

# Bumsub Ham

Assistant Professor, Yonsei University

## Contact

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<http://bsham.github.io>

## Languages

Korean, English

## Programming

C & C++, Matlab, Python  
OpenCV, OpenGL  
 $\text{\LaTeX}$  2<sub>ε</sub>, CSS3

## Equipments

IEEE 1394 camera:  
Pointgrey Inc. Flea®  
Bumblebee®, Ladybug®  
Active range sensor:  
SwissRanger™ SR4000®  
Microsoft Kinect®

## Interests

Computer vision, computational photography, and machine learning

## Education

- 03/08–08/13 **Ph.D. School of Electrical & Electronic Engineering** Yonsei University, Seoul, Korea  
Revisiting the Relationship Between Adaptive Smoothing and Anisotropic Diffusion: Robust Edge-Preserving Regularization Methods and Its Applications
- 03/03–02/08 **B. S. School of Electrical & Electronic Engineering** Yonsei University, Seoul, Korea

## Experience

- 08/16–Now **Yonsei University** Seoul, Korea  
*Assistant Professor @ School of Electrical & Electronic Engineering*  
Research in computer vision, machine learning, and image processing
- 05/14–07/16 **INRIA & École Normale Supérieure** Paris, France  
*Postdoctoral Research Fellow @ WILLOW team*  
Research in computer vision and machine learning with [Prof. Jean Ponce](#)
- 09/13–04/14 **Yonsei University** Seoul, Korea  
*Postdoctoral Research Fellow @ School of Electrical & Electronic Engineering*  
Work with Prof. Kwanghoon Sohn in depth reasoning from 2D images
- 09/12–12/12 **University of Illinois at Urbana-Champaign** Illinois, USA  
*Research Assistant @ Coordinated Science Lab*  
Research with [Prof. Minh N. Do](#) in probability based image rendering
- 03/08–08/13 **Yonsei University** Seoul, Korea  
*Research Assistant @ Digital Image Media Lab*  
Participation in several research projects
- 03/08–12/08 **Yonsei University** Seoul, Korea  
*Teaching Assistant*  
Signal and Systems and Advanced Digital Signal Processing

## Awards

- 2014 **Grand Prize** Chun-Gang Memorial Foundation  
Chun-Gang Outstanding Research Award
- 2013 **Certificate of Merit** Yonsei University  
Yonsei University Thesis Award Spring
- 2012 **Grand Prize** Qualcomm Inc.  
Qualcomm Innovation Fellowship
- 2011 **Honor Prize** Samsung Electronics Co., Ltd.  
17<sup>th</sup> Samsung Human-Tech Prize on Signal Processing

## Publications

## Journals

### Proposal Flow: Semantic Correspondences from Object Proposals

Bumsub Ham, Minsu Cho, Cordelia Schmid, and Jean Ponce  
IEEE Trans. Pattern Anal. Mach. Intell. (**TPAMI**), (accepted).

### FCSS: Fully Convolutional Self-Similarity for Dense Semantic Correspondence

Seungryong Kim, Dongbo Min, Bumsub Ham, Stephen Lin, and Kwanghoon Sohn  
IEEE Trans. Pattern Anal. Mach. Intell. (**TPAMI**), (accepted).

### Robust Guided Image Filtering Using Nonconvex Potentials

Bumsub Ham, Minsu Cho, and Jean Ponce  
IEEE Trans. Pattern Anal. Mach. Intell. (**TPAMI**), vol. 40, no. 1, pp. 192-207, Jan. 2018.

### DASC: Robust Dense Descriptor for Multi-modal and Multi-spectral Correspondence Estimation

Seungryong Kim, Dongbo Min, Bumsub Ham, Minh N. Do, and Kwanghoon Sohn  
IEEE Trans. Pattern Anal. Mach. Intell. (**TPAMI**), vol. 39, no. 9, pp. 1712-1729, Sep. 2017.

### Fast Domain Decomposition for Global Image Smoothing

Youngjung Kim, Dongbo Min, Bumsub Ham, and Kwanghoon Sohn  
IEEE Trans. Image Process. (**TIP**), vol. 26, no. 8, pp. 4079-4091, Aug. 2017.

### Robust Interactive Image Segmentation Using Structure-Aware Labeling

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
Expert Systems with Applications (**ESWA**), vol. 79, no. 8, pp. 90-100, Aug. 2017.

