

SMART LOCK SYSTEM

AI powered FSM based lock

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About

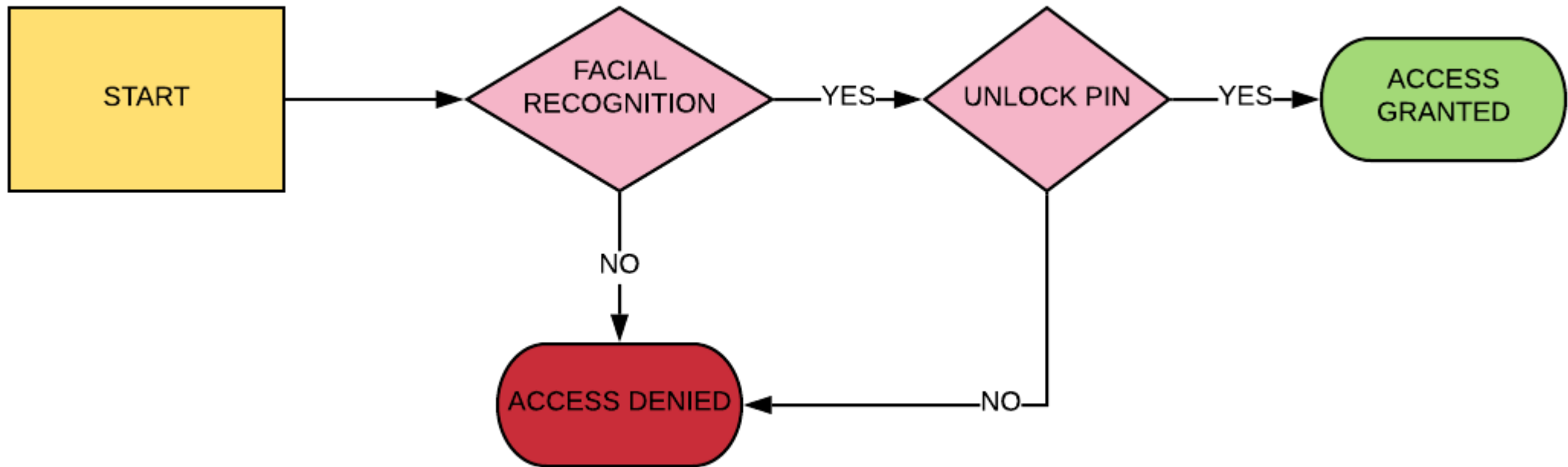
- A lock system that has two levels of security.
- First, Face Recognition to decide whether the person is authorised to open the lock
- Second, A pin system, which unlocks only on entering the right pin.



