DESIGN AND IMPLEMENTATION OF A SMART DOORBELL BASED ON FACIAL DETECTION AND IOT: AN AUTOMATED SECURITY SOLUTION FOR SMART HOMES

SVTH: Phan Đình Quý, Trương Phước Thịnh, Trần Đình Bảo - 21ES
Trần Hoàng Minh, Nguyễn Thị Tâm - 21ECE
GVHD: PhD Lê Quốc Huy
Mentor: PhD Nguyễn Huỳnh Nhật Thương

FACULTY OF ADVANCED SCIENCE AND TECHNOLOGY

INTRODUCTION

In the context of home burglaries that cause financial and emotional harm, the smart doorbell system is developed to enhance home security. This system integrates a camera, sensors, and IoT technology to monitor, detect faces, and provide real-time alerts, giving users greater peace of mind when managing their homes.

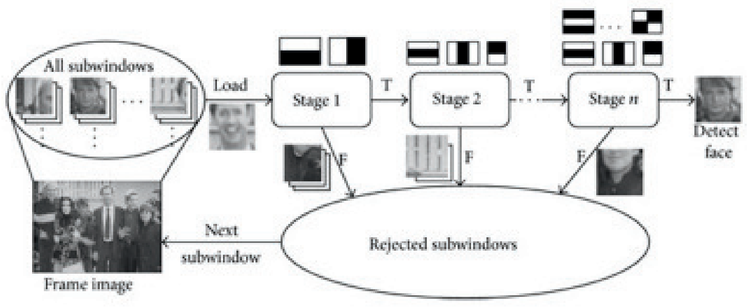
OBJECTIVE

The aim of this research is to develop a cost-effective smart doorbell system that enables:

- Face recognition using the Haar Cascade algorithm.
- Image capture and storage on cloud platforms (Firebase, Cloudinary).
- Real-time connectivity and interaction via a mobile application, allowing users to monitor and control their home security remotely.

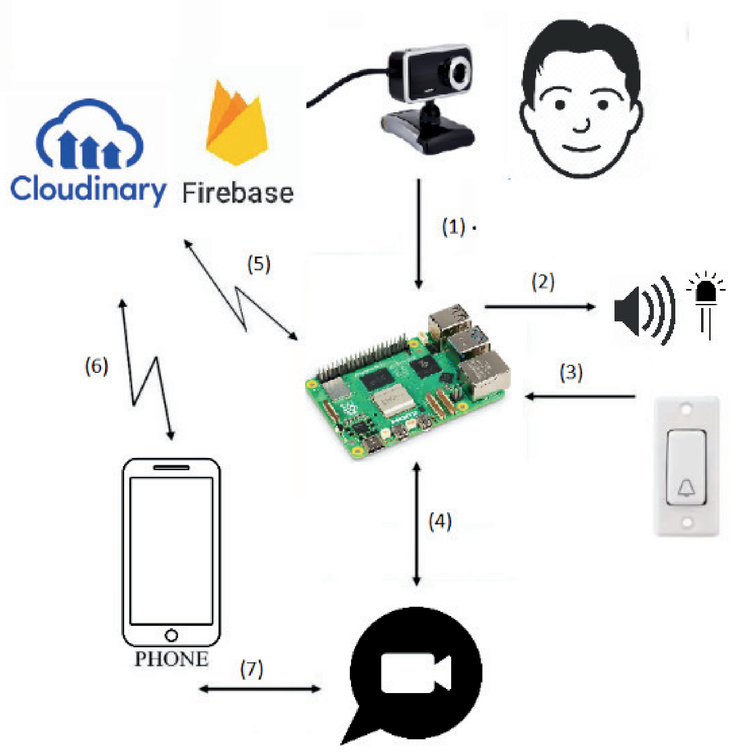
BACKGROUND THEORY

The system is based on the Haar Cascade face detection algorithm—a method introduced by Viola and Jones in 2001. This algorithm uses Haar-like features to quickly detect faces in images, ensuring efficiency and fast processing suitable for real-time IoT applications.