### Structure Selective Depth Super-Resolution for RGB-D Cameras

Youngjung Kim, Bumsub Ham, Changjae Oh, and Kwanghoon Sohn  
IEEE Trans. Image Process. (**TIP**), vol. 25, no. 11, pp. 5227-5238, Nov. 2016.

### Real-Time Rear Obstacle Detection Using Reliable Disparity for Driver Assistance

Hunjae Yoo, Jongin Son, Bumsub Ham, and Kwanghoon Sohn  
Expert Systems with Applications (**ESWA**), vol. 56, no. 9, pp. 186-196, Sep. 2016.

### Depth Analogy: Data-driven Approach for Single Image Depth Estimation using Gradient Samples

Sunghwan Choi, Dongbo Min, Bumsub Ham, Youngjung Kim, Changjae Oh, and Kwanghoon Sohn  
IEEE Trans. Image Process. (**TIP**), vol. 24, no. 12, pp. 5953-5966, Dec. 2015.

### Unsupervised Texture Flow Estimation Using Appearance-Space Clustering and Correspondence

Sunghwan Choi, Dongbo Min, Bumsub Ham, and Kwanghoon Sohn  
IEEE Trans. Image Process. (**TIP**), vol. 24, no. 11, pp. 3652-3665, Nov. 2015.

### Visual Fatigue Relaxation for Stereoscopic Video via Nonlinear Disparity Remapping

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
IEEE Trans. Broadcast. (**TB**), vol. 61, no. 2, pp. 142-153, Jun. 2015.

### Depth Super-Resolution by Transduction

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn  
IEEE Trans. Image Process. (**TIP**), vol. 24, no. 5, pp. 1524-1535, May 2015.

### Fast Global Image Smoothing Based on Weighted Least Squares

Dongbo Min, Sunghwan Choi, Jiangbo Lu, Bumsub Ham, Kwanghoon Sohn, and Minh N. Do  
IEEE Trans. Image Process. (**TIP**), vol. 23, no. 12, pp. 5638-5653, Dec. 2014. (Integrated into [OpenCV 3.1.](#))

### Mahalanobis Distance Cross-Correlation for Illumination Invariant Stereo Matching

Seungryong Kim, Bumsub Ham, Bongjo Kim, and Kwanghoon Sohn  
IEEE Trans. Circuits Syst. Video Technol. (**TCSVT**), vol. 24, no. 11, pp. 1844-1859, Nov. 2014.

### Probability-Based Rendering for View Synthesis

Bumsub Ham, Dongbo Min, Changjae Oh, Minh N. Do, and Kwanghoon Sohn

IEEE Trans. Image Process. (**TIP**), vol. 23, no. 2, pp. 870-884, Feb. 2014.

### A Generalized Random Walk with Restart and Its Application to Depth Up-sampling and Interactive Segmentation

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn

IEEE Trans. Image Process. (**TIP**), vol. 22, no. 7, pp. 2574-2588, Jul. 2013.

### Space-time Hole Filling with Random Walks in View Extrapolation for 3-D Video

Sunghwan Choi, Bumsub Ham, and Kwanghoon Sohn

IEEE Trans. Image Process. (**TIP**), vol. 22, no. 6, pp. 2429-2441, Jun. 2013.

### Revisiting the Relationship between Adaptive Smoothing and Anisotropic Diffusion with Modified Filters

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn

IEEE Trans. Image Process. (**TIP**), vol. 22, no. 3, pp. 1096-1107, Mar. 2013.

### Robust Scale Space Filter using Second-Order Partial Differential Equations

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn

IEEE Trans. Image Process. (**TIP**), vol. 21, no. 9, pp. 3937-3951, Sep. 2012.

## Conferences

### SCNet: Learning Semantic Correspondence

Kai Han, Rafael S. Rezende, Bumsub Ham, Kwan-Yee K. Wong, Minsu Cho, Cordelia Schmid, Jean Ponce  
in Proc. IEEE Int. Conf. Comput. Vis. (**ICCV**), Oct. 2017.

### Deep Stereo Confidence Prediction for Depth Estimation

Sunok Kim, Dongbo Min, Bumsub Ham, Seungryong Kim, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2017.

### Unsupervised Stereo Matching using Correspondence Consistency

Sunghun Joung, Seungryong Kim, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2017.

### Convolutional Cost Aggregation for Robust Stereo Matching

Somi Jeong, Seungryong Kim, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2017.

