EyeDecrypt — Private Interactions in Plain Sight

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AT&T Security Research Center

at&t

“Shoulder Surfing”

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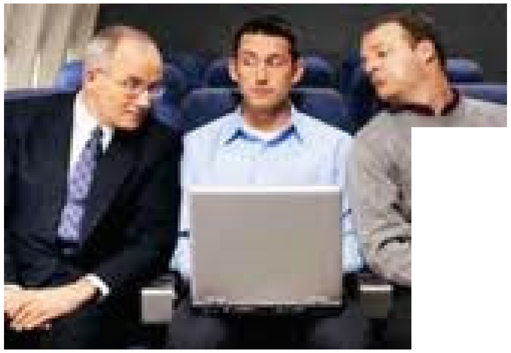

“Shoulder Surfing”

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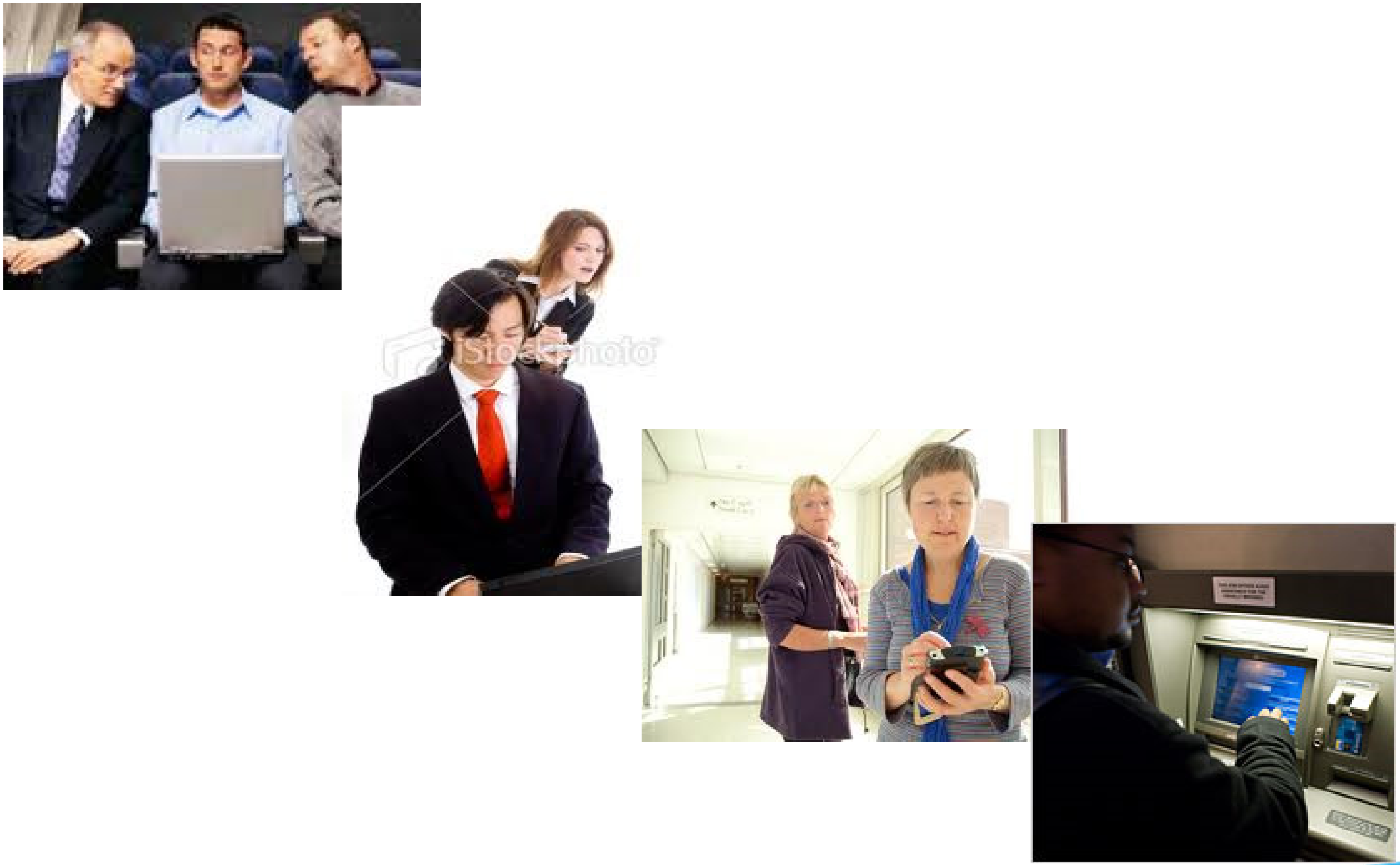

This Work: *EyeDecrypt*

- Content protection in new setting: *public-view* rendering device

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- Three main components:
  - *EyeDecrypt* security definition
  - *Visualizable* encryption scheme
  - Visual encoding technique(s)

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“For your eyes only!”

