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Symbol-Based Visual Cryptographic Authentication Mechanisms: Attacks and New Constructions

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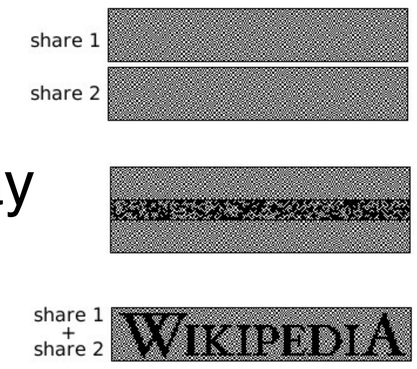
I. Visual Cryptography

- Divide each pixel into 4 sub-pixels, overlap two shares, distinguish by gray level:

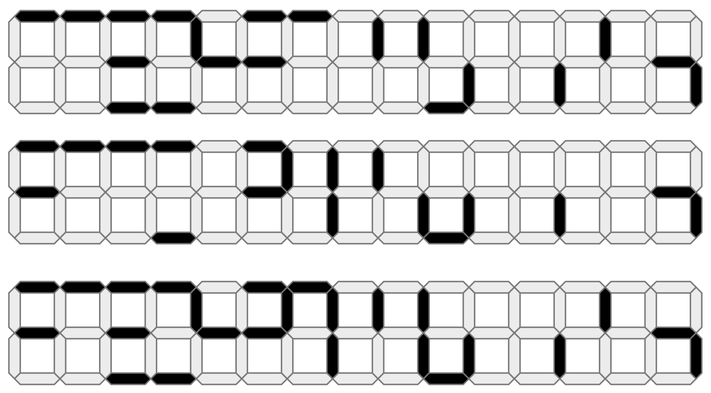
  ■ + ■ = ■ 0

  ■ + ■ = ■ 1



II. PassWindow: Symbol-Based Authentication

- Use Digits as symbols to authenticate



customer holds the secret
i.e., transparent credit card

challenge sent by server
server knows the secret

user authenticate with
response 7

Animation of 15 (4 digit and 11 noise) frames is shown in PassWindow[1].

III. Attacks

- Take a whole column (7 edges) into consideration. Model the problem theoretically.

- $X_{p,k}$, where p ranges over all positions on a frame, and k ranges over P_K, the set of all patterns that can be used on the key.
  $X_{p,k} = 1$ if and only if the key has pattern k at position p.

$$\sum_{k \in P_K} X_{p,k} = 1$$

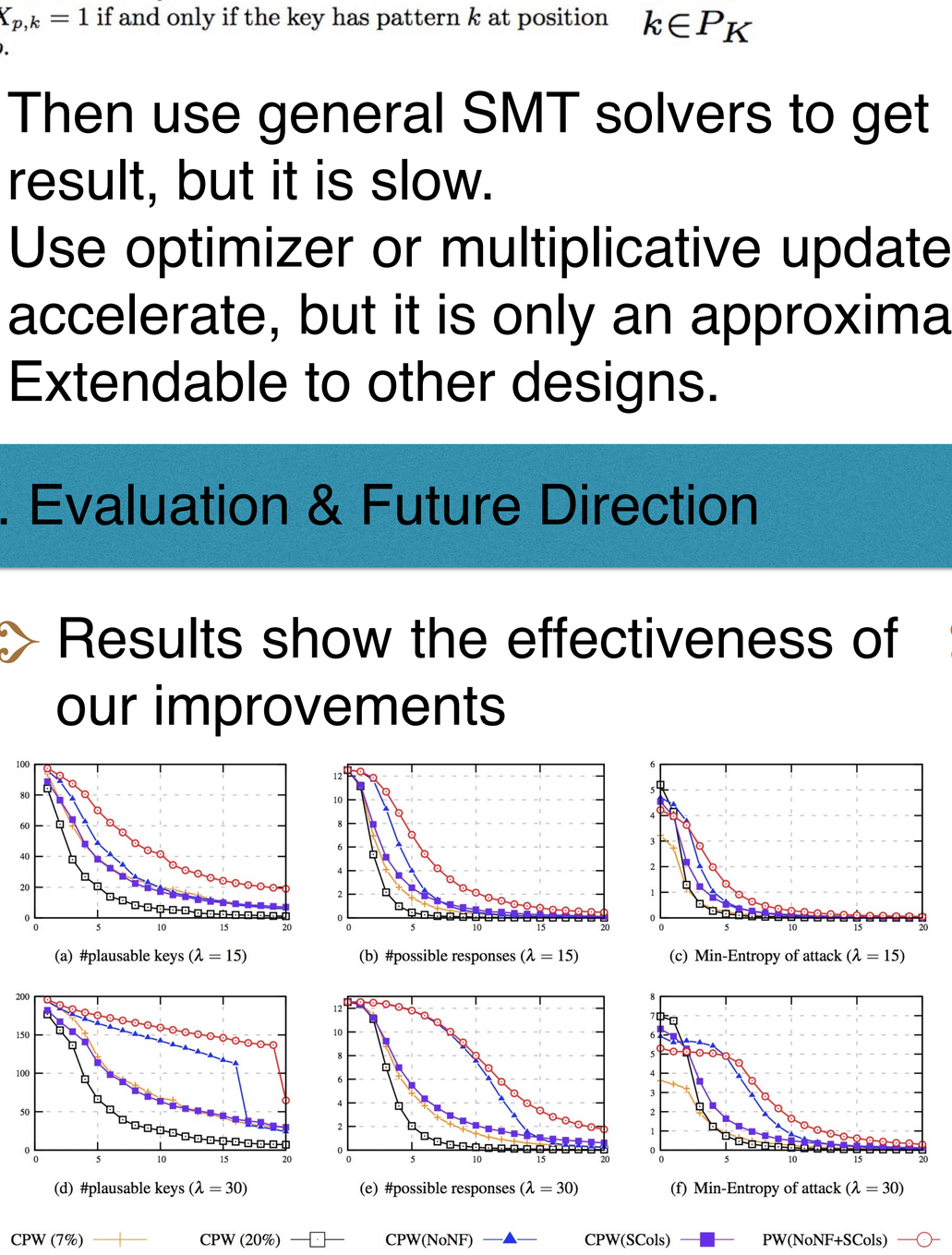
- Then use general SMT solvers to get result, but it is slow.
- Use optimizer or multiplicative update to accelerate, but it is only an approximate.
- Extendable to other designs.

