SMART LOCK SYSTEM

AI powered FSM based lock

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About

- A lock system that has two levels of security.
- First, Face Recognition to decide whether the person is authorised to open the lock
- Second, A pin system, which unlocks only on entering the right pin.

Motivation

- Locks are very essential for safeguarding valuables and protection against intruders.

- The Smart lock design implemented here uses two step validation method to allow access.

- Inspired by Machine Learning – IoT (Internet of Things) based applications.
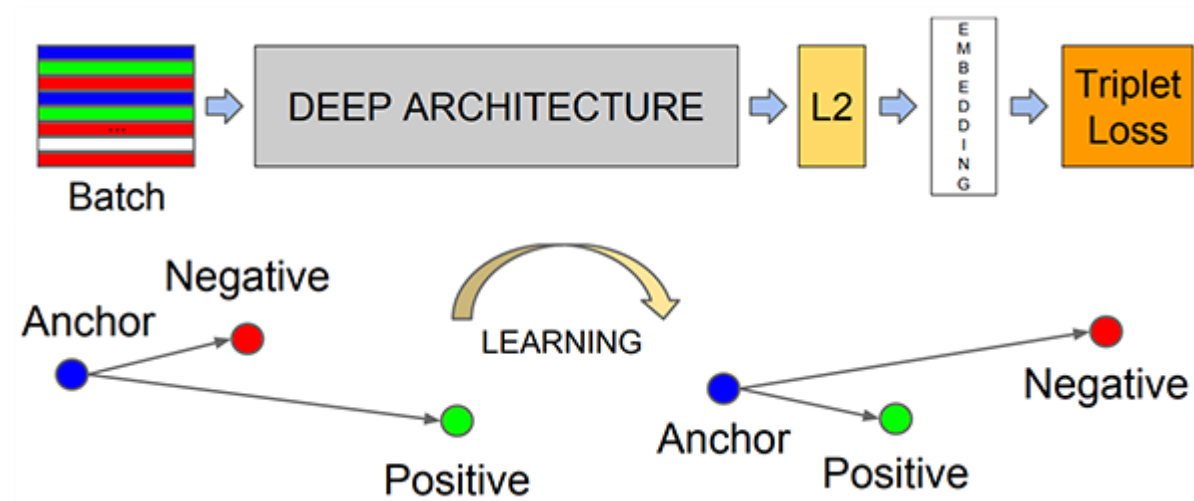
Model Blueprint
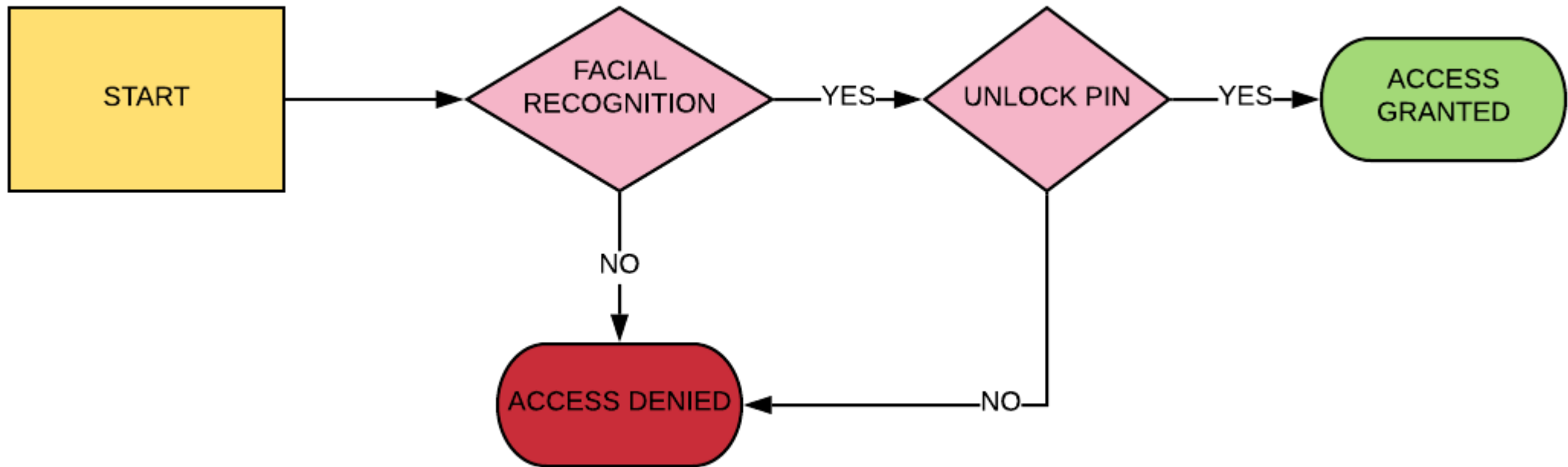
IMPLEMENTATION

