Information Hiding

13th International Conference, IH 2011
Prague, Czech Republic, May 18-20, 2011
Revised Selected Papers
Preface

The International Hiding Conference was founded 15 years ago, with the first conference held in Cambridge, UK, in 1996. Since then, the conference locations have alternated between Europe and North America. In 2011, during May 18–20, we had the pleasure of hosting the 13th Information Hiding Conference in Prague, Czech Republic. The 60 attendees had the opportunity to enjoy Prague in springtime as well as inspiring presentations and fruitful discussions with colleagues.

The International Hiding Conference has a tradition in attracting researchers from many closely related fields including digital watermarking, steganography and steganalysis, anonymity and privacy, covert and subliminal channels, fingerprinting and embedding codes, multimedia forensics and counter-forensics, as well as theoretical aspects of information hiding and detection. In 2011, the Program Committee reviewed 69 papers, using a double-blind system with at least 3 reviewers per paper. Then, each paper was carefully discussed until consensus was reached, leading to 23 accepted papers (33% acceptance rate), all published in these proceedings.

The invited speaker was Bernhard Schölkopf, who presented his thoughts on why kernel methods (and support vector machines in particular) are so popular and where they are heading. He also discussed some recent developments in two-sample and independence testing as well as applications in different domains.

At this point, we would like to thank everyone, who helped to organize the conference, namely, Jakub Havránek from the Mediaform agency and Bára Jeníková from CVUT in Prague. We also wish to thank the following companies and agencies for their contribution to the success of this conference: European Office of Aerospace Research and Development, Air Force Office of Scientific Research, United States Air Force Research Laboratory (www.london.af.mil), the Office of Naval Research Global (www.onr.navy.mil), Digimarc Corporation (www.digimarc.com), Technicolor (www.technicolor.com), and organizers of IH 2008 in Santa Barbara, CA, USA. Without their generous financial support, the organization would have been very difficult.

July 2011

Tomáš Filler
Tomáš Pevný
Scott Craver
Andrew Ker
Organization

13th Information Hiding Conference
May 18–20, 2011, Prague (Czech Republic)

General Chair

Tomáš Pevný  Czech Technical University, Czech Republic

Program Chairs

Tomáš Filler  SUNY Binghamton / Digimarc Corp., USA
Scott Craver  SUNY Binghamton, USA
Andrew Ker  University of Oxford, UK

Program Committee

Ross Anderson  University of Cambridge, UK
Mauro Barni  Università di Siena, Italy
Patrick Bas  CNRS, France
Rainer Böhme  University of Münster, Germany
François Cayre  GIPSA-lab/Grenoble INP, France
Ee-Chien Chang  National University of Singapore, Singapore
Christian Collberg  University of Arizona, USA
Ingemar J. Cox  University College London, UK
George Danezis  Microsoft Research Cambridge, UK
Gwenaël Doërr  Technicolor, France
Jessica Fridrich  SUNY Binghamton, USA
Teddy Furon  INRIA, France
Neil F. Johnson  Booz Allen Hamilton and JJTC, USA
Stefan Katzenbeisser  TU Darmstadt, Germany
Darko Kirovski  Microsoft Research, USA
John McHugh  University of North Carolina, USA and RedJack, LLC.
Ira S. Moskowitz  Naval Research Laboratory, USA
Ahmad-Reza Sadeghi  Ruhr-Universität Bochum, Germany
Rei Safavi-Naini  University of Calgary, Canada
Phil Sallee  Booz Allen Hamilton, USA
Berry Schoenmakers  TU Eindhoven, The Netherlands
Kaushal Solanki  Mayachitra Inc., USA
Kenneth Sullivan  Mayachitra Inc., USA
Paul Syverson  Naval Research Laboratory, USA
Local Organization

Jakub Havránek Mediaform, Czech Republic
Barbora Jeníková Czech Technical University, Czech Republic

External Reviewer

Boris Škorić Eindhoven University of Technology, The Netherlands

Sponsoring Institutions

European Office of Aerospace Research and Development
Office of Naval Research
Digimarc Corporation, USA
Technicolor, France
Table of Contents

Fingerprinting

Asymptotic Fingerprinting Capacity for Non-binary Alphabets ........ 1
  Dion Boesten and Boris Škorić

Asymptotically False-Positive-Maximizing Attack on Non-binary
  Tardos Codes .................................................... 14
  Antonino Simone and Boris Škorić

Towards Joint Tardos Decoding: The ‘Don Quixote’ Algorithm ........ 28
  Peter Meerwald and Teddy Furon