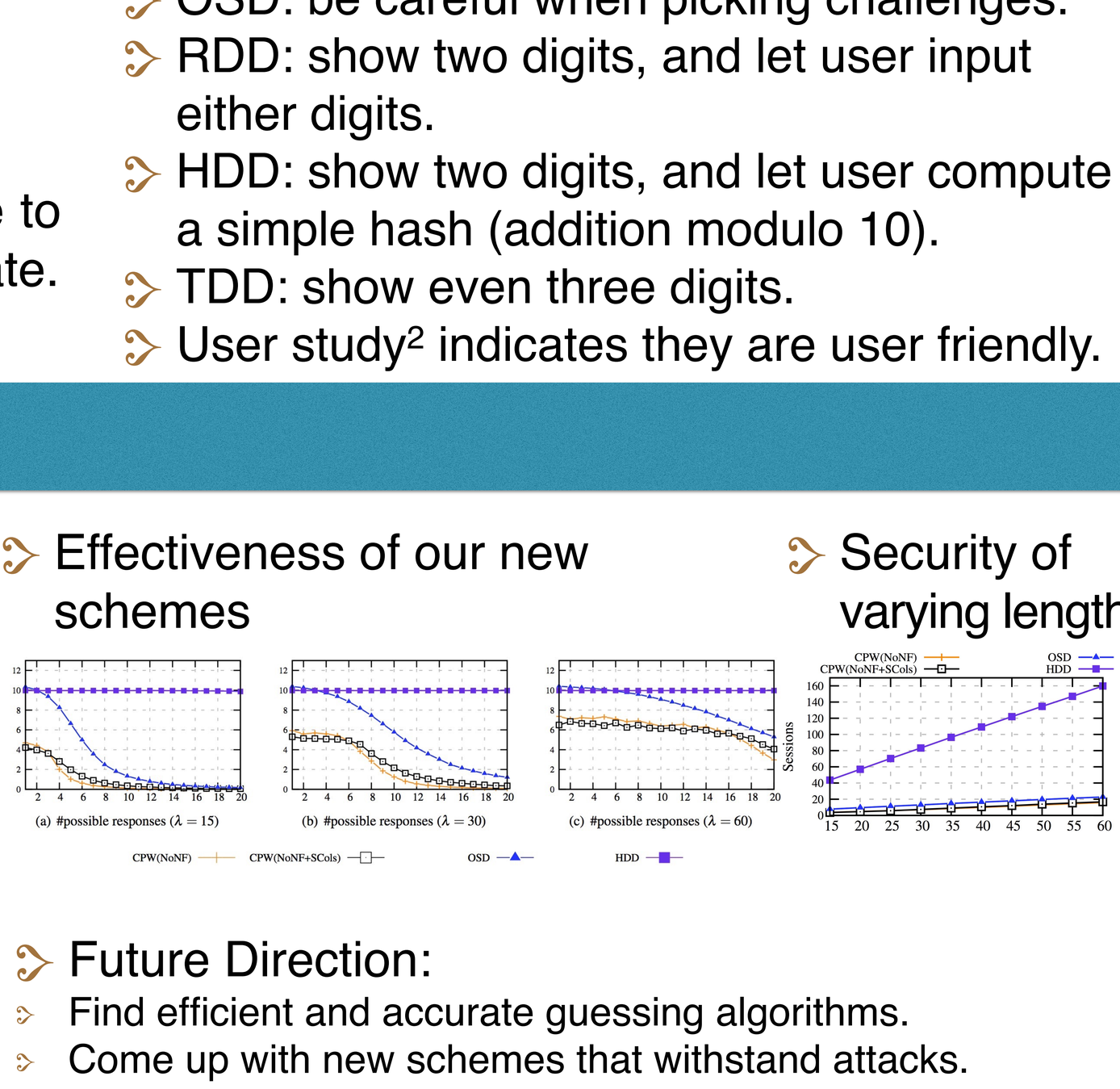
IV. New Constructions

- SCol: split columns.
- NoNF: remove noisy frames.
- OSD: be careful when picking challenges.
- RDD: show two digits, and let user input either digits.
- HDD: show two digits, and let user compute a simple hash (addition modulo 10).
- TDD: show even three digits.
- User study[2] indicates they are user friendly.

V. Evaluation & Future Direction

- Results show the effectiveness of our improvements
- Effectiveness of our new schemes
- Security of varying length





- Future Direction:
  - Find efficient and accurate guessing algorithms.
  - Come up with new schemes that withstand attacks.
  - Take advantage of other human solvable problems (Captcha).
  - Use it to build primitives for Physical Cryptography.

1. passwindow.com
2. dunes.cs.purdue.edu/wang2842/pass_window_survey/index.php

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