A Practitioner Survey Exploring the Value of Forensic Tools, AI, Filtering, & Safer Presentation for Investigating Child Sexual Abuse Material (CSAM)

By

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Agenda

- Introduction
- Previous Work
- Survey
- Results
- Challenges
- Future Work
- Acknowledgements

Problems

- The investigative process:
  - Individual investigations may deal with terabytes of data, containing millions of still images and hundreds of hours of video, and multiple devices (Quick and Choo, 2014)
  - Examining such large volumes of data can be a long, unmanageable, and unproductive process
    - Contributes to lost time in cases and backlogs

Problems, continued

- Impact on investigators and victims:
  - Due to exposure to explicit content, investigators may experience a physical and emotional impact on self and home, intrusive images and thoughts about the viewed content, and a heightened protectiveness or paranoia regarding the safety of children (Burns et al., 2008).
  - Victims may also be further traumatized and re-victimized as a permanent record of their abuse exists and may be viewed by others

Previous Work

- *Psychological Aspect/Trauma*
  - Burns et al (2008)
  - Powell et al (2015)
  - Bourke and Craun (2013)
  - Seigfried-Spellar (2017)
- *Tools, Techniques, and Automation*
  - Powell et al. (2014)
  - Sae-Bae et al. (2014)
  - Ulges and Stahl (2011)
  - de Castro Polastro and da Silva Eleuterio (2010)
- *Triaging*
  - Rogers et al. (2006)
  - Shaw and Browne (2013)
  - Marturana and Tacconi (2013)
  - Baggili et al. (2014)
- *Articial Intelligence (AI)*
  - Peersman et al. (2016)
  - Mahadeokar and Pesavento (2016)
  - PhotoDNA Cloud Service, n.d.
  - Vitorino et al. (2018)
  - Anda et al. (2018),

Contributions

- First comprehensive study to explore practitioner assigned value of current CSAM investigative tools
- First comprehensive survey to study current use of Data Science techniques and technologies in CSAM investigations
- Explores and identifies what investigators deem to be acceptable false positives and false negatives in CSAM investigative technologies

Survey

- Motivation: improve workflow, shorten the amount of time of an investigation, and limit investigative exposure to CSAM content
- The questions focused on what tools and technologies are utilized by CSAM investigators and how they feel about these tools and technologies.
- Consisted of 49 questions:
  - 7 Likert Scale
  - 11 Multiple-Choice
  - 7 Multiple-Selection
  - 6 Free Response
  - 2 Rank
  - 1 Drop Down List
  - 15 Numerical Sliders

Survey, continued

- Question Categories:
  - Demographic
  - Tools – Processing
  - Tools – Detection
  - Technology – Implementation and Usage
  - Technology – Value, Ranking, and Preference
  - Technology – False Positives and Negatives
  - Workflow
  - Tool Processing Times - Acquisition, Processing, Analysis, & Reporting Time
  - Tool Processing Times - Acquisition Processing Times for Android Phones
- 106 participants

Results – Demographics

- Majority of the sample population → white (93.40%) males ranging from ages 35-54 (65.10%) with at least a high school diploma.
- Highest level of education → Bachelor's Degree (41.51%) with most related to the fields of technology and law
- Respondents indicate being most competent in Digital Forensics (99%); 41% neither agrees nor disagrees on being competent in Data Science
- 69% have received formal training to investigate CSAM cases

Tools – Processing

- Two questions, presented in a multiple-answer format, asked participants to identify all the tools they use to process CSAM images and videos.
- Unsurprisingly, for both questions the results indicated that commercial tools appear to be utilized more than free or open-source tools.
- Limitations:
  - Feature/capability related (62%) → lacking filtering, safe-viewing, carving, photo enhancement, photo grouping, accuracy, user-friendliness

Tools - Detection

- Usage of currently available technology to automatically detect pornographic content:
  - iCOP/iCAC COP → 50%
  - Yahoo NSFW → 2.56%
  - Both → 1.28%
  - Neither → 46.15%
- Benefits → quickness (22.92%)
- Limitations → able to identify only known or hashed content (25%)

Technology –Implementation and Usage

- Respondents were asked if the following technologies are implemented by their image and video processing tools:
  - Skin tone detection
  - Face recognition
  - Face detection
  - Age estimation
  - Child nudity detection
  - Object detection
  - Face presentation
  - Nudity blocker

Technology – Implementation Results

	Count	Percentage
Technology Implemented by Image Processing Tools		
Skin Tone Detection	76	56.30%
Face Recognition	6	4.44%
Face Detection	16	11.85%
Age Estimation	1	0.74%
Gender Estimation	1	0.74%
Child Nudity Detection	8	5.93%
Object Detection	5	3.70%
Face Presentation	1	0.74%
Nudity Blocker	3	2.22%
None of the above	13	963%
I do not use tools	5	3.70%
Technology Implemented by Video Processing Tools		
Skin Tone Detection	80	56.34%
Face Recognition	6	4.23%
Face Detection	16	11.27%
Gender Estimation	1	0.70%
Child Nudity Detection	10	7.04%
Object Detection	8	5.63%
Face Presentation	1	0.70%
Nudity Blocker	3	2.11%
None of the above	13	9.15%
I do not use tools	4	2.82%