An Asymmetric Fingerprinting Scheme Based on Tardos Codes ....... 43
  Ana Charpentier, Caroline Fontaine, Teddy Furon, and Ingemar Cox

Special Session on BOSS Contest

“Break Our Steganographic System”— The Ins and Outs of Organizing
  BOSS ................................................................. 59
  Patrick Bas, Tomáš Filler, and Tomáš Pevný

A New Methodology in Steganalysis : Breaking Highly Undetectable
  Steganography (HUGO) ........................................... 71
  Gokhan Gul and Fatih Kurugollu

Breaking HUGO – The Process Discovery ........................... 85
  Jessica Fridrich, Jan Kodovský, Vojtěch Holub, and Miroslav Goljan

Steganalysis of Content-Adaptive Steganography in Spatial Domain ... 102
  Jessica Fridrich, Jan Kodovský, Vojtěch Holub, and Miroslav Goljan

Anonymity and Privacy

I Have a DREAM! (DiffeRentially privatE smArt Metering) ............ 118
  Gergely Ács and Claude Castelluccia

Anonymity Attacks on Mix Systems: A Formal Analysis ............ 133
  Sami Zhioua

Differentially Private Billing with Rebates .......................... 148
  George Danezis, Markulf Kohlweiss, and Alfredo Rial
# Table of Contents

## Steganography and Steganalysis

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistical Decision Methods in Hidden Information Detection</td>
<td>163</td>
</tr>
<tr>
<td>Cathel Zitzmann, Rémi Cogranne, Florent Retraint, Igor Nikiforov, Lionel Fillatre, and Philippe Cornu</td>
<td></td>
</tr>
<tr>
<td>A Cover Image Model for Reliable Steganalysis</td>
<td>178</td>
</tr>
<tr>
<td>Rémi Cogranne, Cathel Zitzmann, Lionel Fillatre, Florent Retraint, Igor Nikiforov, and Philippe Cornu</td>
<td></td>
</tr>
<tr>
<td>Video Steganography with Perturbed Motion Estimation</td>
<td>193</td>
</tr>
<tr>
<td>Yun Cao, Xianfeng Zhao, Dengguo Feng, and Rennong Sheng</td>
<td></td>
</tr>
</tbody>
</table>

## Watermarking

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft-SCS: Improving the Security and Robustness of the Scalar-Costa-Scheme by Optimal Distribution Matching</td>
<td>208</td>
</tr>
<tr>
<td>Patrick Bas</td>
<td></td>
</tr>
<tr>
<td>Improving Tonality Measures for Audio Watermarking</td>
<td>223</td>
</tr>
<tr>
<td>Michael Arnold, Xiao-Ming Chen, Peter G. Baum, and Gwenaël Doërr</td>
<td></td>
</tr>
<tr>
<td>Watermarking as a Means to Enhance Biometric Systems: A Critical Survey</td>
<td>238</td>
</tr>
<tr>
<td>Jutta Hämmerle-Uhl, Karl Raab, and Andreas Uhl</td>
<td></td>
</tr>
<tr>
<td>Capacity-Approaching Codes for Reversible Data Hiding</td>
<td>255</td>
</tr>
<tr>
<td>Weiming Zhang, Biao Chen, and Nenghai Yu</td>
<td></td>
</tr>
</tbody>
</table>

## Digital Rights Management and Digital Forensics

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code Obfuscation against Static and Dynamic Reverse Engineering</td>
<td>270</td>
</tr>
<tr>
<td>Sebastian Schrittwieser and Stefan Katzenbeisser</td>
<td></td>
</tr>
<tr>
<td>Countering Counter-Forensics: The Case of JPEG Compression</td>
<td>285</td>
</tr>
<tr>
<td>ShiYue Lai and Rainer Böhme</td>
<td></td>
</tr>
</tbody>
</table>

## Data Hiding in Unusual Content

<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stegobot: A Covert Social Network Botnet</td>
<td>299</td>
</tr>
<tr>
<td>Shishir Nagaraja, Amir Houmansadr, Pratch Piyawongwisal, Vijit Singh, Pragya Agarwal, and Nikita Borisov</td>
<td></td>
</tr>
</tbody>
</table>
# Table of Contents

CoCo: Coding-Based Covert Timing Channels for Network Flows .......................... 314  
*Amir Houmansadr and Nikita Borisov*

LinL: Lost in n-best List ........................................................................... 329  
*Peng Meng, Yun-Qing Shi, Liusheng Huang, Zhili Chen, Wei Yang, and Abdelrahman Desoky*

**Author Index** .................................................................................... 343