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

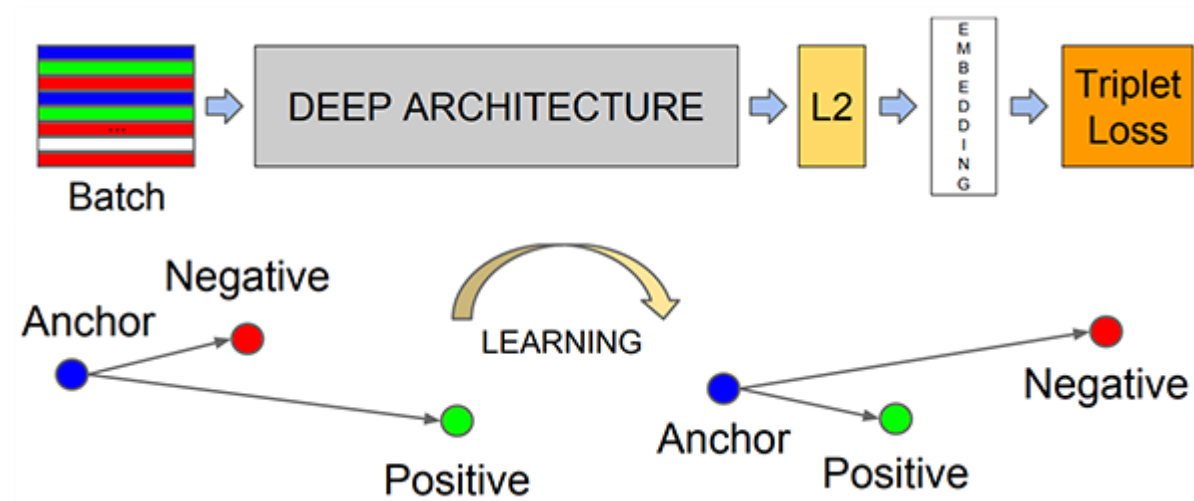


IMPLEMENTATION

- 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:-

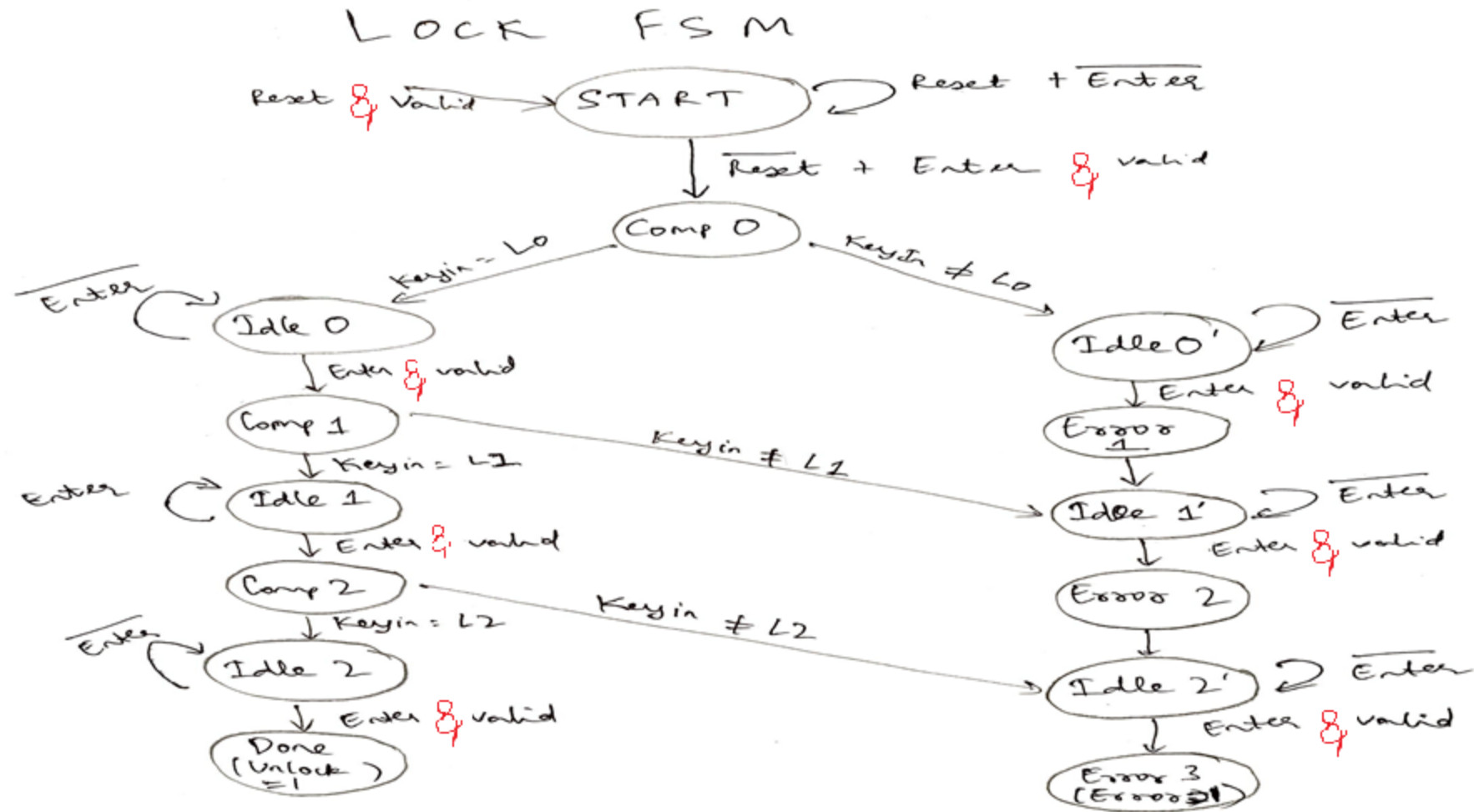
- Inputs – The inputs to the FSM
 - Keyin – 0 or 1 value to enter the binary number to open the lock
 - Enter – To confirm after Keyin press
 - Reset – Takes back to the initial state
- Outputs – The outputs from the FSM
 - Unlock – 1 for access granted and 0 for access denied
 - Error – 1 for access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



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.