Model: Parties

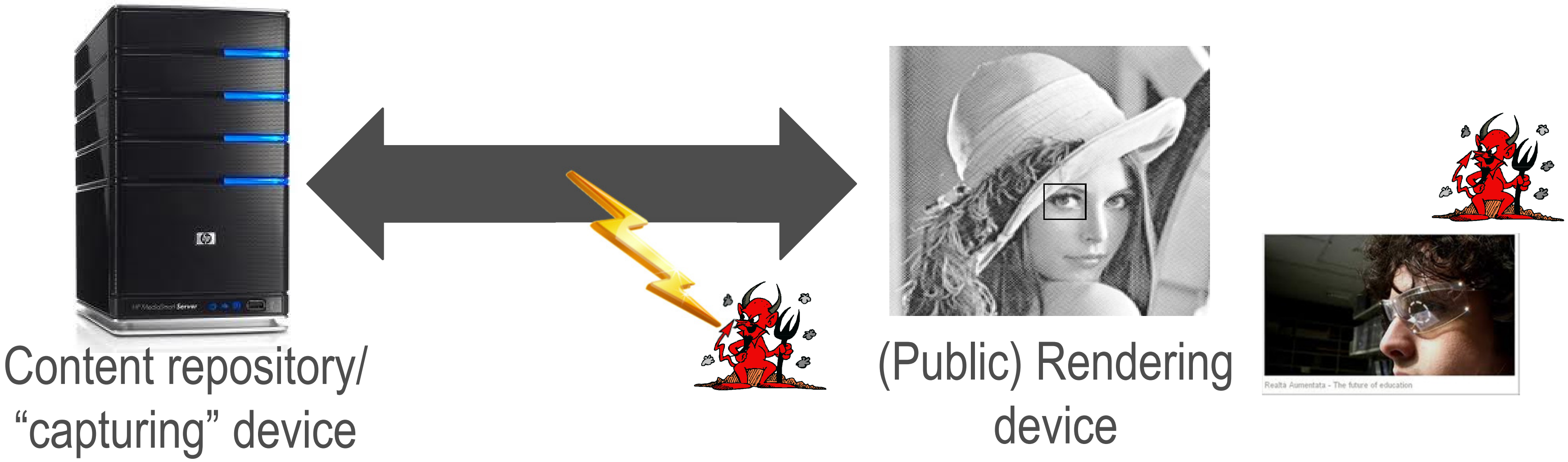
Server

Adv

Realta Aumentata - The future of education

User
(Viewing device)

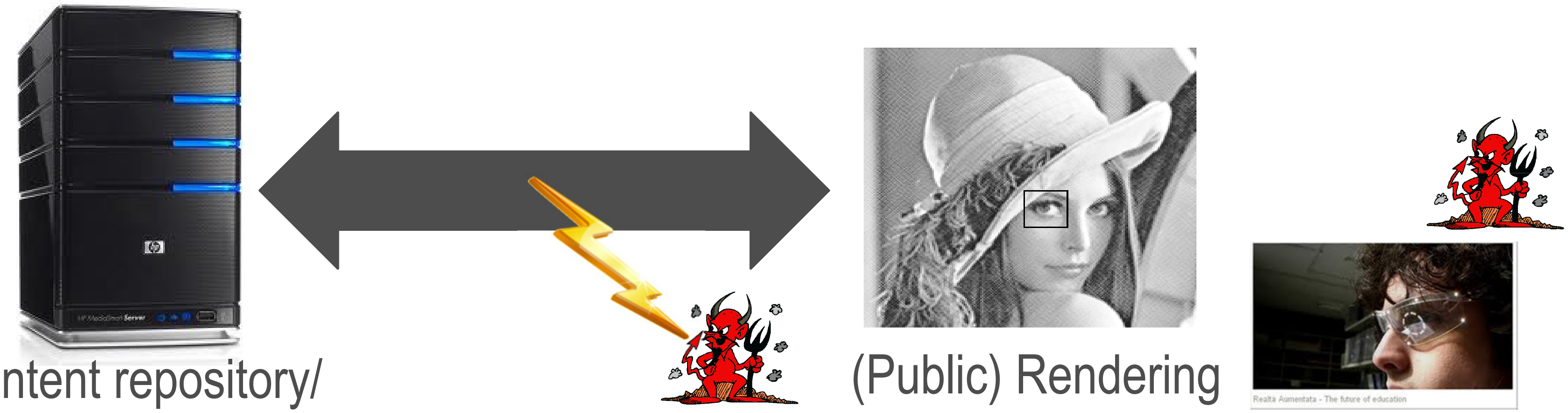
Model: Parties (cont’d)



Content repository/ “capturing” device

(Public) Rendering device

Model: Parties (cont’d)



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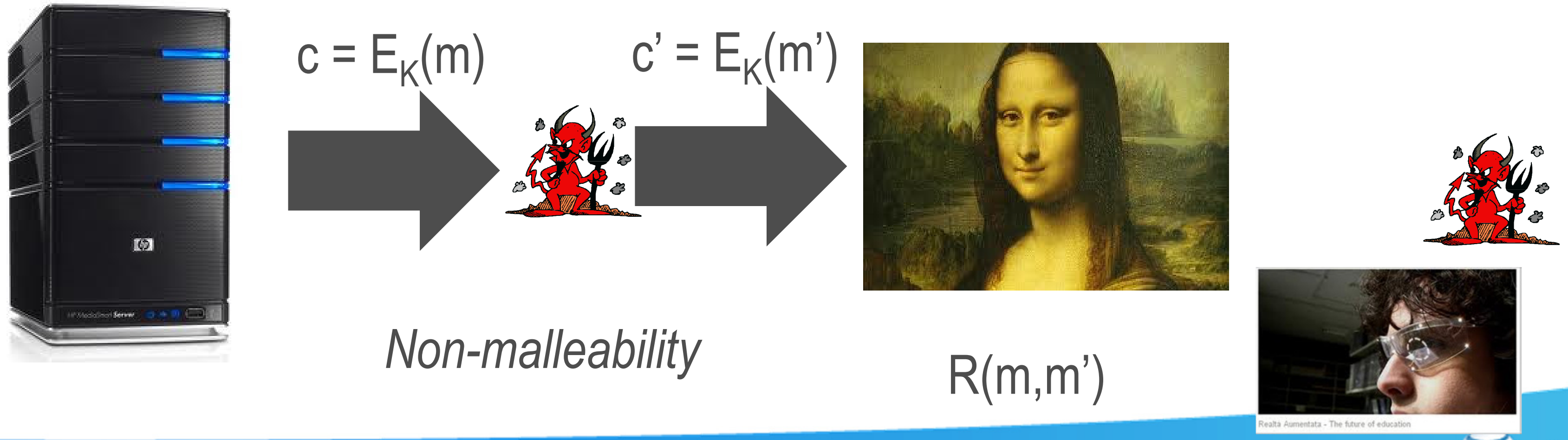

