Machine Readability
and
Automation of Holographic Authentication

International Conference

Asian Anti-counterfeiting Association

Shenzhen, China, 2007

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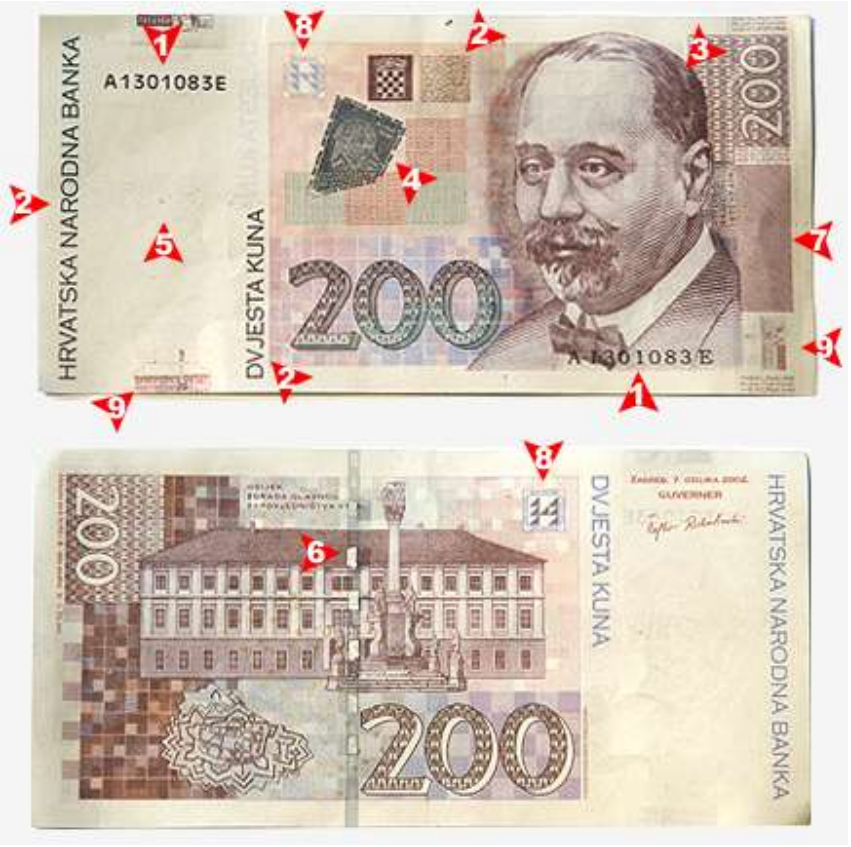
Counterfeiting **is a global menace….**



Security against counterfeiting

should start with the basic assumption that ….

Anything manmade can be counterfeited !

….and it has reached such a stage that…

Even God made

***objects are counterfeited* !!!**

Digital imaging and processing….

Modern digital tools see images as color or monochrome dots and easily copy, scan, or capture…., process and print.....

Counterfeiting / forgery made easy….

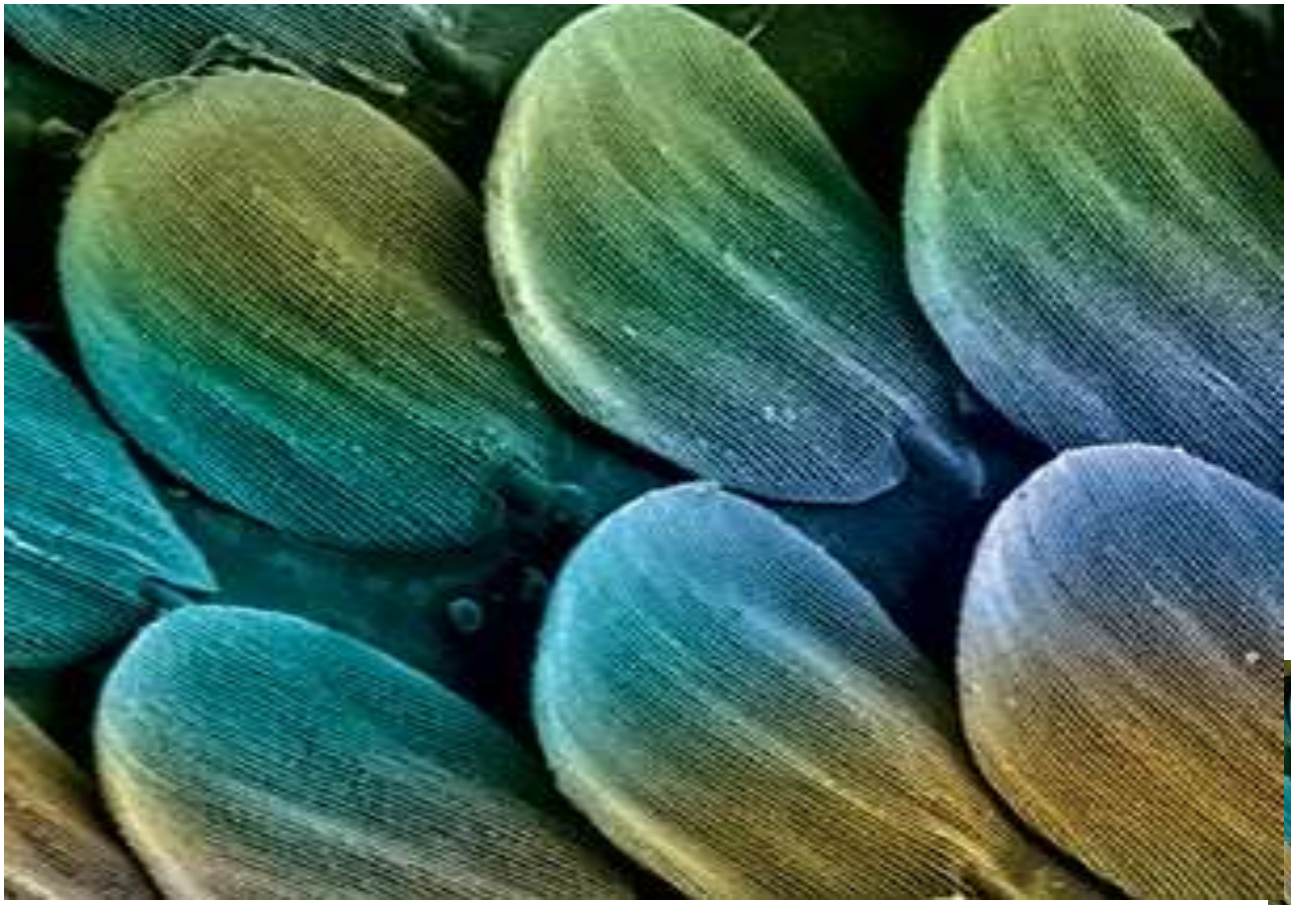
The good old sanctity of photographic evidence was lost !!!

During the first half of the 80s….

Security Holography evolved as an effective tool to fight against counterfeiting and forgery.