Technology – Usage Results

Technology Utilized by Respondents to Process Images		
Skin Tone Detection	67	52.34%
Face Recognition	7	5.47%
Face Detection	10	7.81%
Age Estimation	1	0.78%
Gender Estimation	1	0.78%
Child Nudity Detection	5	3.91%
Object Detection	6	4.69%
Face Presentation	1	0.78%
Nudity Blocker	3	2.34%
None of the options provided	16	12.50%
I do not use any technologies	11	8.59%
Technology Utilized by Respondents to Process Videos		
Skin Tone Detection	57	46.34%
Face Recognition	5	4.07%
Face Detection	9	7.32%
Age Estimation	1	0.81%
Gender Estimation	1	0.81%
Child Nudity Detection	6	4.88%
Object Detection	6	4.88%
Nudity Blocker	2	1.63%
None of the options provided	25	20.33%
I do not use any technologies	11	8.94%

Technology – Value, Ranking, and Preference

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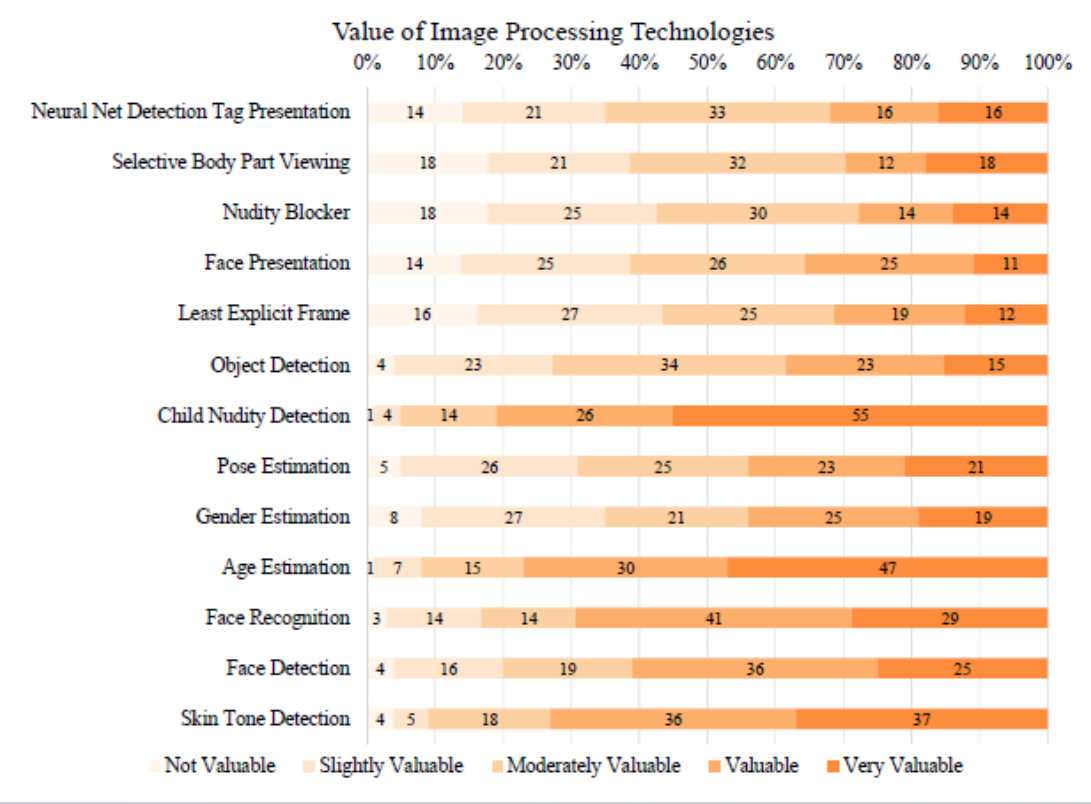
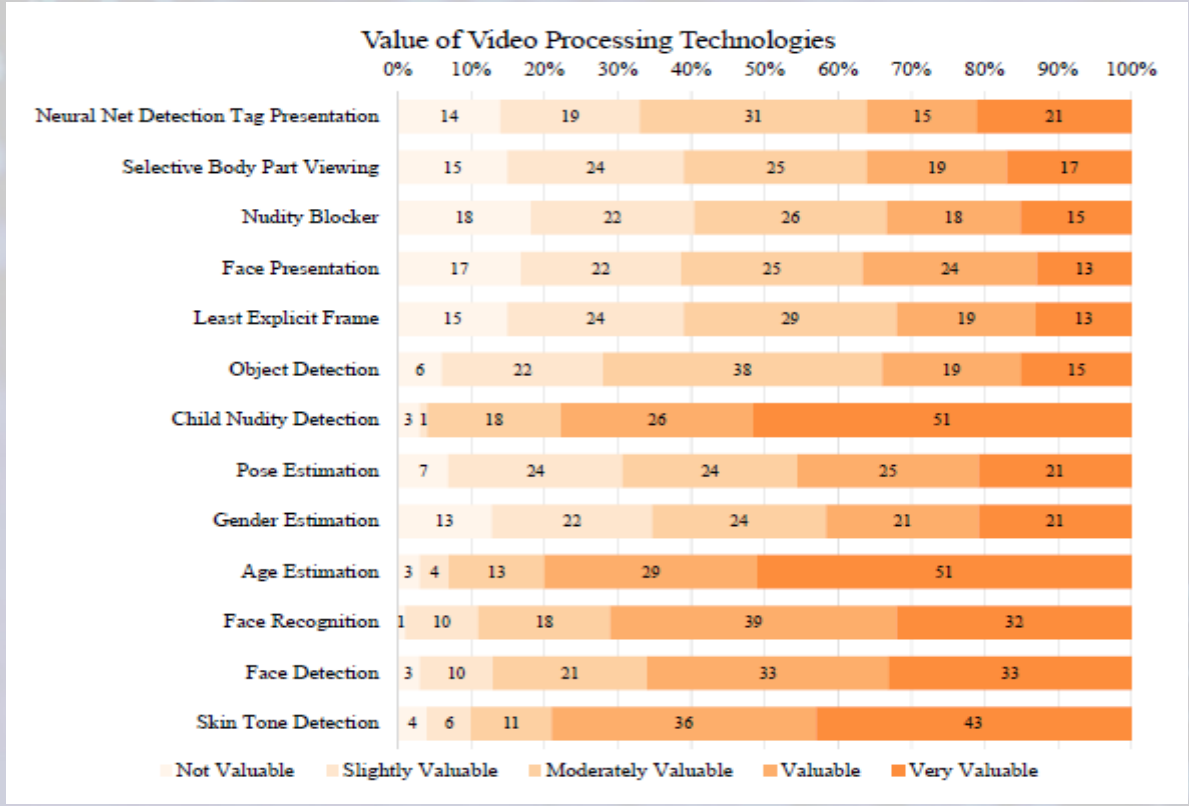
- Results indicate the implementation of filtering technologies have a higher value than safe-viewing technologies