$c = E_K(m)$

$c' = E_K(m')$

Non-malleability

$R(m,m')$

EyeDecrypt in a Nutshell

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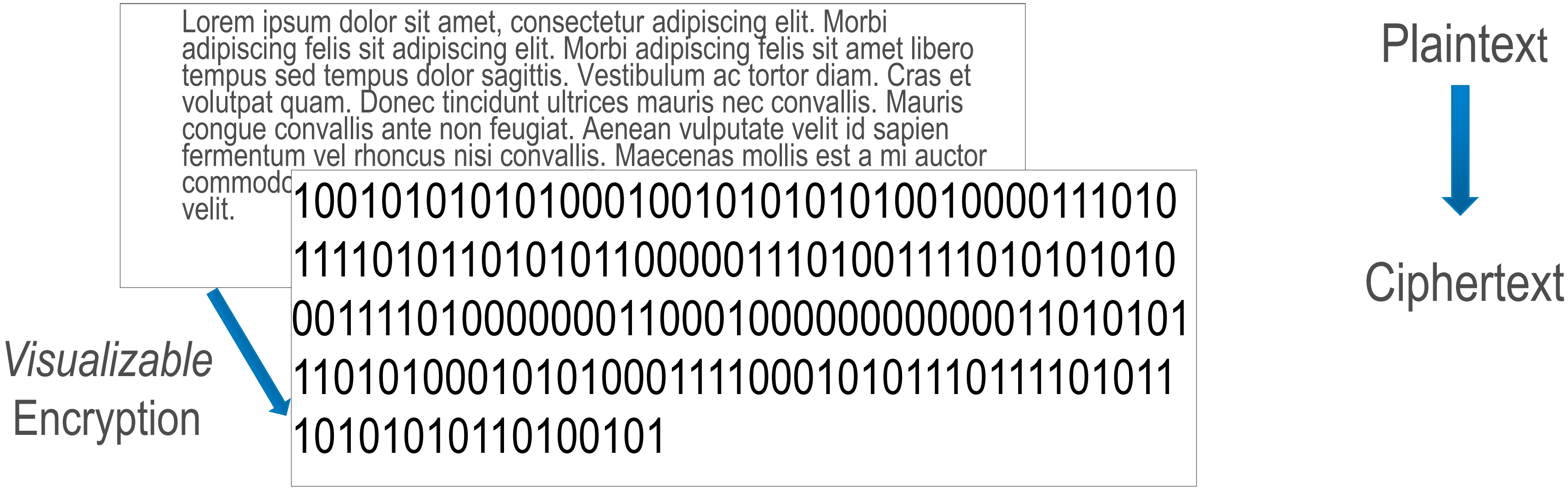
Plaintext

EyeDecrypt in a Nutshell



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Visualizable
Encryption

Plaintext

Ciphertext

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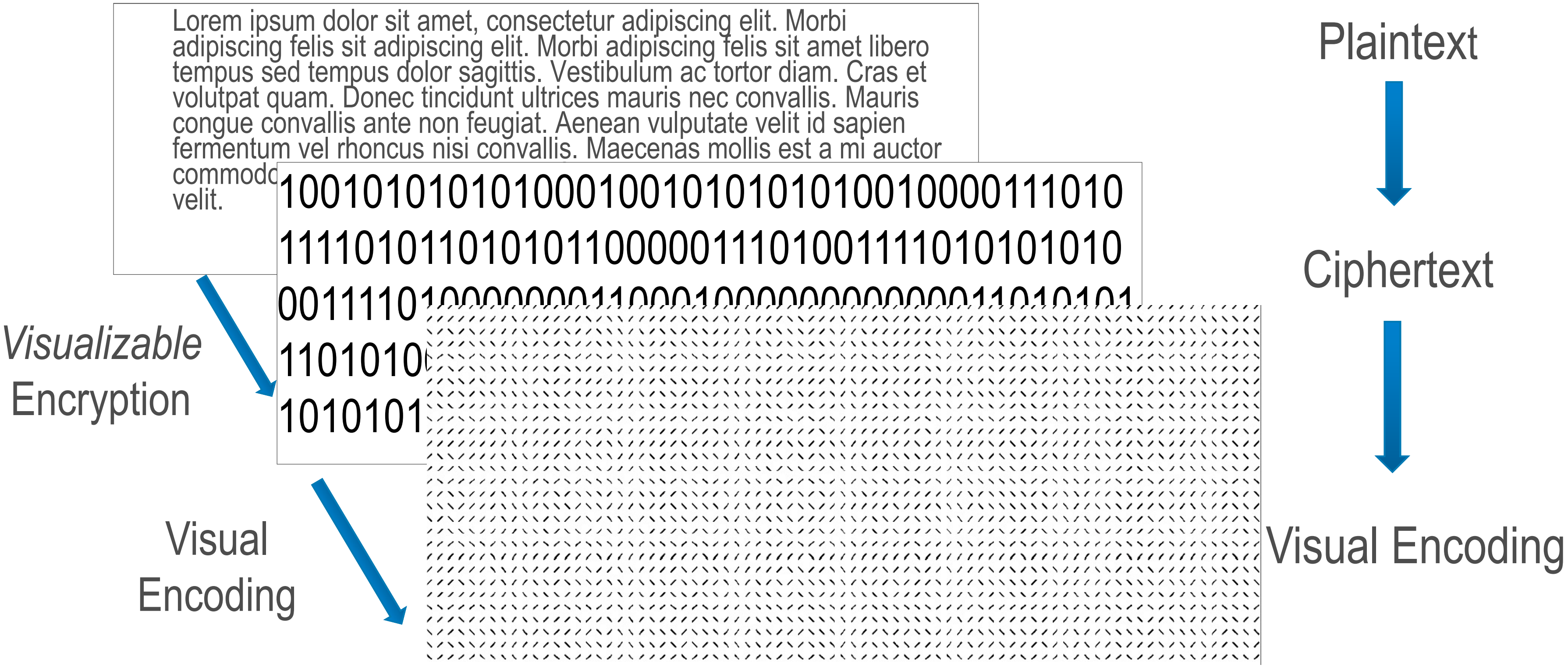