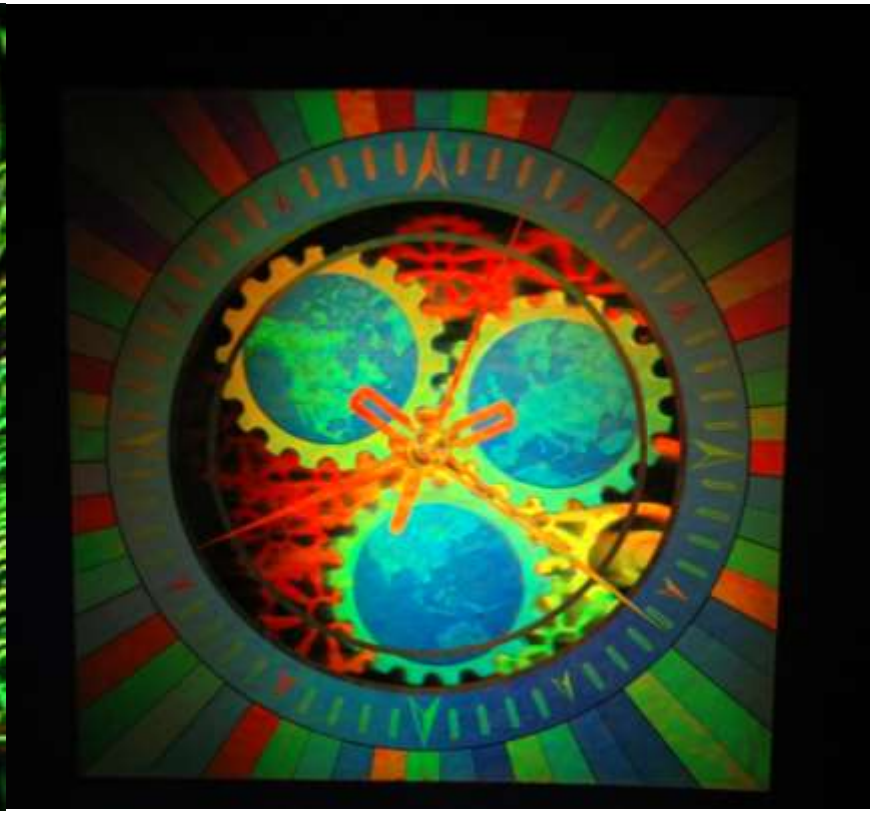
Man on Mother Nature's Trail

Diffracting structures with Specific order



Diffracting structures with Specific order

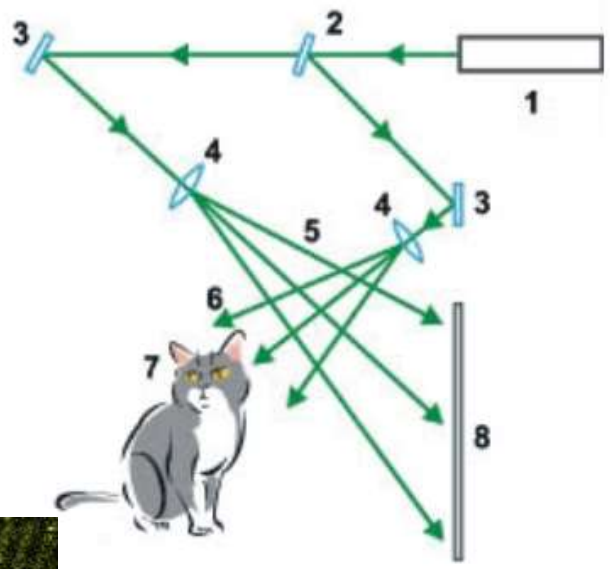
Man on Mother Nature's Trail…



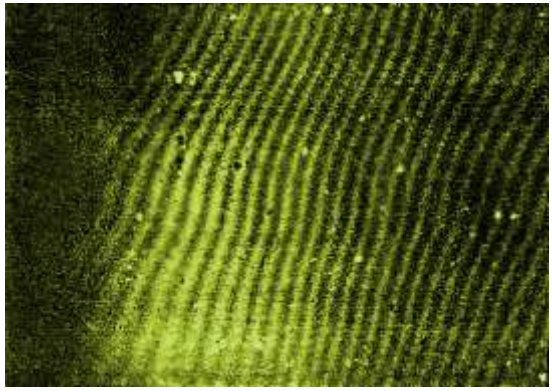
A Hologram……

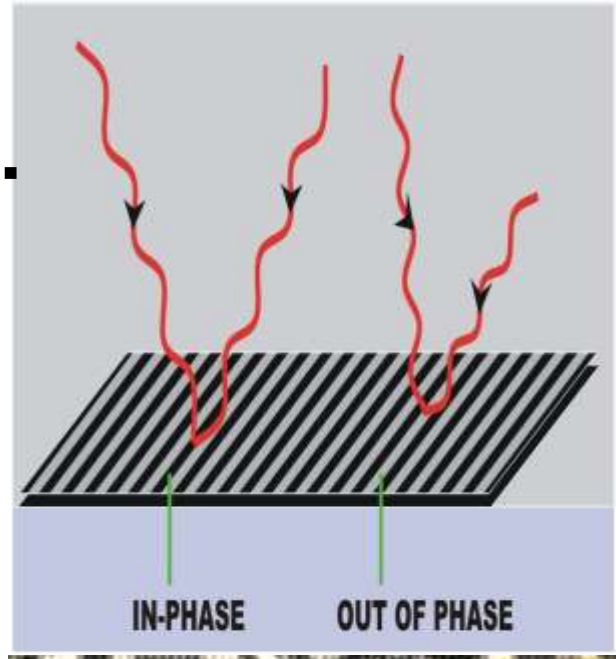
is a recording of a pattern formed by interference of two fields.

