StegoAppDB: A Benchmark Database for Mobile Steganography

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Project Rationale & Goals

Why we need a reference StegoAppDatabase :

1. Stego apps are popular, simple, and stealthy.
2. No current database has images reflective of mobile stego cases.
3. No algorithms/software have successfully detected images from stego apps.

What we can do with StegoAppDatabase:

1. Test current tools/software on mobile stego images.
2. Create/benchmark new algorithms.
3. Potential applications to other digital image forensics problems.

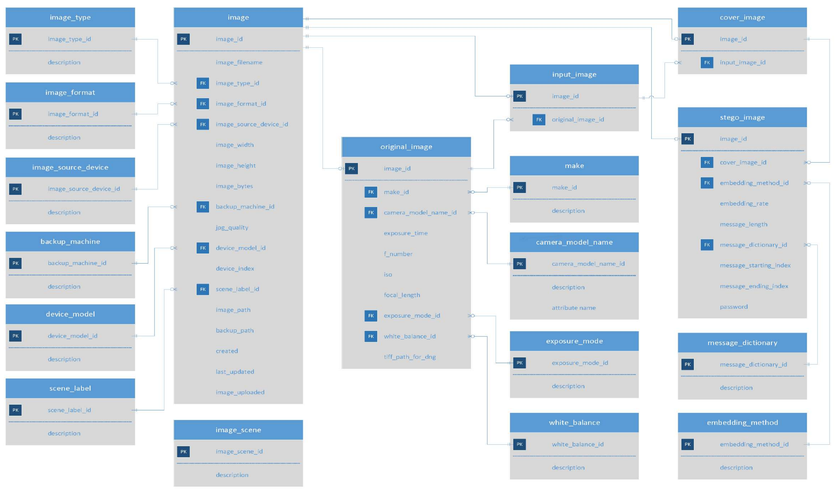
What challenges we are facing:

1. Forensics applications require data authentication and copyright/privacy-free.
2. Each app has unique characteristics and requires reverse-engineering.
3. Need a fast and efficient method to batch-generate many images.

Example: Steganography Apps in Google Play Store

App Name	Installs	Open Source	Output Format	Image Resizing	Payload Pre-processing			Embedding Technique
					Encryption	Signature Strings	Length Data	
PixelKnot	100,000+	Yes	JPG	Downsampling	Yes	No	Yes	F5
Steganography Master	10,000+	No	PNG	No	No	Yes	No	1's digit replacement
Steganography_M	10,000+	No	PNG	No	No	Yes	No	LSB replacement
DaVinci Secret Image	5,000+	No	PNG	User specified	No	Yes	Yes	Alpha channel encoding
Steganography_T	5,000+	No	PNG	No	No	No	Yes	LSB replacement
Stegais	1,000+	No	JPG	Downsampling	No	No	Yes	Unknown
PocketStego	1,000+	No	PNG	Downsampling	No	Yes	No	LSB
MobiStego	1,000+	Yes	PNG	Downsampling	Yes	Yes	No	RGB channels LS2B
NiaStego	1,000+	No	PNG	Upsampling	Yes	Yes	No	RGB channels LSB
Passlok	1,000+	Yes	JPG	No	Yes	Yes	No	Non-shrinkage F5

Entity Relationship Diagram of the StegoAppDatabase



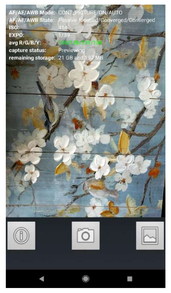
Data Collection and Current Status of the Database

24 Lab Smartphones (2+ phones per model)

Google Pixel 1
Google Pixel 2
HTC 10
OnePlus 5
Samsung Galaxy S7
Samsung Galaxy S8

iPhone 6S
iPhone 6S Plus
iPhone 7
iPhone 7Plus
iPhone 8
iPhone X

48,240 original JPEGs and DNGs
100 images per scene, 2,412 labeled scenes
10 different exposure settings for each scene

