Geometric Approach**
- **Analysis of Body Kinematics using Accelerometer** – BE Project at *IIT Delhi*
- **Short Works** - Shape Recognition, Algorithms for Image Magnification and Arbitrary Rotation, Data Compression, Fast Correlation and more (in the annexure).

SOFTWARE SKILLS

Languages	C, C++, MATLAB, Visual Basic
Utilities	Latex, Adobe Photoshop, Microsoft Office, Gimp

STREAM-RELEVANT COURSES TAKEN

COURSE NAME	MAJOR TOPICS	GRADE
Digital Image Processing	Spatial and Fourier Domain Processing, Image Transforms, Enhancement, Restoration, Morphological Operators	A (10/10)
Pattern Recognition	Feature Extraction, Bayesian Classifier, Linear Discriminant Functions, Feature Selection, Neural Networks, Clustering	A (10/10)
Computer Vision	Fundamentals of Imaging, Structure from X, Epipolar Geometry, Multiview Constraints, Novel View Synthesis	A (10/10)
Computational Geometry	Convex Hulls, Orthogonal Range Searching, Proximity Problems, Voronoi Diagrams, Delaunay Triangulations	A (10/10)
Advanced Problem Solving	Algorithmic coding of problems in various areas like combinatorics, geometry, strings and numbers	A (10/10)

ACHIEVEMENTS

- Secured **2**nd rank in district and **8**th in state in **Mathematics** in "***Prakharata Shodh Kashoti***", a prestigious exam held by the Gujarat Board.
- Won **Gold** and **Silver** medals for my **12**th **and 10**th class performances respectively.

PERSONAL INFORMATION

Date of Birth	4th May, 1982.
Hometown	Ahmedabad, Gujarat.
Hobbies	Puzzles and Riddles; Playing Bridge, Chess, Cricket and Carrom; Discussions
Strengths	A penchant for seeking optimal solutions, Never-say-die attitude

MISCELLANEOUS

- Delivered **talks** on **RANSAC** (a model fitting paradigm amid outliers) & **mosaicing**.
- **Co-founded** *'AshaKiran'*, an organization working for the welfare of the underprivileged.
- Represented my school in **Elocution Competitions** in senior secondary education.

REFERENCES

- **Dr C. V. Jawahar** (jawahar@iiit.net), Associate Professor, IIIT Hyderabad.
- **Dr P. J. Narayanan** (pjn@iiit.net), Dean R&D, IIIT Hyderabad.

ANNEXURE: MAJOR PROJECTS

Robust Registration for Video Mosaicing Using Camera Motion Properties
(Published in *IEE WMVC, 2007*)

Video mosaicing is being increasing used in diverse areas such as video indexing, aerial imaging, virtual environments and many more. In this work, a novel video mosaicing framework was formulated by exploiting the unexplored fact that the registration of one pair of video frames is often related to that of another by virtue of the motion properties of the camera. In one approach, smoothness of the camera motion is employed to refine erroneous *homographies*. Another one capitalizes the camera motion model to reduce the number of parameters to be estimated for registration. For several motion models, these parameters can be estimated in closed-form using Singular Value Decomposition (SVD). These robust algorithms have outperformed the recent graph-based + bundle adjustment approaches, yielding accurate registration/mosaicing of even low-and-repetitive-texture videos.

Geo-registration – Project done for **ADE, DRDO**.

Heavily used in aerial surveillance for locating targets and building/updating maps, geo-registration is the process of aligning an aerial video frame with a satellite image coupled with a Digital Elevation Map (DEM), by refining the rough estimate of the telemetry available. Firstly, the satellite image and the aerial video frame, which are heterogeneous, are brought onto a common framework by perspectively projecting the satellite image using the DEM and the noisy telemetry. The registration, then, is done by optimizing over the telemetry parameters directly. Several point and area based objective functions (image similarity measures) have been explored with different optimization methods like the Quasi-Newton method.

Derivation of Motion Constraints for Homography Estimation (Published in *IET VIE, 2006*)

In machine controlled environments (such as robotics and automobiles), the camera motion often follows a model, naturally or by imposition. In this theoretical work, a set of constraints relating the homographies in a video sequence was derived using various camera motion models. These constraints are utilized for improving homography estimation in videos.

Video Mosaicing Toolkit – Developed for **ADE**, **DRDO**.

A powerful, interactive application for mosaicing aerial videos was developed and delivered. It employs the *RANSAC (RANdom SAmple Consensus)* paradigm for rejecting outlier points, followed by the *Direct Linear Transform (DLT)* algorithm for registration. The tool is enabled with utilities like masking of video frames, monitoring and editing of correspondences, quality metrics and mosaic splitting. We employ *alpha blending* to ensure no seam in the resultant mosaic while stitching.

A Novel Quality Measure for Mosaics

With the advance of mosaicing techniques in the last decade, the desirability for a quality measure for mosaics is to not to distinguish between a perfectly accurate and a grossly inaccurate mosaic, but to detect fine differences between two reasonably accurate mosaics. To this end, we have devised a simple yet effective measure, which is evaluated while stitching each frame onto the (current) mosaic, bypassing the need for an additional computational step. The evaluation involves applying the *Fisher's Z transform* on the *Normalized Cross Correlation (NCC)* values of local image patches. This measure has been found to be discriminative, smooth and devoid of local maxima.

Camera Pose Estimation using a Geometric Approach

The pose – the position and orientation or [R T] of the camera - is estimated from the 2d-3D point correspondences, given the calibration matrix K. Although four correspondences ensure the uniqueness of the pose, multiple corresponding points are used for greater accuracy under noise. After computing the camera-point distances, *Absolute Orientation Determination* is performed, wherein the similarity transformation relating two sets of matched 3d points is estimated. The results are analyzed by a comparison with those obtained from *camera calibration*.

SHORT WORKS

Algorithms for Image Magnification and Arbitrary Rotation

The devised algorithms differ significantly from the traditional techniques [involving bilinear/bicubic/spline interpolation] but perform at par (sometimes better).

A light weight Curve-Plotting Algorithm

Involves no complex, computationally intensive entities (like B splines) and still produces very smooth curves (passing through all the input points).

A Score Predictor for Cricket - Comparable to the *D/L system* currently in use.

Determines the revised target in a rain-interrupted match, under various scenarios.

Fast Robust Correlation

Implementation of a translational, area-based image matching technique using FFTs.

2D shape Recognition

KNN is employed to classify binary images of 2D shapes using invariant features like affine moment invariants *(AMIs)*, compactness, eccentricity and more.

Data Compression using Huffman (Adaptive and Non-adaptive) coding

Any file, regardless of its type, is compressed by being treated as a bit stream.

Time-table Generator - Employs a simple heuristic to speed up the search.

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