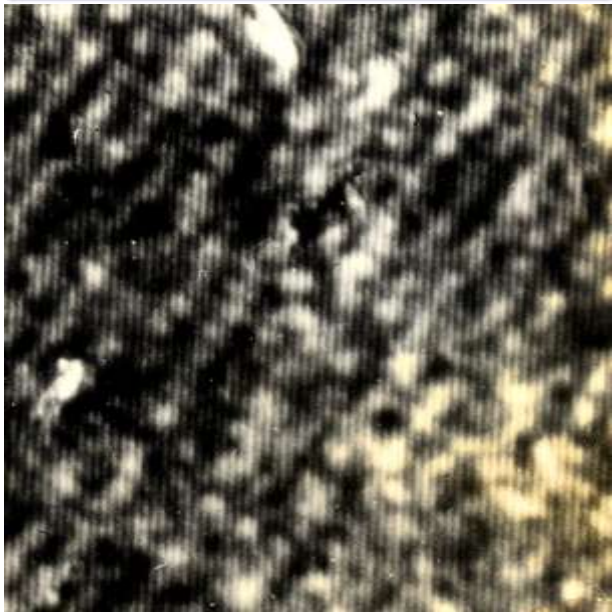
Optical Holography



1. Laser
2. BS
3. Mirror
4. Lens
5. Reference Beam
6. Object Beam
7. Object
8. Photoplate

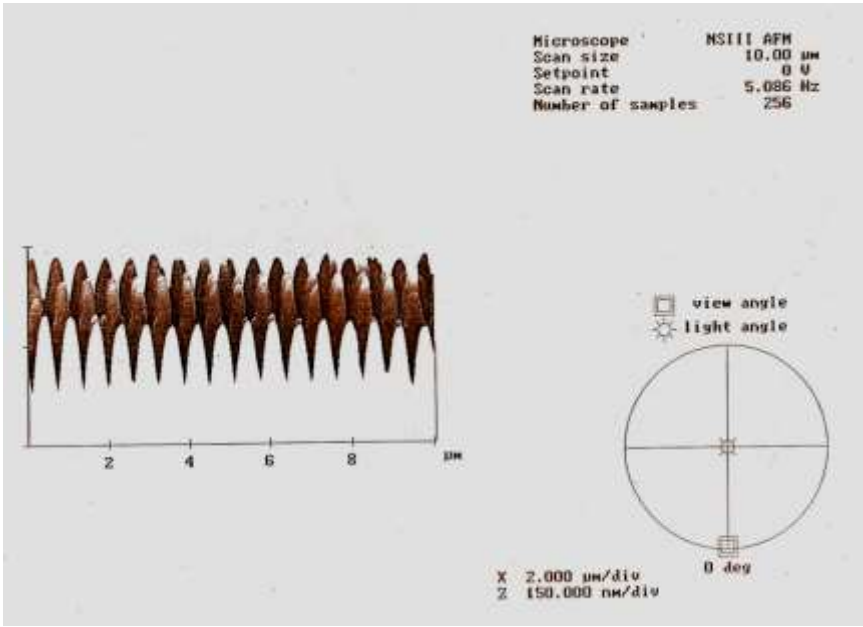


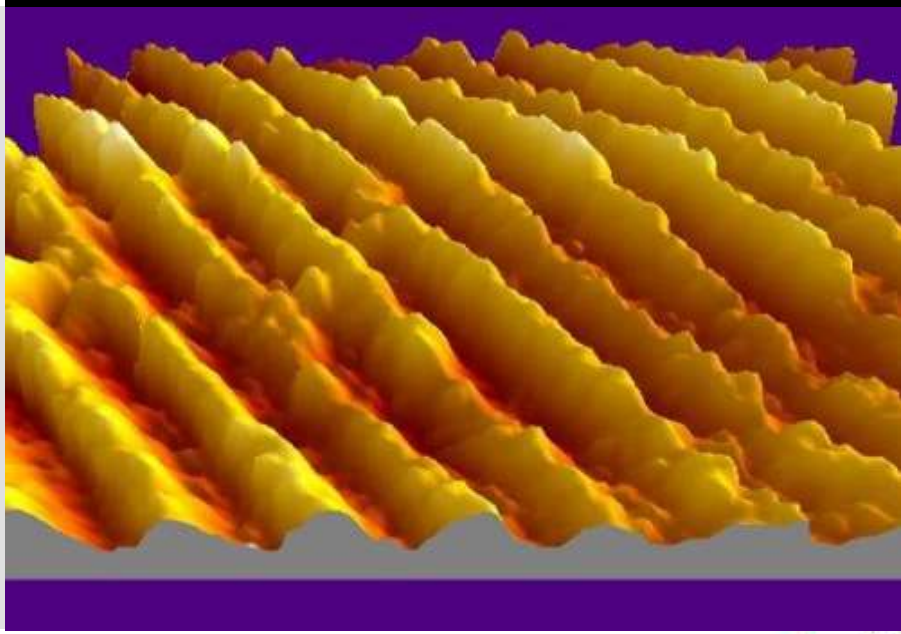




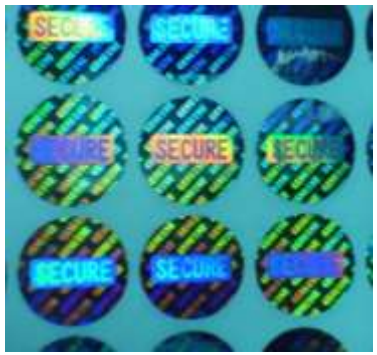
Security hologram....

is generally, a hologram with a microscopic relief structure



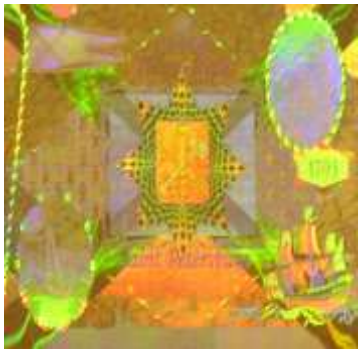


Categories

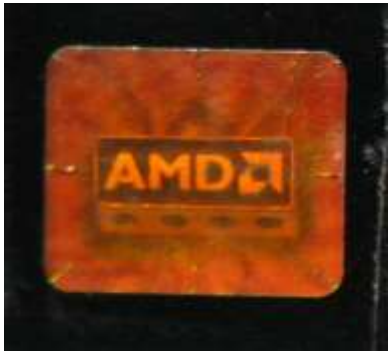


2D/**3D**

Dot-matrix



e-beam



Photopolymer

A 2D/3D Mastering

- **2D Layers** of Images are Superposed at Different Depth to **form a 3D** Structure.
- **Specific Colors** are **Assigned**

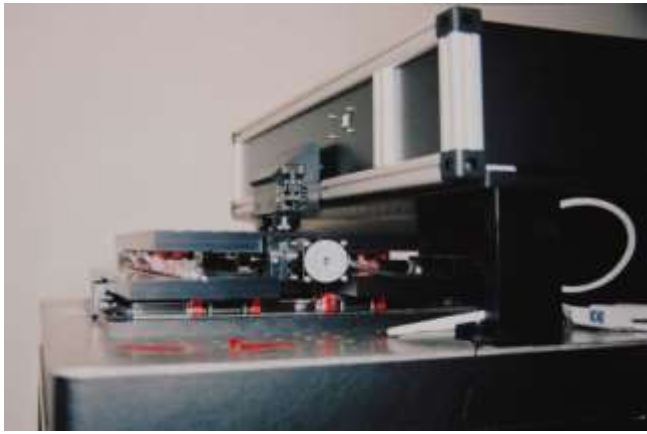
2D/3D Hologram

- **Security Depends lot on the Design and the Skill of the Holographer.**

Image-matrix System

Creates complex relief structures

Creates identical structures if repeated



Dot-matrix holograms

- **Security depends mainly on the integrity of the origination company.**

E-beam origination

- **Very Complex Patterns with High Resolution**
- **Less number of Players**

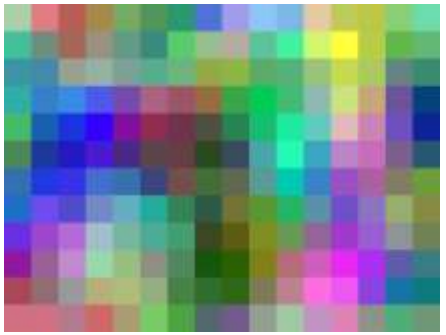
Complex content in e-beam holograms

- **Security depends mainly on the integrity of the origination company.**

Why security holograms ?