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11110101101010110000011101001111010101010
0011110100000000110001000000000000011010101
1101010
1010101
```

Visualizable Encryption

Visual Encoding

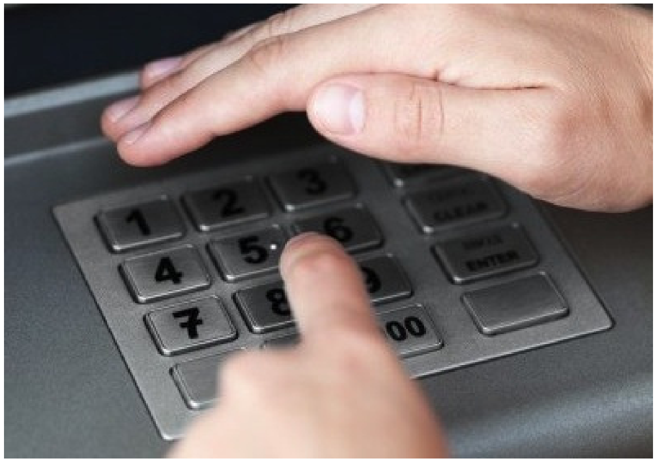
Plaintext

Ciphertext

Visual Encoding

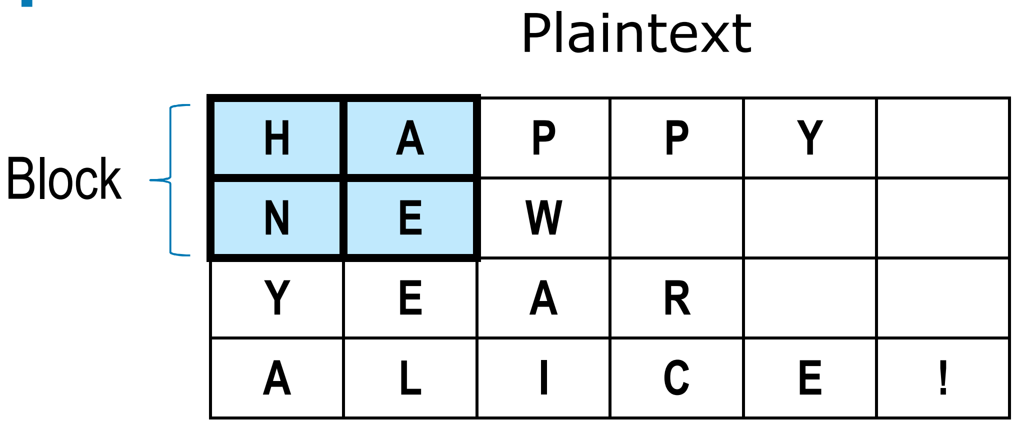
Defining *EyeDecrypt*'s Security

- **Important:** Encryption ***does not*** (on its own) make new application secure — solve shoulder surfing in our case
- Attacker can still see the buttons that the user presses, gestures, eye movement,…