- Software:-
  - Face Recognition – OpenCV, Keras (Tensorflow)
  - PIN Checking – FSM (Moore Machine) – in Verilog
- Hardware:-
  - Raspberry Pi
  - Raspberry Pi Camera
  - Solenoid Lock
  - External DC power source
  - Jumper wires

SOFTWARE IMPLEMENTATION

- 1) FACE RECOGNITION

Training – Done to reduce the Triplet Loss function. This brings the embedding vectors of similar faces close to each other.

Evaluation -
The Neural Network Model generates a 128 – Dimensional embedding for each face. It checks this with the embeddings to find to which it is closest to.

SOFTWARE IMPLEMENTATION - Continued

- 2) Lock Pin System – A Moore Machine implemented in Verilog.

Description of the FSM:-

- Inputs – The inputs to the FSM
  - Keyin – 0 or 1 value to enter the binary number to open the lock
  - Enter – To confirm after Keyin press
  - Reset – Takes back to the initial state
- Outputs – The outputs from the FSM
  - Unlock – 1 for access granted and 0 for access denied
  - Error – 1 for access denied and 0 for access granted

SOFTWARE IMPLEMENTATION - Continued

Description of the FSM - continued:-

▪ Lock_key – a n-bit binary number representing the key for unlocking

▪ Valid – A single bit number denoting if the face is recognised. 1 – face recognised, 0 – face unrecognised.

FSM – State Diagram

LOCK FSM
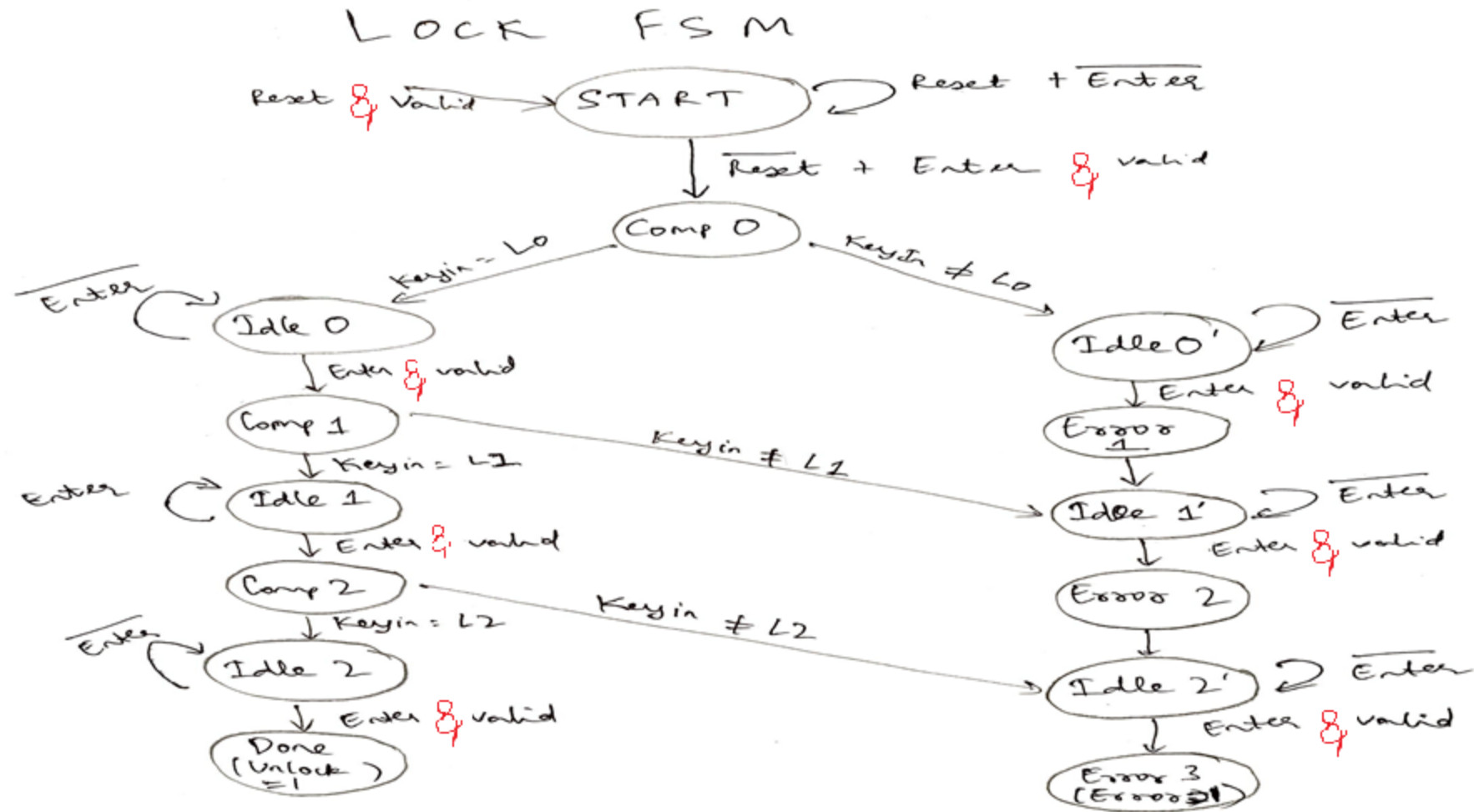
Here, Lock Key = $L2 L1 L0$ (A 3 bit lock key)