Very attractive and efficient security device

Security value….



- **Difficult to copy by conventional digital tools**
- **Virtually impossible to duplicate, even by the originator**
- **Image formation through diffraction.**

Reality….

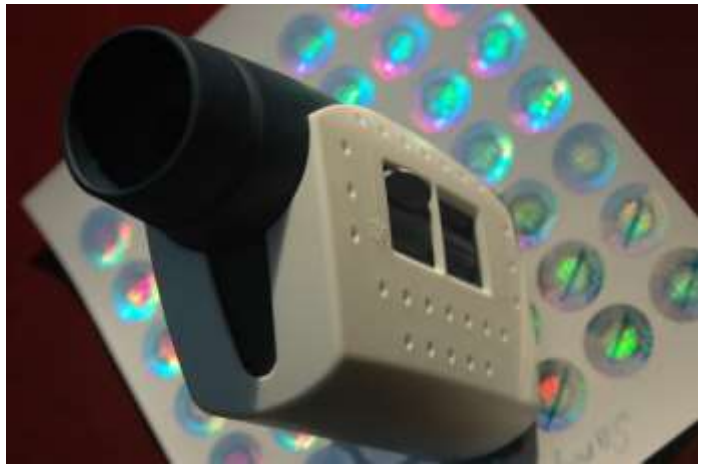
- Authentication is not simple
- End users are not trained
- Features can not be advertised
- Overt Features alone does not Authenticate

- There are look alike holograms
- Clients / Customers are confused
- There is doubt about the efficacy of holography
- Needs Experts and Special tools for Authentication.

Authentication

- Client / end user – Visual Inspection - **Primary**
- End User / client – Reference Hologram - **Intermediate Reading Devices**
- Expert – Specialized Tools - **Third Level**

Intermediate Systems

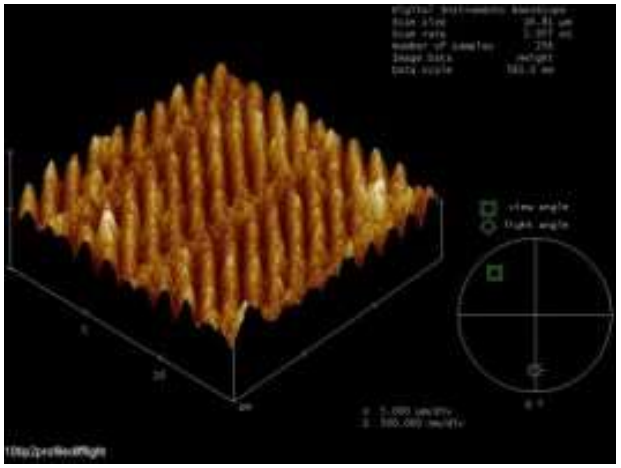


Machine Readability

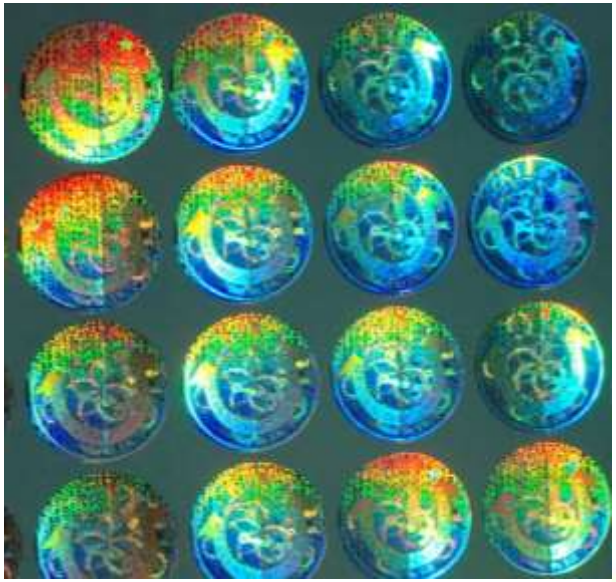
- **Features Need not to be Disclosed to the End User**
- **Yet, should be Verified**
- **Has to be Quick**
- **Reliable**
- **Expert Verification only if Machine Rejects.**

True Reader

- **Physical Structure Based**



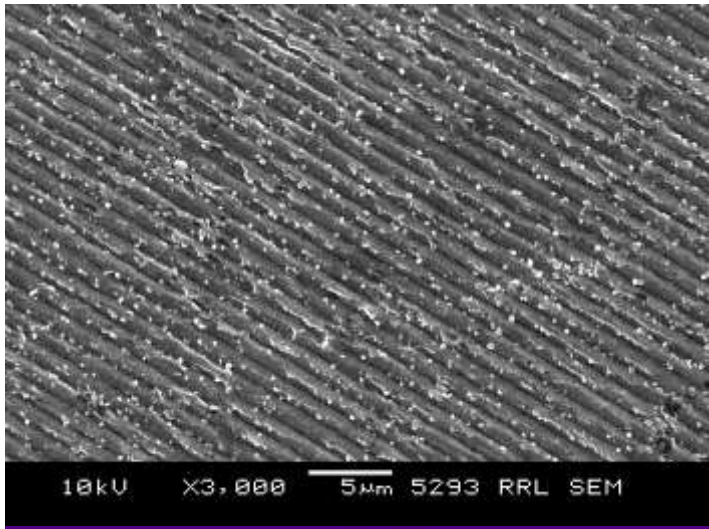
- **Wavefront Based**

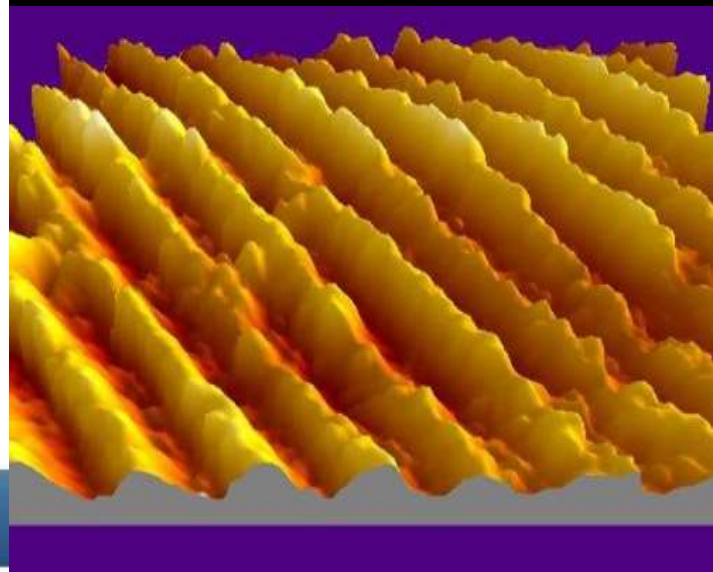


Physical Structure Based

- **A High Resolution Microscope can be used to image the structure of the hologram**