- Security is defined with respect to a function *Leak* that determines, at each step, the information learned by Adv



A Visualizable Encryption Scheme

- Plaintext space is a matrix of text (for example)



Plaintext

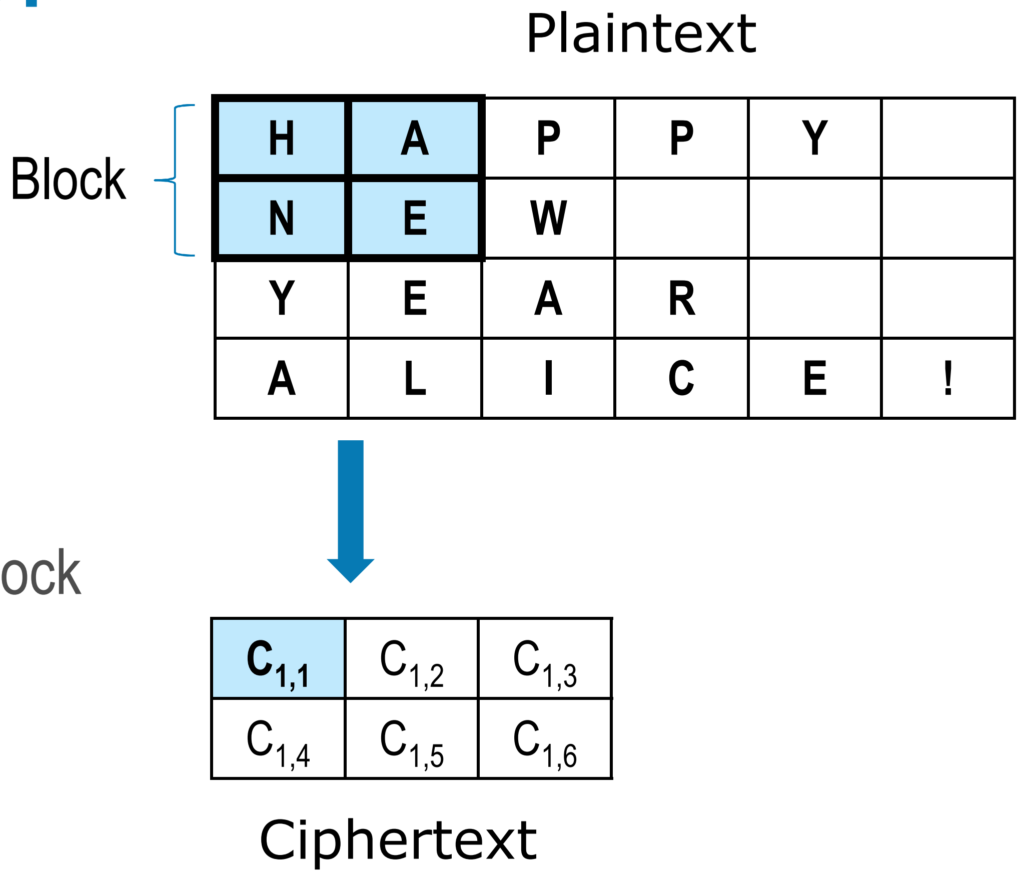
Block

H	A	P	P	Y	
N	E	W			
Y	E	A	R		
A	L	I	C	E	!

A Visualizable Encryption Scheme

- Plaintext space is a matrix of text (for example)

- Encryption is performed per block



Plaintext

Block

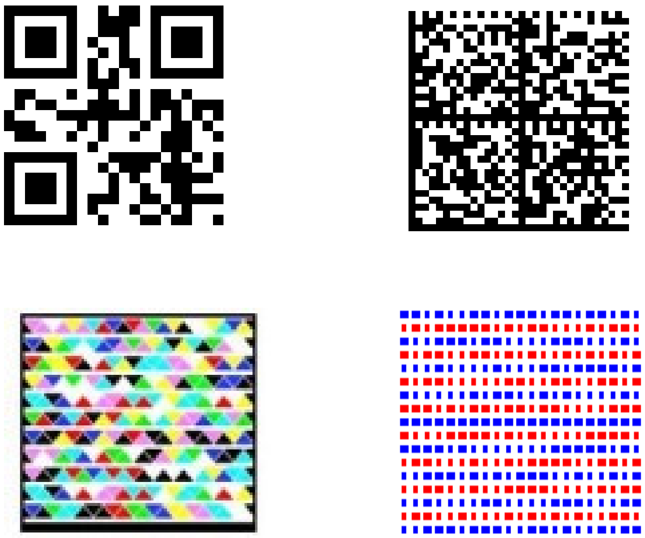
H	**A**	**P**	**P**	**Y**	
N	**E**	**W**			
Y	**E**	**A**	**R**		
A	**L**	**I**	**C**	**E**	**!**

$\mathbf{C_{1,1}}$	$C_{1,2}$	$C_{1,3}$
