SURF

SURF (Speeded Up Robust Feature) is a robust image detector & descriptor, first presented by Herbert Bay et al. in 2006, that can be used in computer vision tasks like object recognition or 3D reconstruction. It is partly inspired by the SIFT descriptor. The standard version of SURF is several times faster than SIFT and claimed by its authors to be more robust against different image transformations than SIFT. SURF is based on sums of 2D Haar wavelet responses and makes an efficient use of integral images.

It uses an integer approximation to the determinant of Hessian blob detector, which can be computed extremely quickly with an integral image (3 integer operations). For features, it uses the sum of the Haar wavelet response around the point of interest. Again, these can be computed with the aid of the integral image.

An application of the algorithm is patented in the US.[1]

Implementations

Name	Language	Open Source	Description
Original [2]	C++	No	Original implementation
OpenSURF [3]	C++, C#	Yes	Implementation with detailed documentation and reference paper.
OpenSurfCL [4]	C++	Yes	Free implementation of OpenSURF on OpenCL. Wrappers for C# and Java.
OpenCV SURF	C++	Yes	Implementation of SURF feature extraction (OpenCV 2.0)
SURFmex [5]	Matlab		Matlab Interface (MEX) to OpenCV's SURF code.
OpenSURF Matlab [6]	Matlab	Yes	Interface to OpenSURF for Matlab
libmv SURF [7]	C++	Yes	Implementation of extraction and matching.
Python mahotas [8]	Python	Yes	computer vision package which includes an implementation of SURF.
Dlib C++ Library [9]	C++	Yes	Implementation of SURF feature extraction.
Pan-o-matic [10]	C++	Yes	Software which includes an implementation of the SURF algorithm.
Parallel SURF [11]	C++	Yes	Multi-threaded implementation based on Pan-o-matic.
ProcessorSURF [12]	C#	Yes	C# SURF plugin for Multi-Agent Serving System
JavaSurf [13]	Java	Yes	Java implementation of SURF
JOpenSURF [14]	Java	Yes	Java translation of OpenSURF
ImageJ SURF [15]	Java	Yes	SURF implementation as ImageJ plugin with a convenient GUI and output of statistics
BoofCV [16]	Java	Yes	Java computer vision library which includes SURF.
Speeded Up SURF [17]		Yes	GPU Implementation
CUDA SURF [18]	C++ CUDA	Yes	GPU implementation using CUDA
Mathematica [19]	Mathematica	No	Mathematic implementation
GPU SURF [20]		No	GPU Implementation

FPGA SURF [21]		Yes	FPGA Implementation
clsurf [22]	C++		High performance cross platform OpenCL implementation of SURF with nearest neighbors matching
IPOL [23]	C++	Yes	An implementation of SURF based on the original article with detailed explanations

Comparative Studies of Implementations

- David Gossow, Peter Decker and Dietrich Paulus, "An Evaluation of Open Source SURF Implementations", Lecture Notes in Computer Science, 2011, Volume 6556/2011, 169-179
  - Libraries: dlib, OpenCV, OpenSURF (two versions), and Pan-o-Matic
- Peter Abeles, A comparison of several C/C++ and Java implementations for speed and stability. [24] Nov. 2011
  - Libraries: OpenSURF, OpenCV, Pan-o-Matic, Original, BoofCV, JavaSURF, and JOpenSURF.

References

[1] US 2009238460 (http://worldwide.espacenet.com/textdoc?DB=EPODOC&IDX=US2009238460), Ryuji Funayama, Hiromichi Yanagihara, Luc Van Gool, Tinne Tuytelaars, Herbert Bay, "ROBUST INTEREST POINT DETECTOR AND DESCRIPTOR", published 2009-09-24
[2] http://www.vision.ee.ethz.ch/~surf
[3] http://www.chrisevansdev.com/opensurf
[4] http://sourceforge.net/projects/opensurfcl/
[5] http://www.maths.lth.se/matematiklth/personal/petter/surfmex.php
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[22] http://code.google.com/p/clsurf/
[23] http://www.ipol.im/pub/algo/or_speeded_up_robust_features/
[24] http://www.boofcv.org/index.php?title=Performance:SURF

- Herbert Bay, Andreas Ess, Tinne Tuytelaars, Luc Van Gool "SURF: Speeded Up Robust Features" (http://www.vision.ee.ethz.ch/~surf/papers.html), Computer Vision and Image Understanding (CVIU), Vol. 110, No. 3, pp. 346--359, 2008
- Christopher Evans "Notes on the OpenSURF Library", MSc Computer Science, University of Bristol (http://www.chrisevansdev.com)

External links

- Website of SURF: Speeded Up Robust Features (http://www.vision.ee.ethz.ch/~surf)
- First publication of Speeded Up Robust Features (2006) (http://www.vision.ee.ethz.ch/~surf/eccv06.pdf)
- Revised publication of SURF (2008) (http://glorfindel.mavrinac.com/~aaron/school/pdf/bay06_surf.pdf)

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