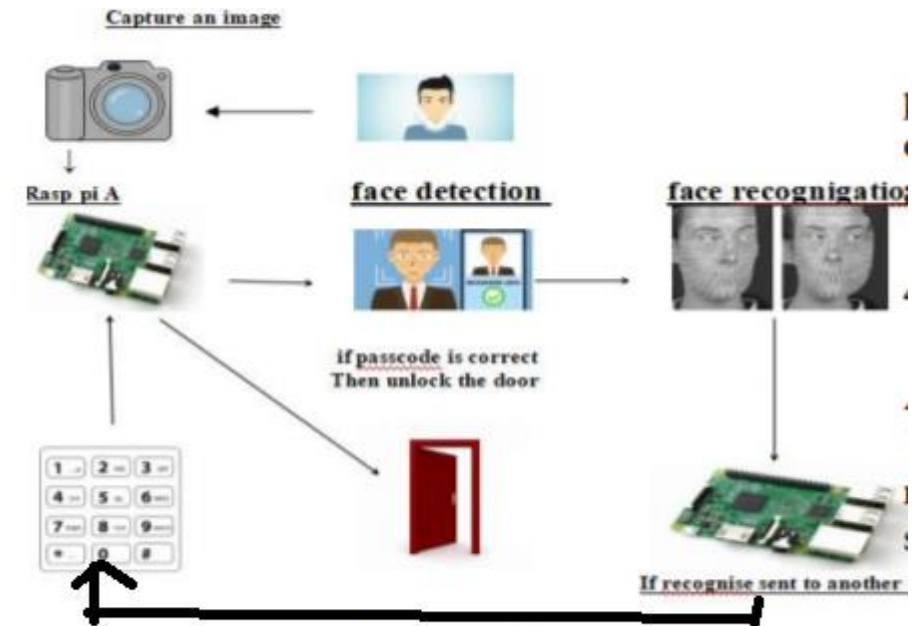


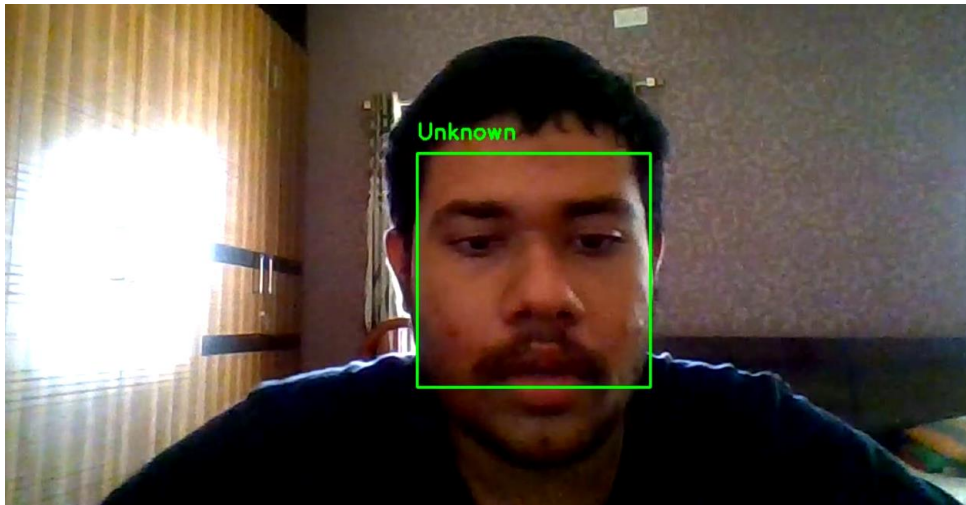
Figure 1: Framework

HARDWARE IMPLEMENTATION

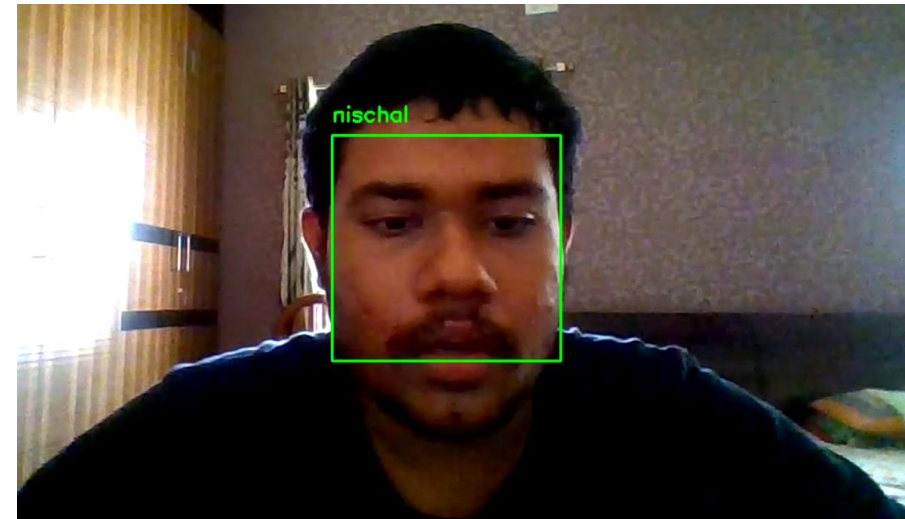
- Raspberry Pi (RP) – An ARM based single board computer. It uses a open-source OS Raspbian.
- Pi CAMERA – This is a custom designed add on for RP. It makes use of CSI bus that carries data at high rates.
- Keypad – With the inputs as required by our FSM (keyin, enter, reset).
- Servo – Attached to the GPIO of the RP (powered by a 6V battery).