$C_{1,4}$	$C_{1,5}$	$C_{1,6}$

Ciphertext

Visual Encoding

- Many existing visual encoding solutions: QR codes, Data Matrix, HCCB,…
- Most require capturing the entire encoding



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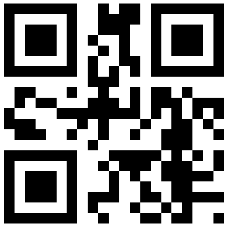
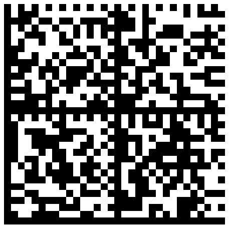
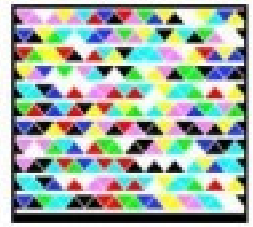
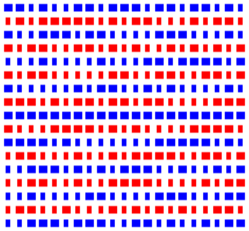
- Most require capturing the entire encoding
- We require:
  - *Locality* – cropped encoding decodes to sub-matrix of input
  - *Relative positioning* – adjacent input sub-matrixes are adjacent in encoded image