FRAMEWORK

STEPS of functioning:-
1) Camera captures the image
2) Image is authorised with the database
3) If image is present in database then "valid" = 1 else "valid"=0
4) If valid = 1 then lock keypad appears – User enters the pin and presses enter.
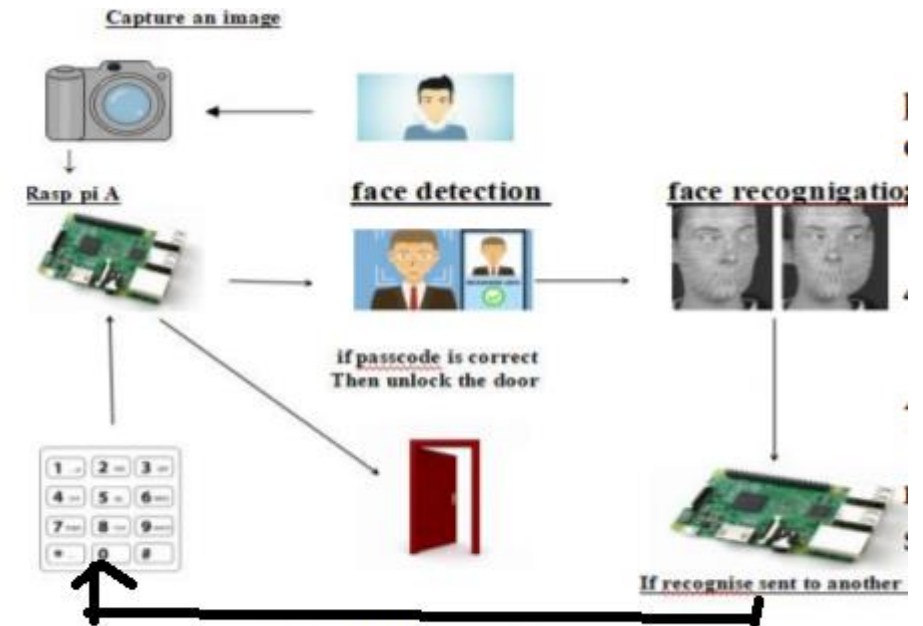5) If pin is right then access is granted.


Figure1:Framework

HARDWARE IMPLEMENTATION

- Raspberry Pi (RP) – An ARM based single board computer. It uses a open-source OS Raspbian.

- Pi CAMERA – This is a custom designed add on for RP. It makes use of CSI bus that carries data at high rates.