Results - Workflow

- Limitations of current workflow →
  - Current tools and technology (28.77%)
  - Workload (20.55%)
  - Time (17.81%)
  - Resources (10.96%)
- Participant suggestions:
  - More resources (36.14%), better tools and technology (33.73%)
  - Adding more CSAM hash databases, make it possible for investigators to share hash values
  - More training for management, implement policies and standards that reflect current workflows

Results – Workflow, continued

- Valuable → 44.93%
- Very valuable → 34.78%
- Slightly to moderately valuable → 18.84%

Results – Workflow, continued

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Type	Suggestion	Count	Total Count	Percentage
Resources	More analysts/examiners/investigators	2	3	16.67%
	More computers	1		
Time	Limit work hours of exposure to CSAM	1	1	5.56%
Tools & Technology	Ability to process large datasets faster	1	11	61.11%
	Add explanation of how automated process generated its result to check for false positives	1		
	Add report options	1		
	After rapid analysis, provide encryption and file hiding analysis to discover steganography attempts	1		
	Assign priority levels to cases based on known presence of CSAM	1		
	Automatically categorize and extract the content of any device (hard drive, usb key, etc.)	1		
	Faster acquisition and analysis	1		
	Implement safer presentation at an earlier stage	1		
	Quickly generate a report	1		
	Retain explicit format and safe presentation	1		
	Utilize reporting software with efficient filters to manually input the data necessary for a case	1		
Other	Availability of an expert witness to testify on behalf of the tool	1	3	16.67%
	System/workflow should allow for division of work into manageable tasks and collaborative/multi-user effort	1		
	Workflow should address data storage, network security, data retention and disposal, granular access and audit trail	1		

Challenges

- The number of participants responding to questions was not the same across the board due in part to intentional skipping of questions and early drop-out rates.
  - Resulted in questions having varying response counts
- Wording may have caused some questions to be misinterpreted by participants.
  - Non-related answers were provided by respondents.
- Some respondents were not consistent in their answers

Recommendations

- Include courses on AI, software design, engineering, and data science in academic DF programs
- Support research of CSAM investigations via a continuous funding model
- Encourage development and use of CSAM centered open source tools
- Establish and implement an up-to-date, standardized workflow
- Encourage non-practitioners to engage in training to better understand the work entailed in CSAM investigations, and the resources needed

Recommendations, continued

- Moving away from hash value identification, utilizing AI techniques to accurately identify CSAM
- Focus research on age estimation
- Develop technology that can identify and group images/video of the same victim and apply age estimation
- Employ novel filtering techniques beyond skin tone detection
- Leveraging novel techniques (e.g. object detection) to provide leads
- Develop technologies allowing for newly identified CSAM to be added to a shared repository between practitioners while adhering to laws

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