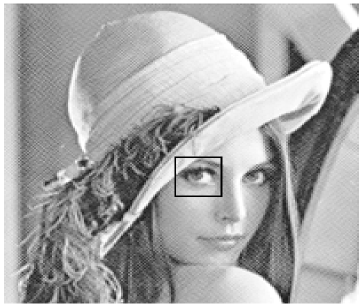
→ ***Dataglyphs***

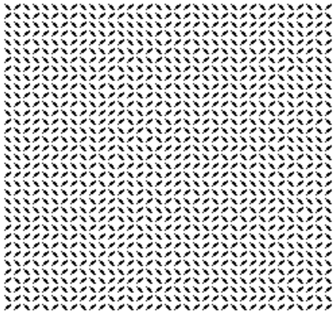












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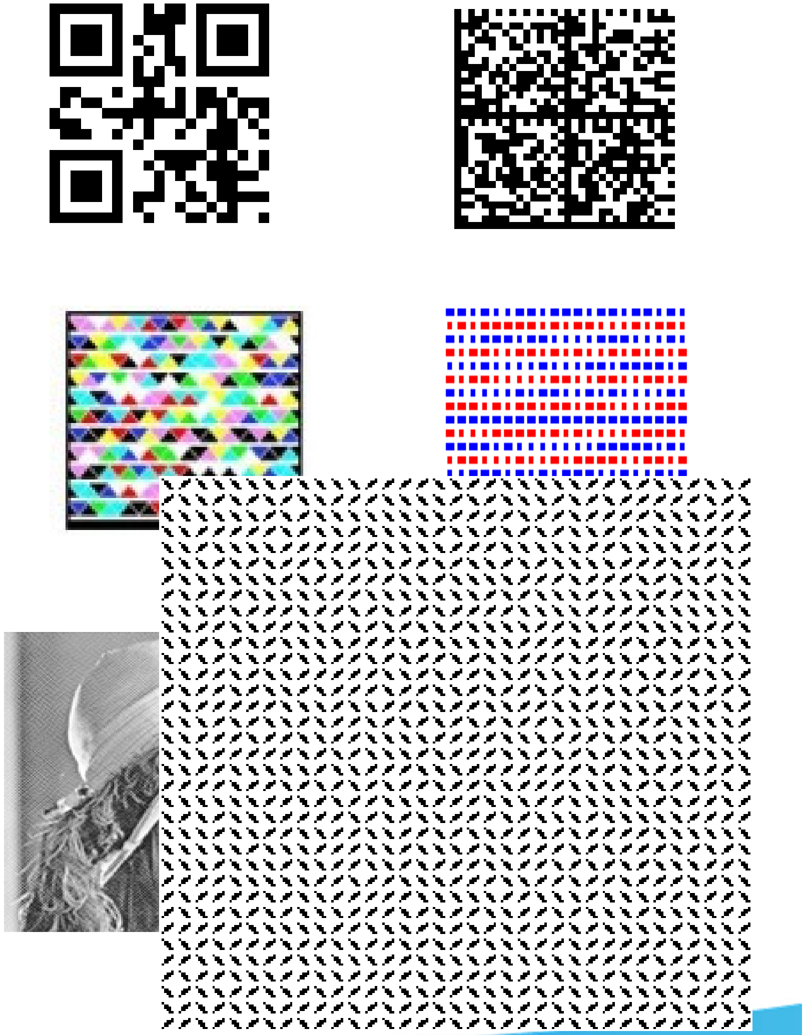
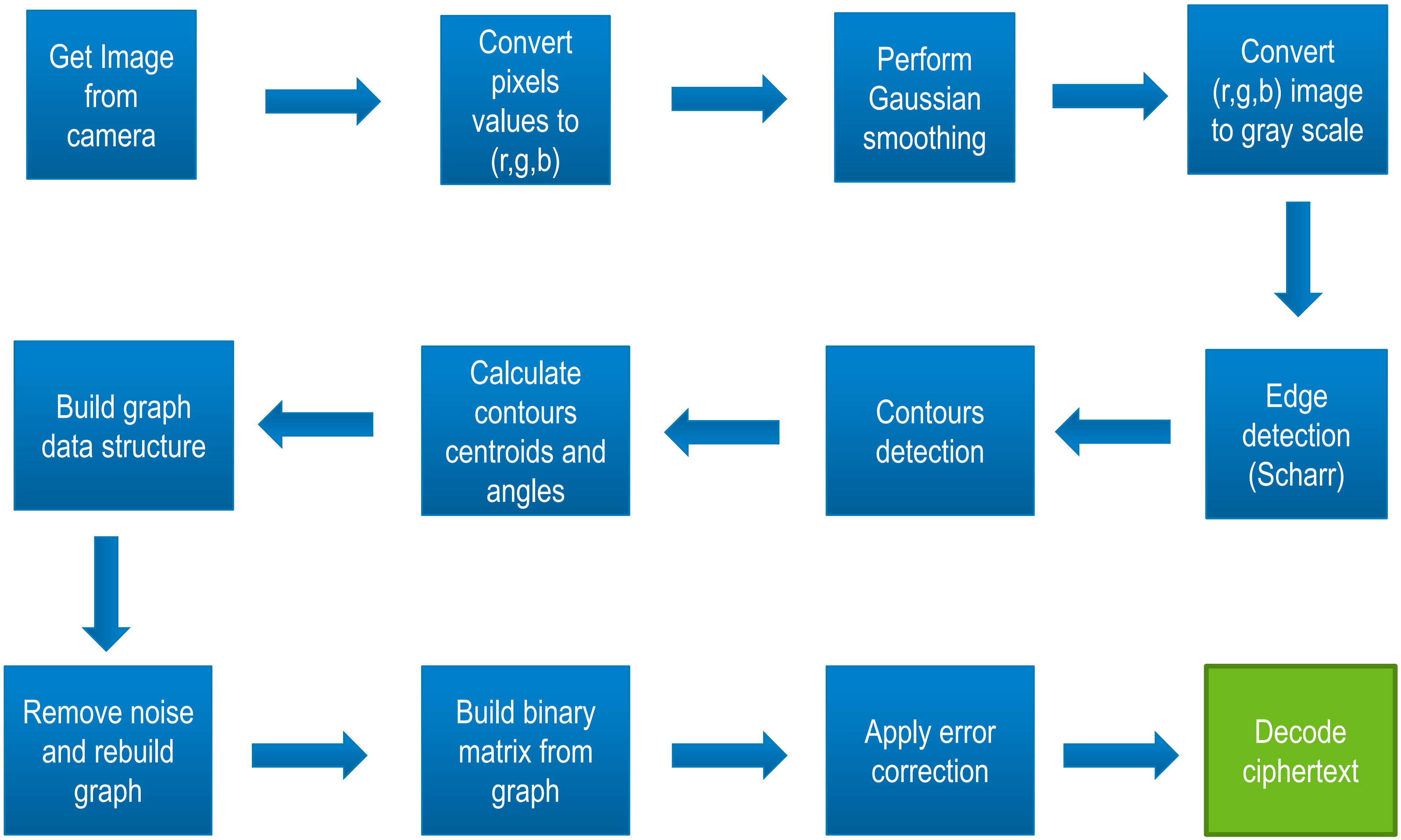


Visual Decoding Steps



Get Image from camera

Convert pixels values to (r,g,b)

Perform Gaussian smoothing

Convert (r,g,b) image to gray scale

Edge detection (Scharr)

Contours detection

Calculate contours centroids and angles

Build graph data structure

Remove noise and rebuild graph

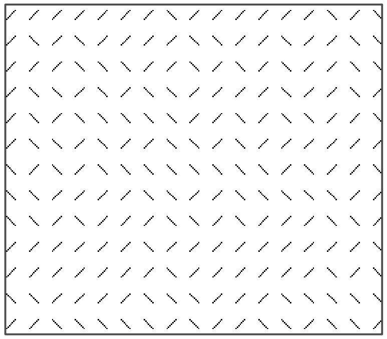
Build binary matrix from graph