Results

- 1) Face recognition model

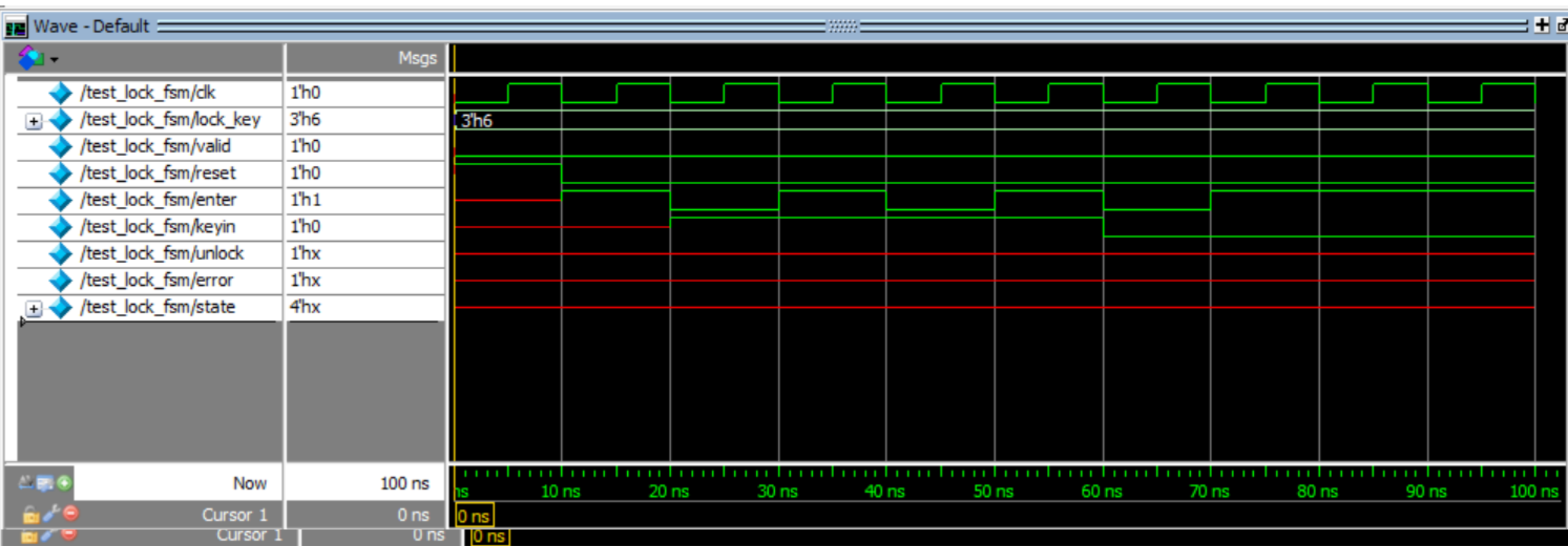


Before Training – Unknown Person – Access Denied



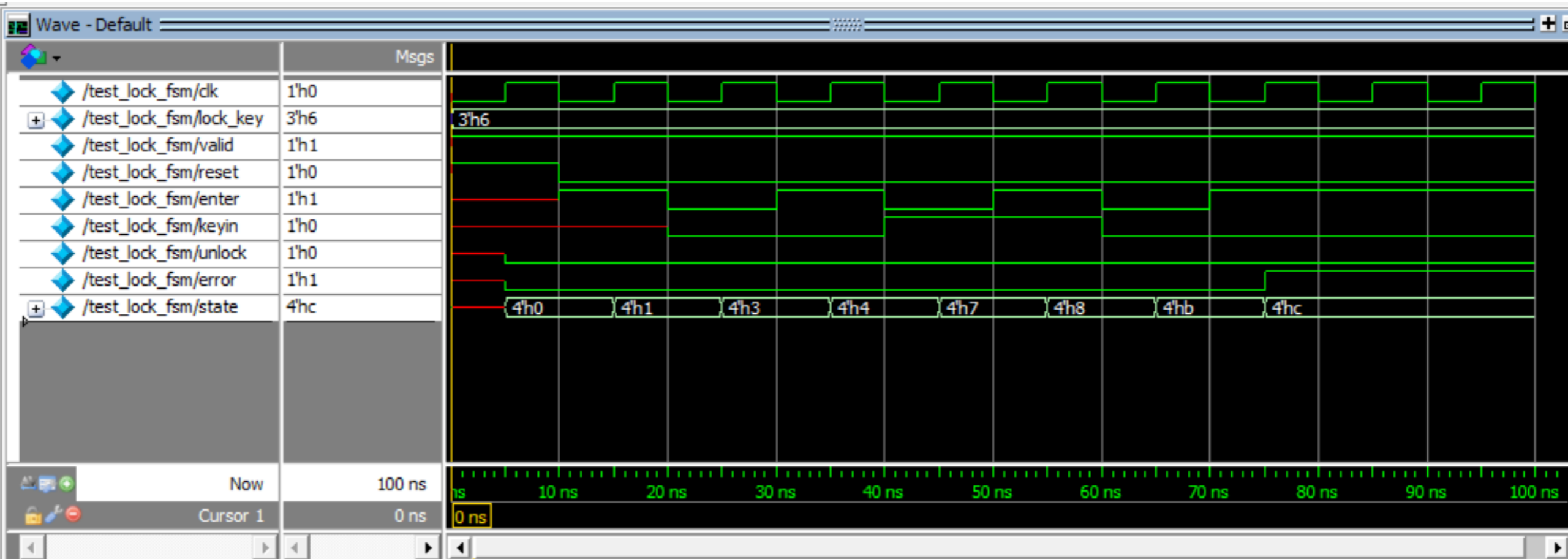
After Training – Person recognised – Access Granted for entering lock pin.