### FCSS: Fully Convolutional Self-Similarity for Dense Semantic Correspondence

Seungryong Kim, Dongbo Min, Bumsub Ham, Sangryul Jeon, Stephen Lin, and Kwanghoon Sohn  
in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (**CVPR**), Jul. 2017.

### Point-cut: Interactive Image Segmentation using One-point Supervision

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
in Proc. Asian Conf. Comput. Vis. (**ACCV**), Nov. 2016.

### Proposal Flow

Bumsub Ham, Minsu Cho, Cordelia Schmid, and Jean Ponce  
in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (**CVPR**), Jun. 2016.

### Robust Image Filtering Using Joint Static and Dynamic Guidance

Bumsub Ham, Minsu Cho, and Jean Ponce  
in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (**CVPR**), Jun. 2015.

### DASC: Dense Adaptive Self-Correlation Descriptor for Multi-modal and Multi-spectral Correspondence

Seungryong Kim, Dongbo Min, Bumsub Ham, Seungchul Ryu, Minh N. Do, and Kwanghoon Sohn  
in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (**CVPR**), Jun. 2015.

### Robust Stereo Matching Using Probabilistic Laplacian Surface Propagation

Seungryong Kim, Bumsub Ham, Seungchul Ryu, Seon Joo Kim, and Kwanghoon Sohn  
in Proc. Asian Conf. Comput. Vis. (**ACCV**), Nov. 2014.

### Local Self-Similarity Frequency Descriptor for Multispectral Feature Matching

Seungryong Kim, Seungchul Ryu, Bumsub Ham, Junhyung Kim, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Oct. 2014.

### Normalized Tone-mapping Operators for Color Quality Improvement in 3DTV

Donghyun Kim, Kilsoo Jung, Bumsub Ham, Youngjung Kim, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Industrial Electronics and Applications (**ICIEA**), Jun. 2014.

### Visual Fatigue Prediction and Its Visualization

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
Global 3D Tech Forum, Oct. 2013. (Best Paper Award)

### Fast Image Retargeting via Axis-aligned Importance Scaling

Sunghwan Choi, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2013.

### Contextual Information Based Visual Saliency Model

Seungchul Ryu, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2013.

### ABFT: Anisotropic Binary Feature Transform Based on Structure Tensor Space

Seungryong Kim, Hunjae Yoo, Seungchul Ryu, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2013. (Top 10% of accepted papers)

### Disparity Search Range Estimation Based on Dense Stereo Matching

Ruei-Hung Li, Bumsub Ham, Changjae Oh, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Industrial Electronics and Applications (**ICIEA**), Jun. 2013. (Nominated as Best Paper Award)

### Probabilistic Correspondence Matching using Random Walk with Restart

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
in British Machine Vision Conference (**BMVC**), Sep. 2012.

### Hybrid Approach for Accurate Depth Acquisition with Structured Light and Stereo Camera

Sunghwan Choi, Bumsub Ham, Changjae Oh, Hyon-gon Choo, Jinwoong Kim, and Kwanghoon Sohn  
in Proc. IEEE Int. Symposium on Broadband Multimedia Systems and Broadcasting (**BMSB**), Jun. 2012.

### Joint Radiometric Calibration and Multi-view Matching with Ground Control Points

Changjae Oh, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Workshop on Advanced Image Technology (**IWAIT**), Jan. 2012.

### Cost Aggregation with Anisotropic Diffusion in Feature Space for Hybrid Stereo Matching

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2011.

### Hole Filling with Random Walks Using Occlusion Constraints in View Synthesis

Sunghwan Choi, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2011.

### Visual Fatigue Evaluation and Enhancement for 2D-plus-Depth Video

Jaeseob Choi, Donghyun Kim, Bumsub Ham, Sunghwan Choi, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Sep. 2010.

### Virtual View Rendering Using Super-Resolution with Multiview Images

Bumsub Ham, Dongbo Min, Jinwook Choi, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Nov. 2009.

### Spatial and Temporal Up-Conversion Technique for Depth Video

Jinwook Choi, Dongbo Min, Bumsub Ham, and Kwanghoon Sohn  
in Proc. IEEE Int. Conf. Image Process. (**ICIP**), Nov. 2009.

### Virtual View Rendering Using Multiple Stereo Images

Bumsub Ham, Dongbo Min, and Kwanghoon Sohn  
in Proc. IEEE Int. Workshop on Advanced Image Technology (**IWAIT**), Jan. 2009.