Apply error correction

Decode ciphertext

Instantiating EyeDecrypt: Secure PIN Entry

- Aka: Randomized keypad



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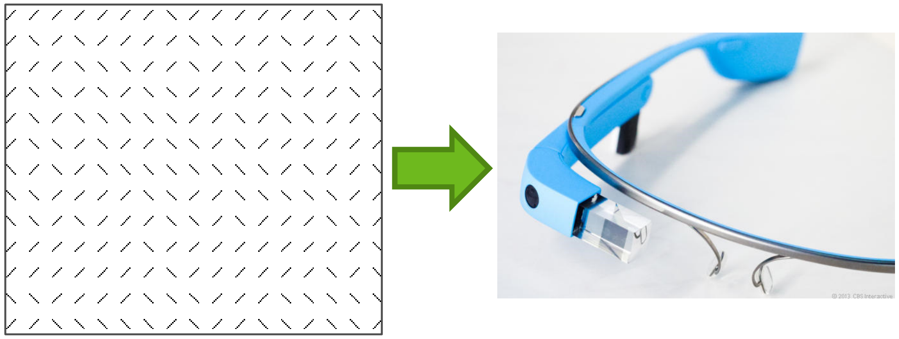

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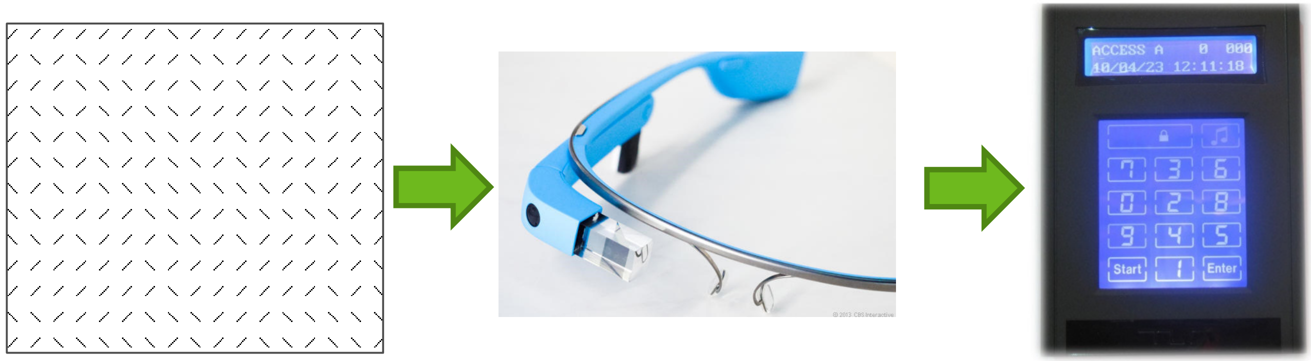

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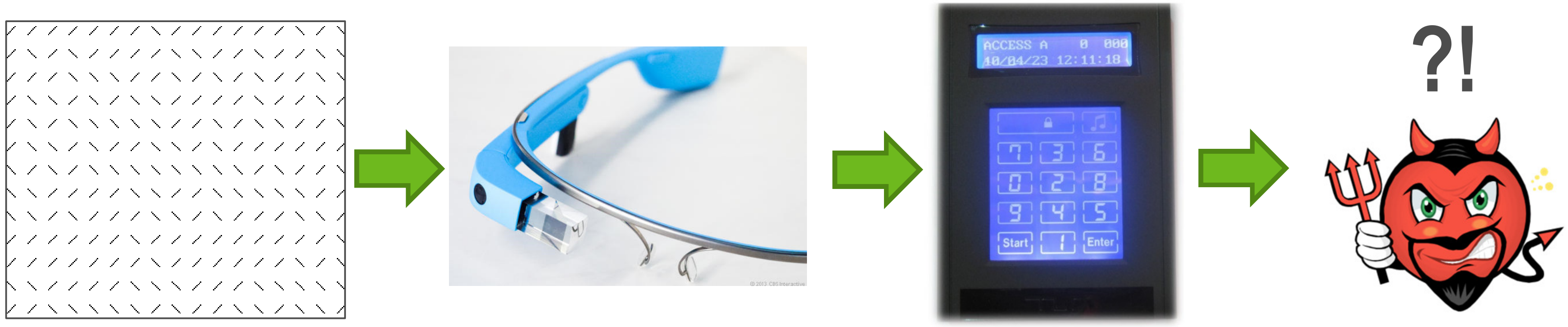
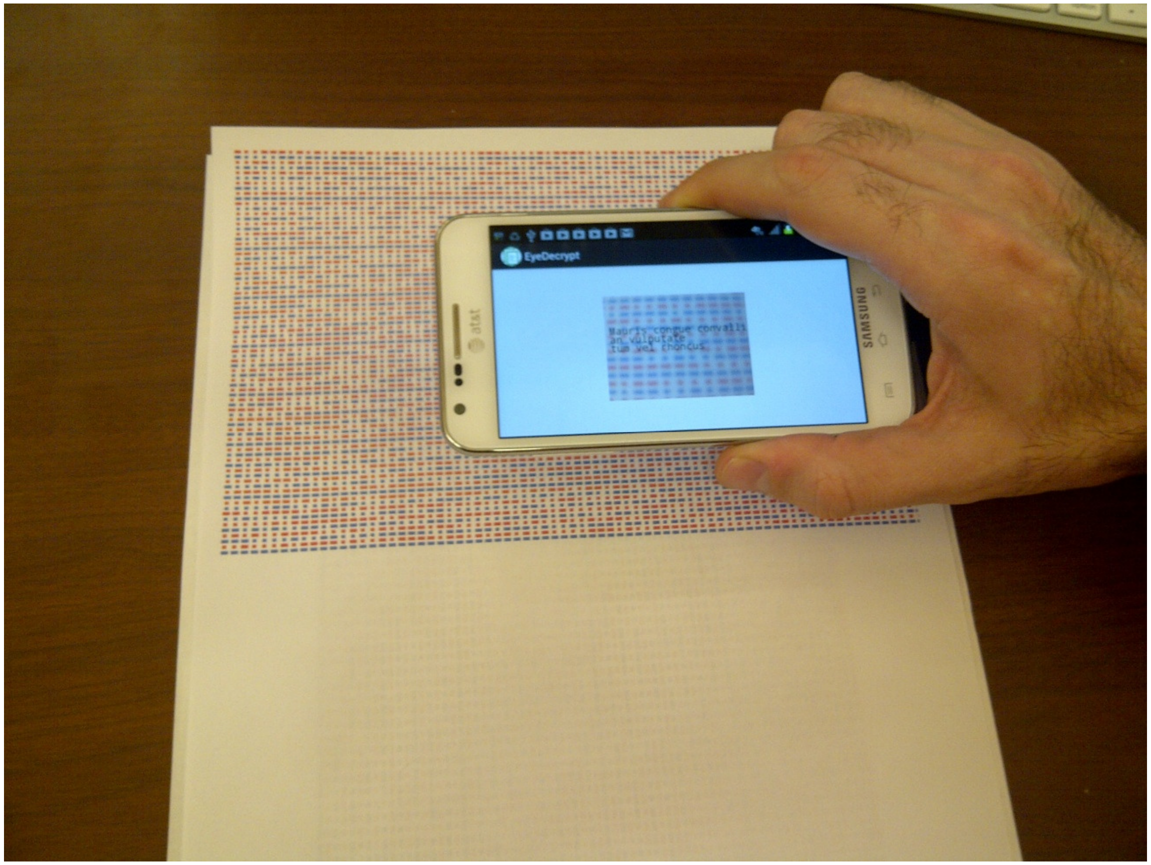
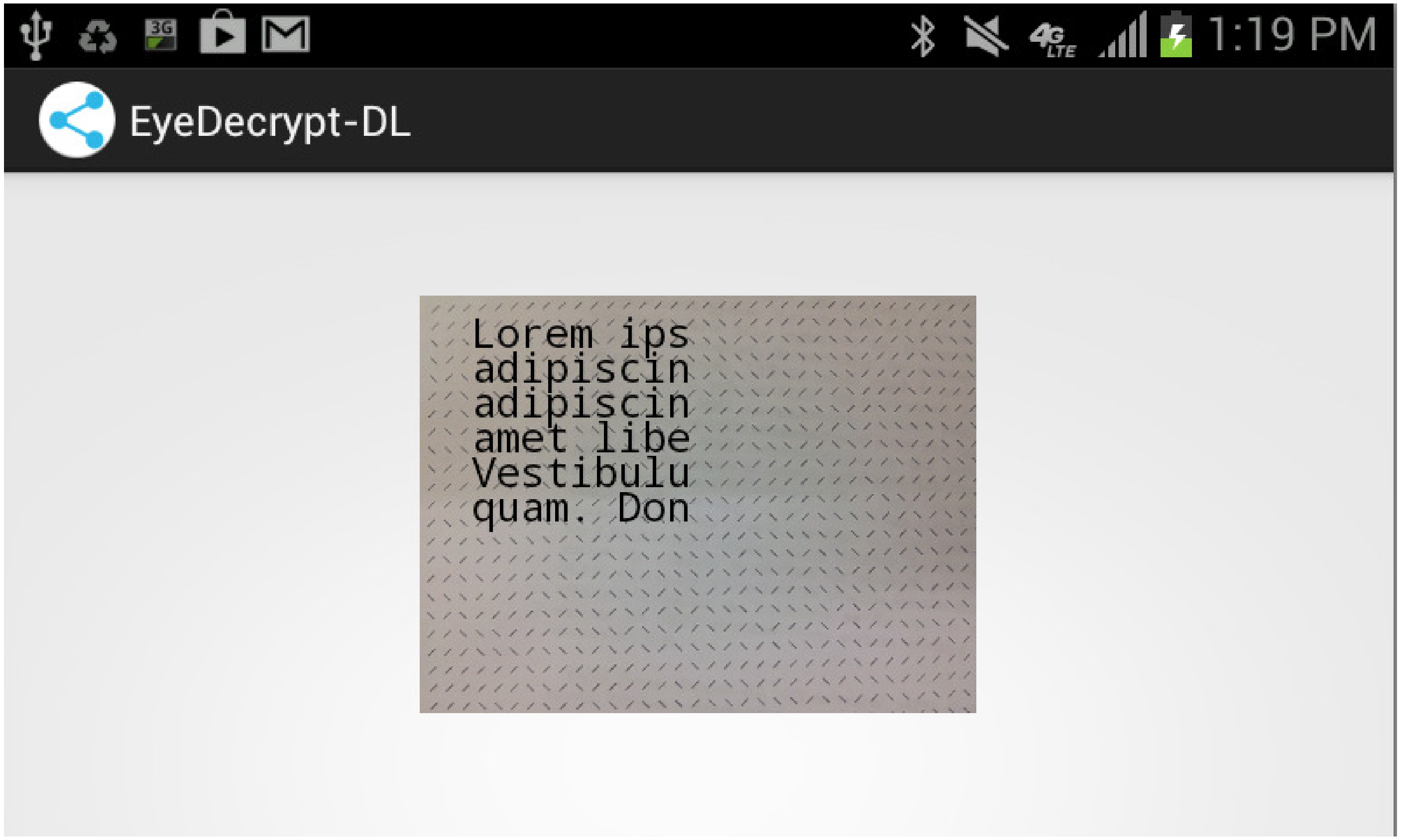


Implementation



Implementation (cont'd)



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Thanks!