- Keypad – With the inputs as required by our FSM (keyin, enter, reset).

- Servo – Attached to the GPIO of the RP (powered by a 6V battery).

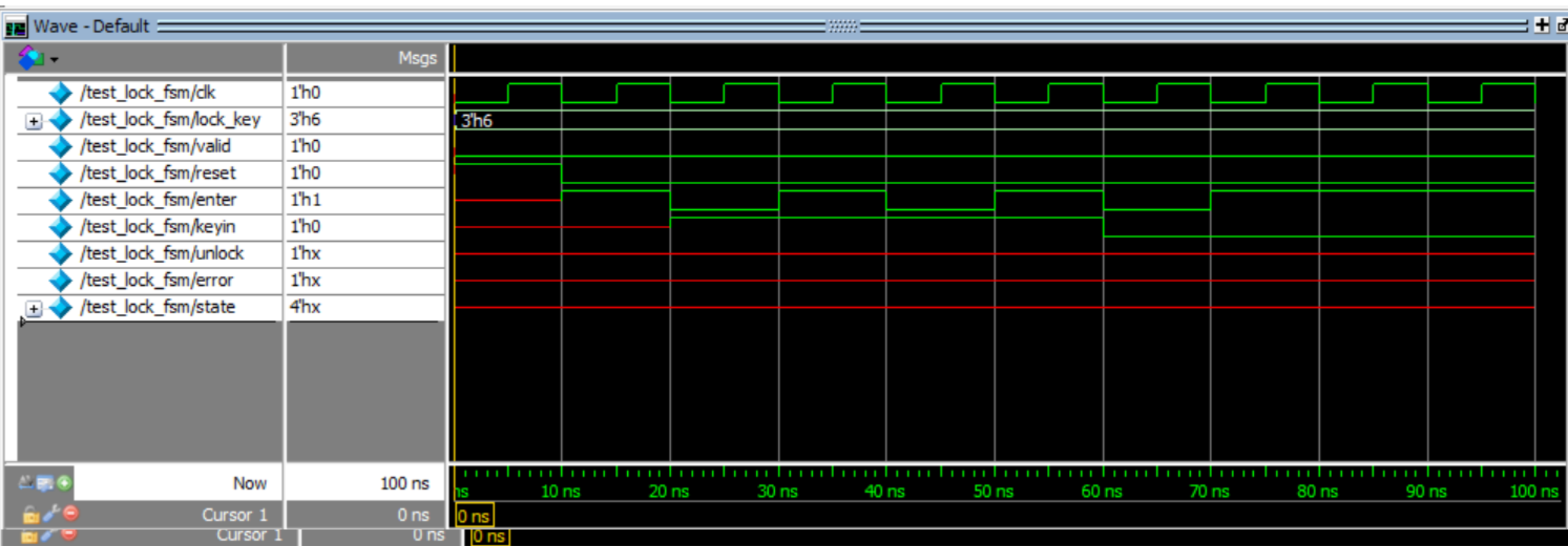# Results

- 1) Face recognition model
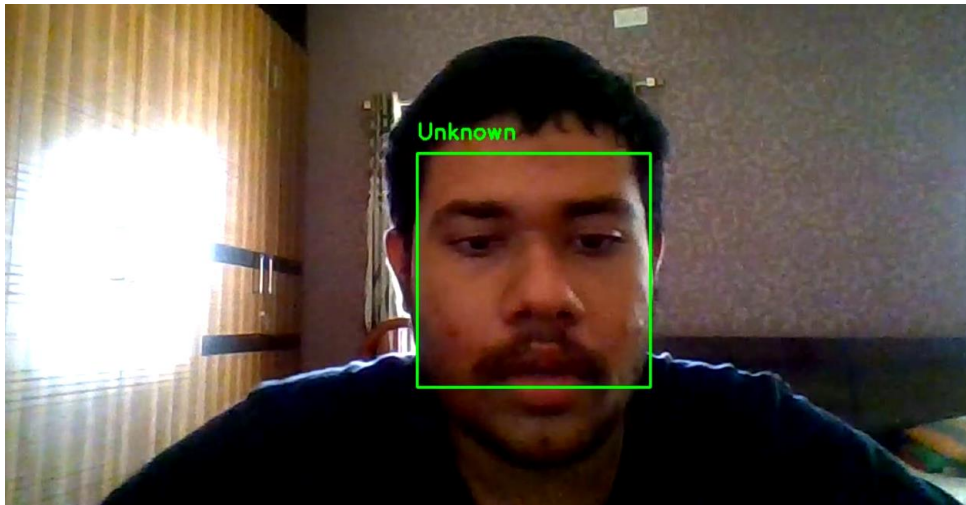
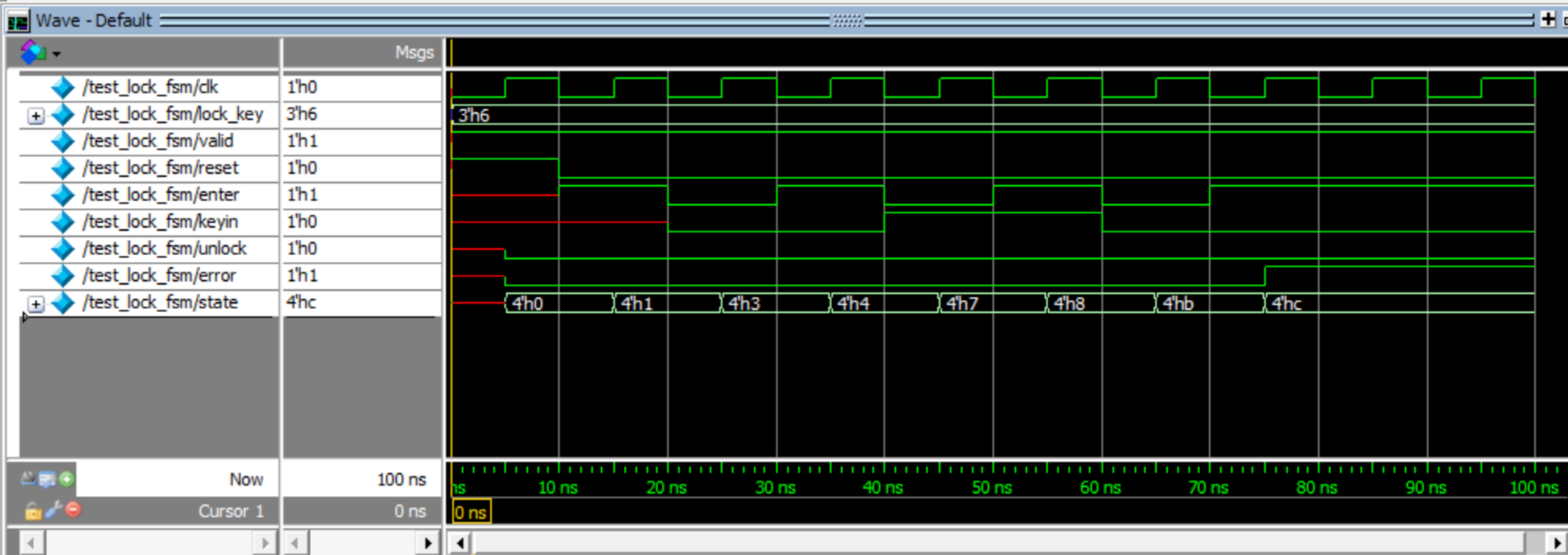Before Training – Unknown Person – Access Denied
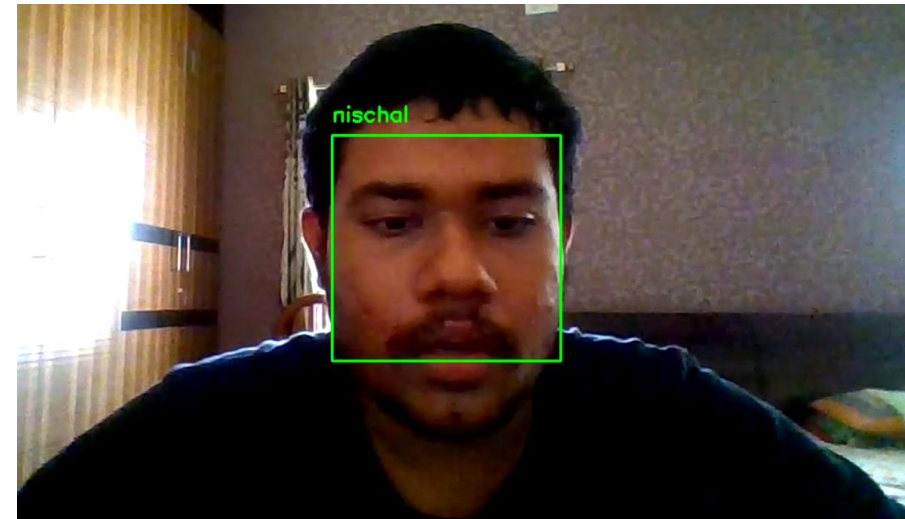