- **Even an AFM can be applied.**





Ideal Situation

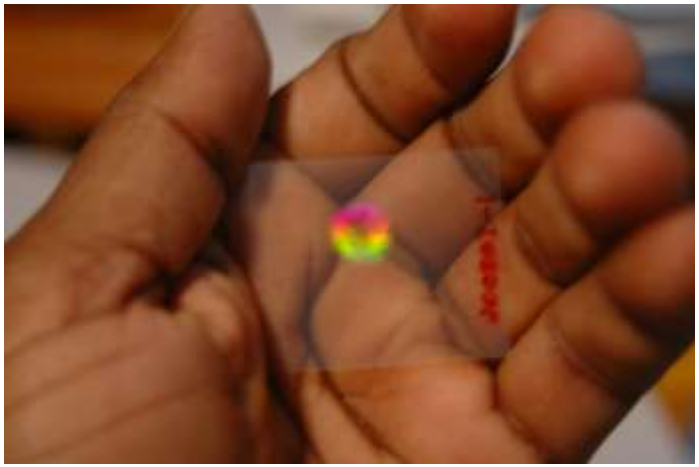
- Machine Images the Hologram
- Compares with the Reference Memory
- Result – **Original** / **Counterfeit**

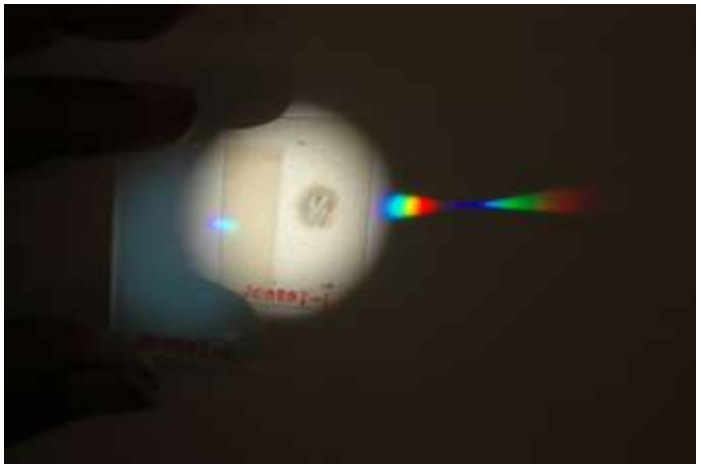
But…., not easy !

- **A high resolution hologram can hold about 200,000 spatial information per inch (8000 lines /mm).**
- **A reader that can read 1000 dots per sec, takes 460 days to read a 25mm/25mm hologram**
- **A 1000 lines/mm hologram and a reader that can read 10000 dots per sec takes about 18 Hours to Read a Hologram**

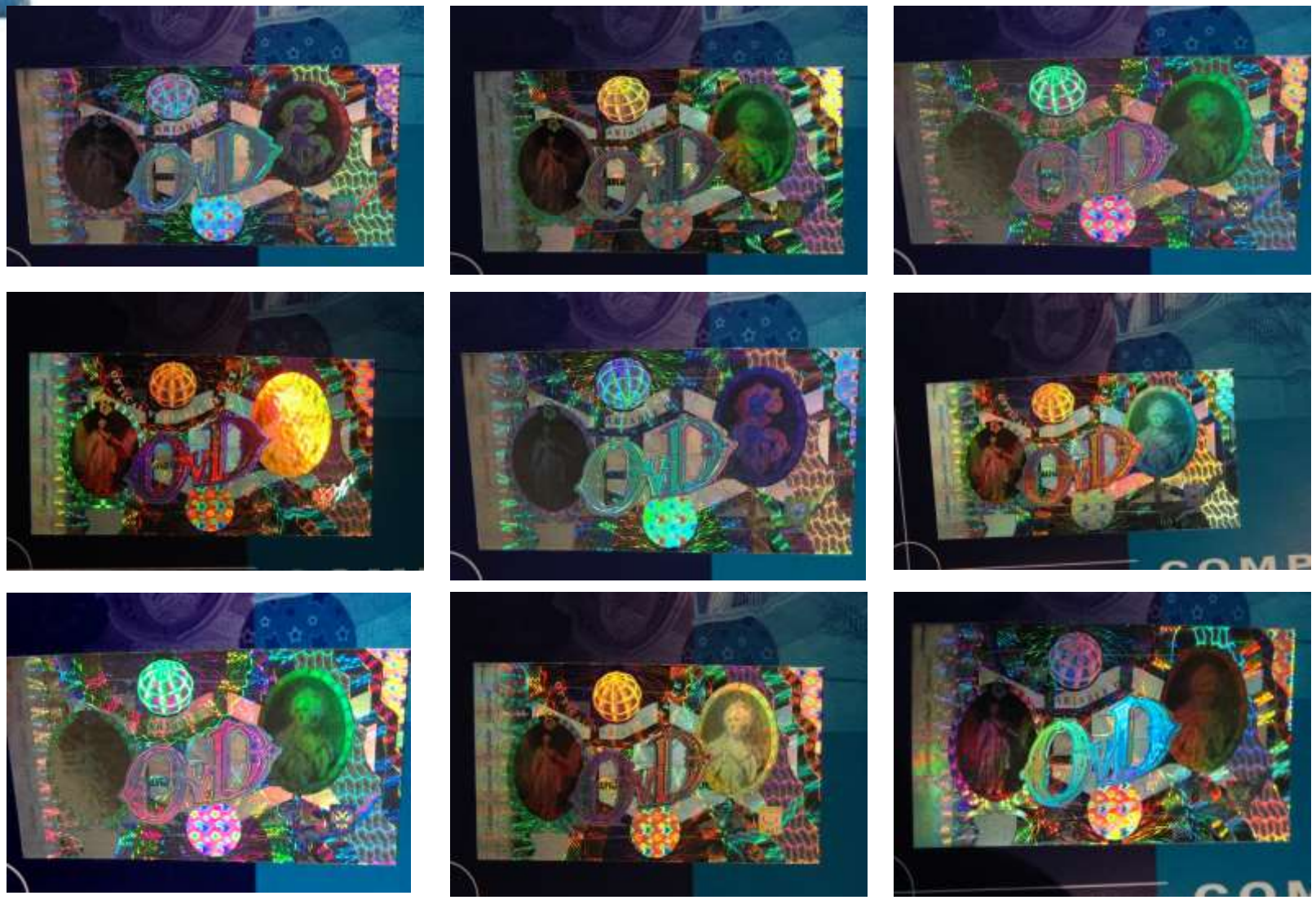
Wavefront Based

- White light is scattered by the diffracting structure and a complex wavefront that varies in color and parallax is reconstructed.
- Hence it takes much time to capture the entire light field and compare it with the reference.
- Also great positioning accuracy is needed.
- Possibility of error is more





Complex content in e-beam holograms



Universal Credit Card Hologram Reader

- with a reading accuracy of 99.99%, one innocent person out of every 10000 users will be jailed / quarantined .