Results - Continued



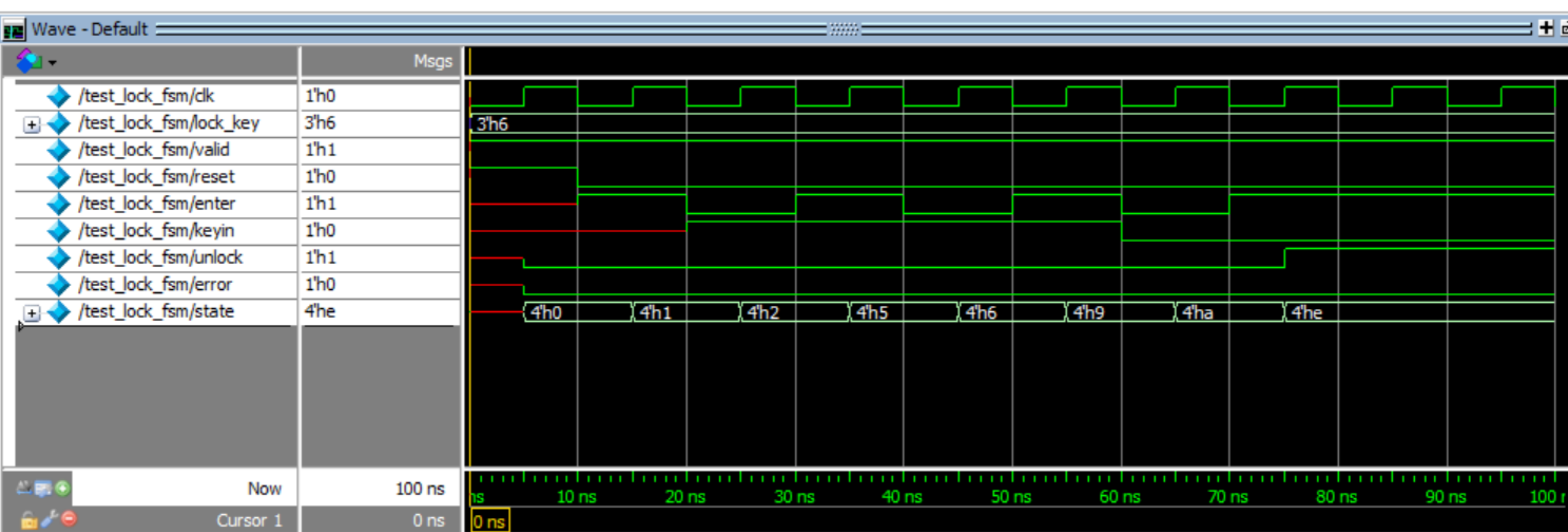
Wave form when valid = 0 (face not recognised) Unlock = Don't care (Not allowed to enter pin)

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](#)