After Training – Person recognised – Access Granted for entering lock pin.
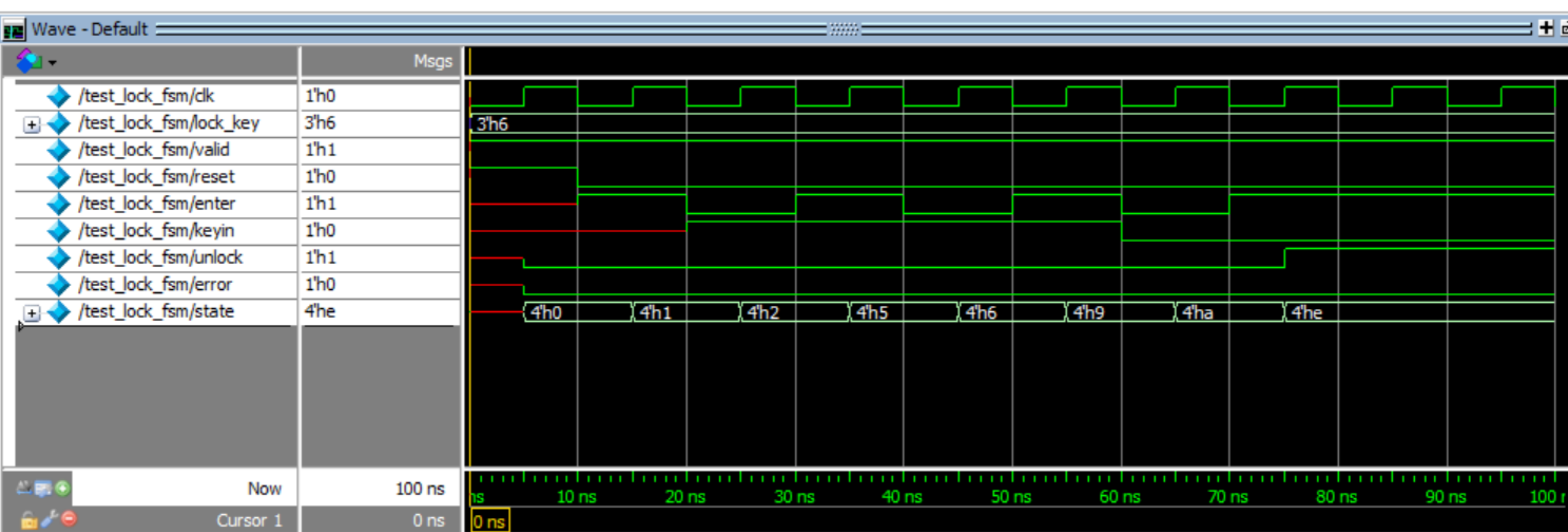
Results - Continued

Wave form when valid = 0 (face not recognised) Unlock = Don't care (Not allowed to enter pin)

Results - Continued

Wave form when valid = 1 (face recognised) and wrong pin entered - Unlock = 0 ; Error = 1 – Access Denied.

Results - Continued

Wave form when valid = 1 (face recognised) and correct pin entered – Unlock = 1 means Access Granted

APPLICATIONS

- For highly confidential safes/ wardrobes.
- In Door lock system for opening the doors of certain rooms/ main house door.

ADVANTAGES

- 2 level security (face recognition, pin entering) – For extremely confidential purposes.

- Easily implementable

- Doesn't require a bulky hardware. Easy to fit on doors and safes.

REFERENCES

- Face detection
- Overall Architecture
- FSM based lock