## Korean Journal & Conference

Conference: 7 papers (in Korean)

## Patents

Apparatus and Method of Processing An Image Considering Fatigue

10-1562111, KR, Oct. 2015.

Contents Retargeting Method and Apparatus

10-1511907, KR, Apr. 2015.

Apparatus and Method for Reconstructing Intermediate View, Recording Medium Thereof

10-1429349, KR, Aug. 2014.

Device and Method for Removing Noise of Image

10-1426610, KR, Jul. 2014.

Contents Retargeting Method and Apparatus

9,443,283, US, Sep. 2016.

## Projects

- |             |  |                                     |
|-------------|--|-------------------------------------|
| 05/14-07/16 | <b>Video world</b>   | European Research Council (ERC)     |
|             | A unified model for video restoration and editing                        |                                     |
|             | • Modeling, interpreting, and manipulating digital video                 |                                     |
|             | • Sparse coding and dictionary learning                                  |                                     |
| 11/13-04/14 | <b>2D to multiview conversion system</b>                                 | Samsung Electronics Co., Ltd.       |
|             | Reasoning a high quality range data from 2D image                        |                                     |
|             | • Data-driven 2D to 3D conversion scheme                                 |                                     |
|             | Wide base line multiview rendering system                                |                                     |
|             | • Error-tolerant view synthesis algorithm                                |                                     |
| 06/10-04/14 | <b>Next generation digital TV broadcasting system</b>                    | ITRC, Ministry of Knowledge Economy |
|             | Core technology for 3D/4K/8K UHDTV broadcasting generation/editing       |                                     |
| 03/12-03/13 | <b>Saliency based realistic 3D representation</b>                        | Samsung Electronics Co., Ltd.       |
|             | Visual fatigue reduction based on visual attention                       |                                     |
|             | • Human visual system based saliency map and non-linear depth control    |                                     |
| 03/11-11/11 | <b>Image matching technology for depth map optimization</b>              | ETRI                                |
|             | Pre- and post-processing methods for high quality depth map              |                                     |
| 08/10-07/11 | <b>Multiview image rendering technology</b>                              | Samsung Electronics Co., Ltd.       |
|             | Stereo (2D+depth) to multiview generation system                         |                                     |
|             | • State-of-the-art matching methods, multiview rendering, and inpainting |                                     |
| 01/10-01/11 | <b>Image enhancement technology with two-lens camera</b>                 | Samsung Electronics Co., Ltd.       |
|             | Stereo matching with asymmetric two lens camera                          |                                     |
|             | • Image matching captured by cameras having different focal lengths      |                                     |
|             | Image matting with symmetric two lens camera                             |                                     |
| 03/10-11/10 | <b>3D interaction technology based on depth</b>                          | ETRI                                |
|             | Depth aware 3D UI and display adaptive 3D rendering scheme               |                                     |
| 03/08-12/09 | <b>Next generation intelligent broadcasting system</b>                   | ITRC, Ministry of Knowledge Economy |
|             | 3D virtual studio with multiple stereo cameras                           |                                     |
|             | • Multiview calibration and rendering with eight HD cameras              |                                     |
|             | Real-time 3D object modeling and interaction system in 3D virtual studio |                                     |
|             | • Fast stereo matching and rendering systems                             |                                     |

## Scholarship

Brain Korea National Science Scholarship of Korea Research Foundation (2008-2014)  
Academic Excellence Scholarship, Yonsei University (2003, 2006, 2007)

## Activities

### Reviewer

IEEE Trans. Pattern Anal. Mach. Intell. (TPAMI)  
IEEE Trans. Image Process. (TIP)  
IEEE Trans. Circuits Syst. Video Technol. (TCSVT)  
IEEE Trans. Multimedia (TMM)  
IEEE Signal Process. Lett. (SPL)  
Elsevier Pattern Recognition Letters (PRL)  
Elsevier Neurocomputing  
Elsevier Signal Processing: Image Communication (SPIC)  
Elsevier Digital Signal Processing (DSP)  
PLOS ONE  
EURASIP Journal on Image and Video Processing (JIVP)  
Circuits, Systems, and Signal Processing (CSSP)  
ACM SIGGRAPH 2016  
ACM SIGGRAPH ASIA 2016  
Eurographics 2017

## References

Available upon request

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