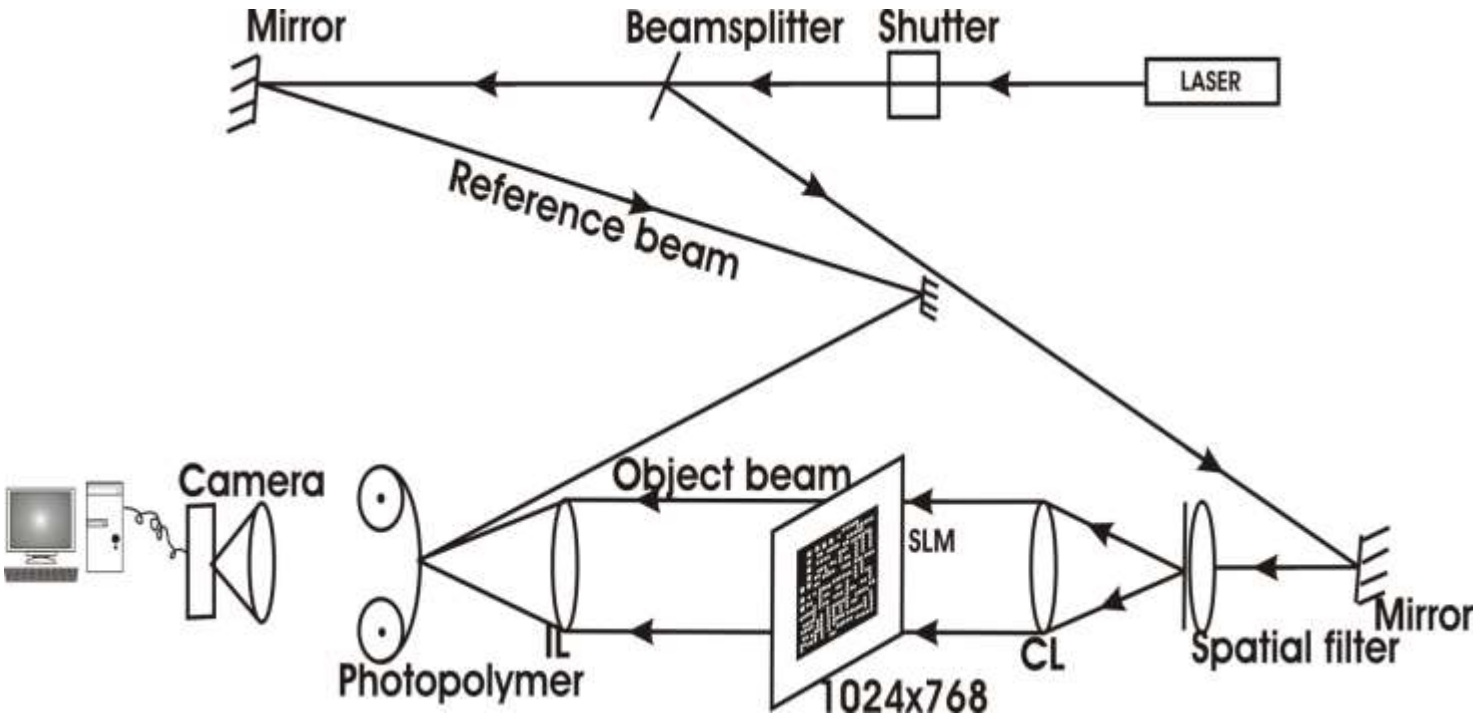
… and as on today, a universal hologram reader is not fully feasible.

Feature based Machine Reader for Primary Authentication

- No feature is revealed
- End User can Handle the Reader
- Quick
- A Variety of Methods
- Good Reliability
- Possibility of Applying Various Emerging Developments in IT and Photonics for Secure coding and Reading.

Entry Level Feature Readers

Machine Readable Hologram Writing …an example.