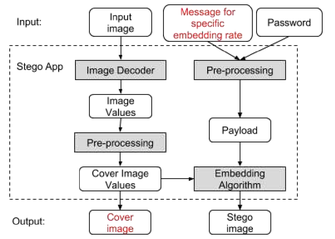


We developed a camera app for efficient data collection:

- **"Cameraw" for Android and iOS**
- **Takes 20 images with one click**
- **Captures both JPEG and DNG**
- **Photographer assigns scene label after capture session**
- **Image metadata are saved along with the collected images**

595,400 stego images on 5 different embedding rates, generated from 7 stego apps:

We reverse-engineer the stego apps and batch-generate cover and stego images, with specific embedding rates.



Evaluation, Results & Discussion

Evaluation of existing steg detection programs on 2000 cover images and 2000 stego images created by the standard F5 embedding algorithm:

Error Type	Programs		
	Stego Hunt	DC3 StegDetect	Provos StegDetect
False Alarm	0.0%	0.0%	24.6%
Missed Detection	5.2%	0.0%	47.4%
Average Error	2.6%	0.0%	36.0%

Evaluation of existing steg detection programs on 4818 cover images and 4818 stego images created by the StegoApp *PixelKnot:*

Error Type	Programs		
	Stego Hunt	DC3 StegDetect	Provos StegDetect
False Alarm	0%	0%	24%
Missed Detection	100%	100%	76%
Average Error	50%	50%	50%

Conclusion: Existing steg detection programs do not perform well on detecting Stego Images created by Apps. [***Appeared in IFIP 11.9 2018***] [1]

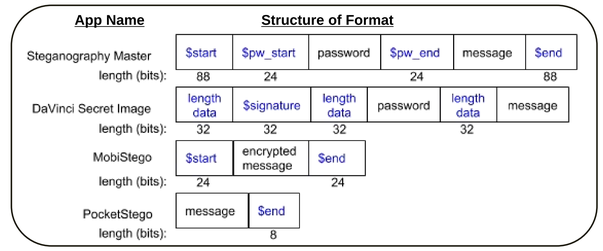
Type of Detection	Advantages
Machine Learning	• Reverse engineering is not required • Run with zero knowledge of signature • Can be retrained to include other stego embedding methods
Signature/Hash-Based	• Very fast to execute, high accuracy • Identifies many types of files, not just images

ML-based Steg Detection: Detecting StegoApp *PixelKnot* using *CC-JRM* features and *FLD* ensemble classifier training on 500 cover-stego pairs of images at 10% embedding rate.

Data Source	Original Format	Input Image Size	Output Image Size	Accuracy
Google Pixel	JPEG	4048*3036	1280*960	99.0%
Samsung S7	JPEG	4032*3024	1280*960	92.4%
OnePlus 5	JPEG	4608*3456	1280*960	99.7%
All	JPEG	-	1280*960	96.8%

Conclusion: Knowing the data source and stego apps, an academic ML-based detection method performs well on the stego images generated from *PixelKnot*. ***[Appeared in APSIPA 2018]*** [2]

Signature-based Steg Detection. It is possible to detect stego images from mobile apps that embed signatures.



Stego App	Test Images	Image Count	Accuracy
Steganography Master	SM Stego Images	42,100	100%
	Other Images	159,980	100%
DaVinci Secret Image	DV Stego Images	42,100	100%
	Other Images	159,980	100%
MobiStego	MS Stego Images	42,100	100%
	Other Images	159,980	100%

1. W. Chen, Y. Wang, Y. Guan, J. Newman, L. Lin, and S. Reinders. "Forensic analysis of android steganography apps," In G. Peterson and S. Shenoi, eds., Advances in Digital Forensics XIV, Cham. Springer Int'l. Publishing, 2018, pp. 293-312.

2. W. Chen, L. Lin, M. Wu, Y. Guan, and J. Newman. "Tackling Android Stego Apps in the Wild," to appear in 2018 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC), Honolulu, HI, 2018.

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