Photopolymer Based Writing

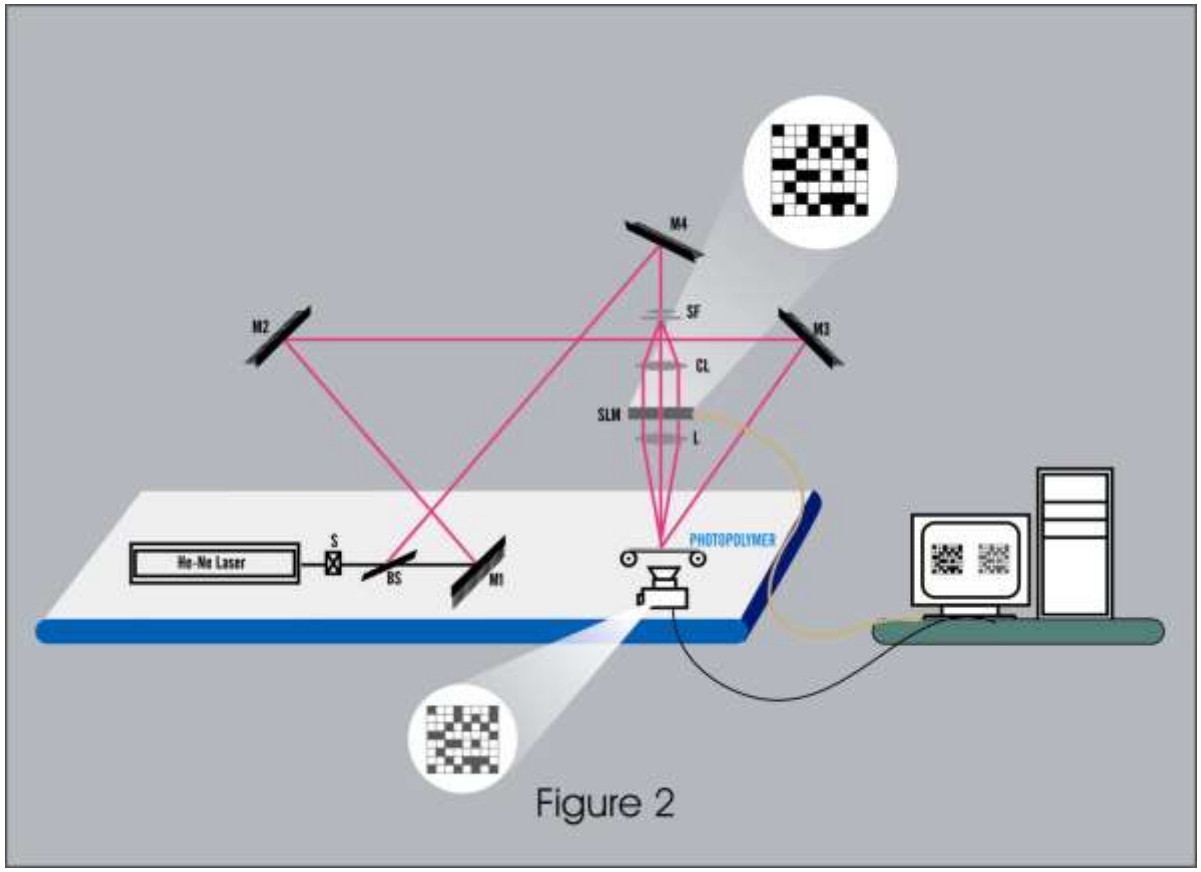
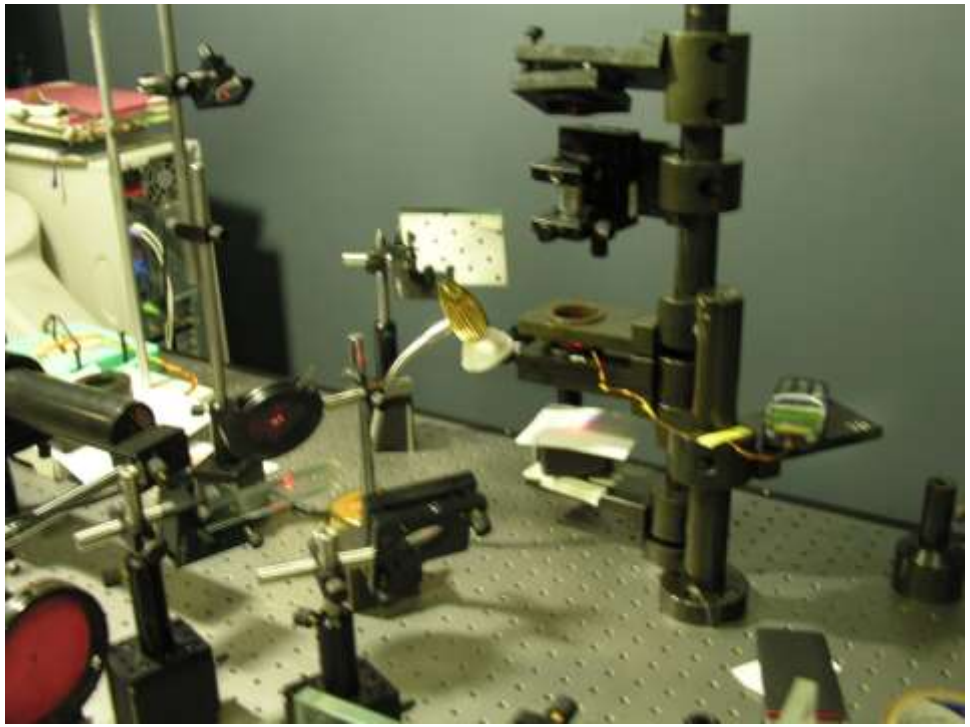
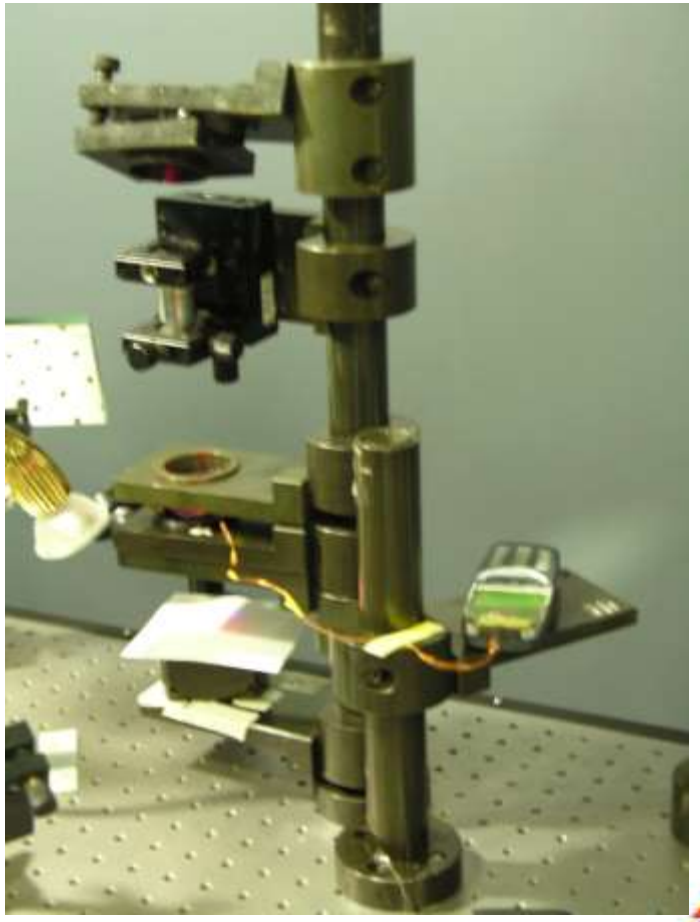


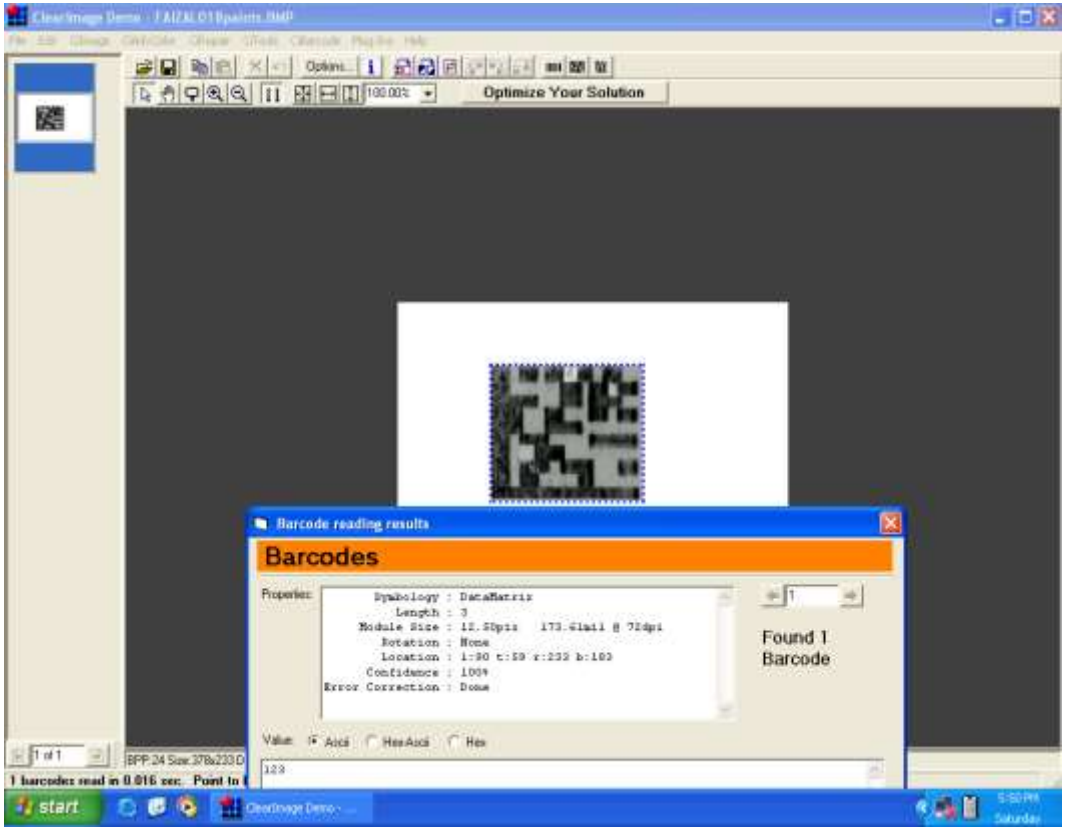
Figure 2

Laboratory System





Hologram Verification
Screen capture

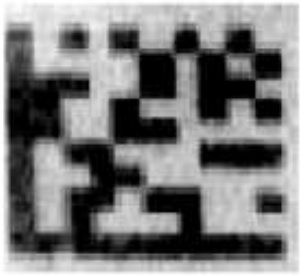


Results

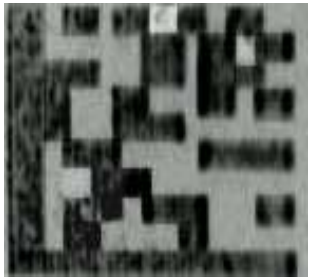
Data matrix Variable data Modulation

- Serial number 123

- Data modulated signal wave

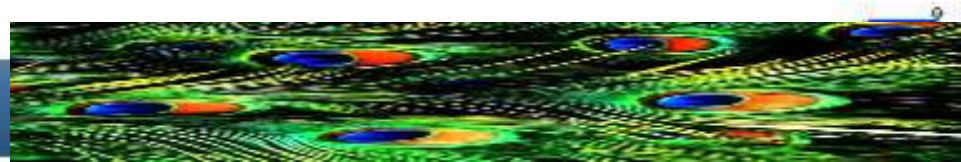


- Processed PP reconstruction

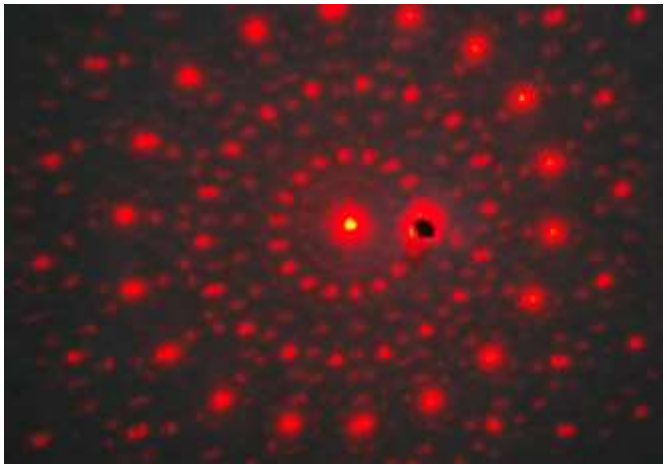


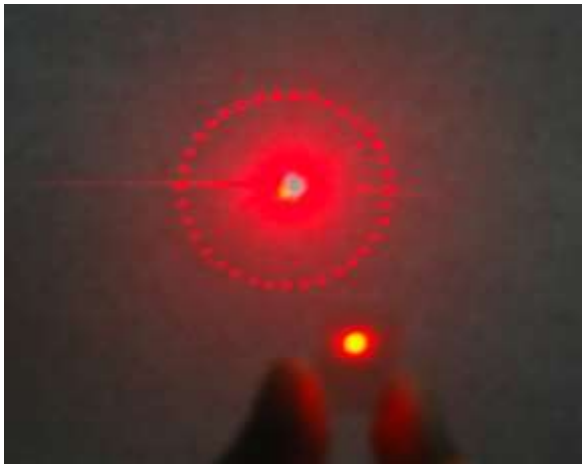
Phase Mask

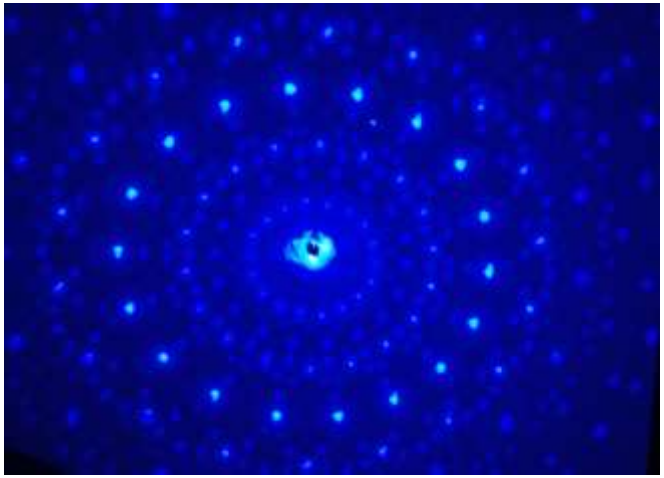
- Spatially Random Phase Modulation
- Interferometric Features can also be used



2D Photonic Crystal Based

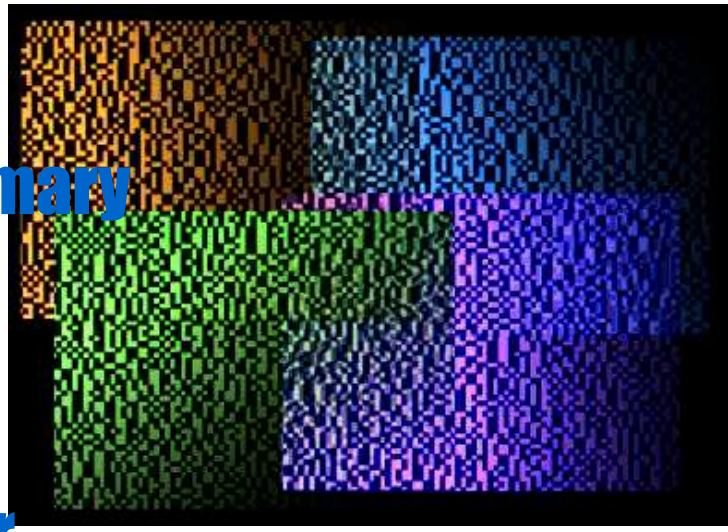






To Conclude....

- A Variety of Feature Based Hologram Readers can be Developed.
- Facilitates Effective and Secure Primary Authentication of Holograms.
- Much Less Error Rate and Faster than the Universal Hologram Reader.
- Possibility of Data Encryption and Added Security.




THANKS