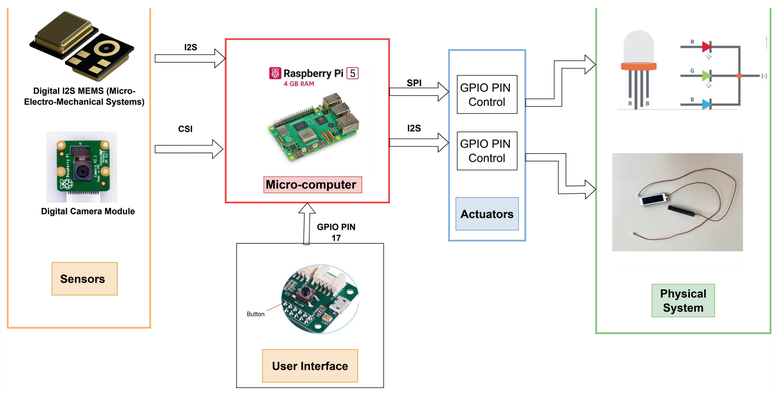


SYSTEM DESIGN

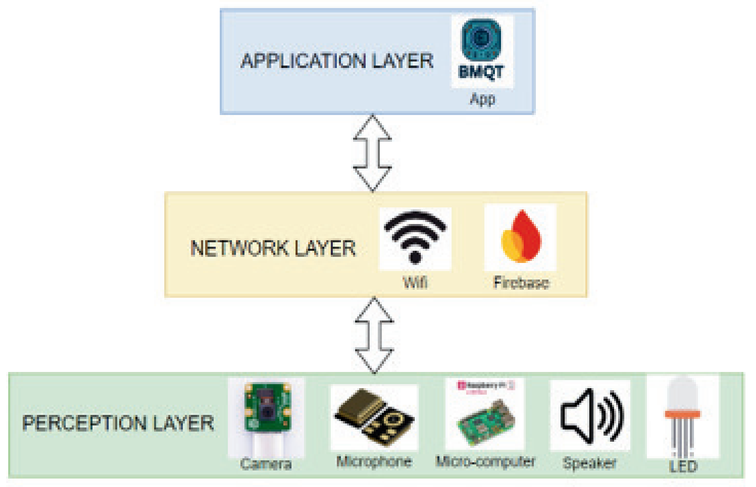
General Design



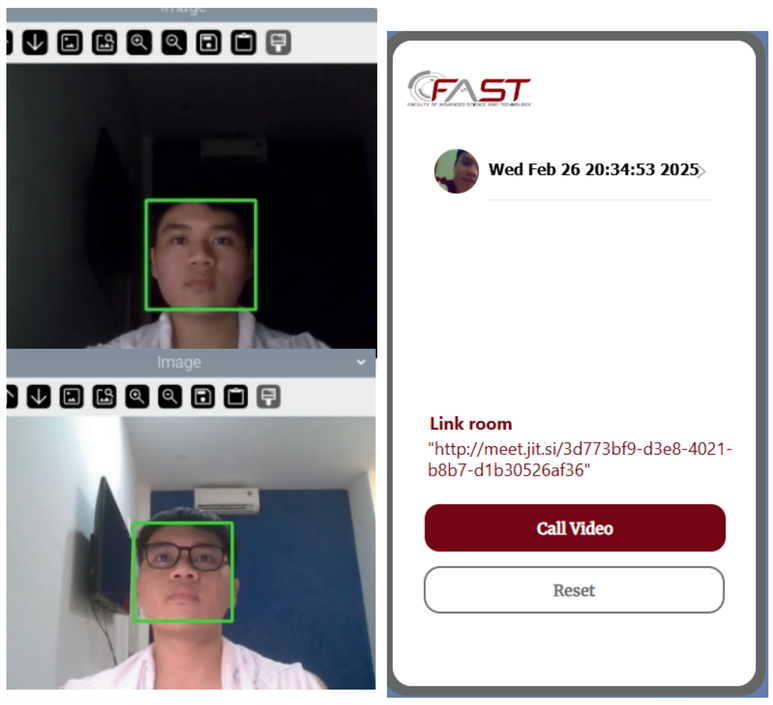
Embedded System



IOT ARCHITECTURE



EXPERIMENTS



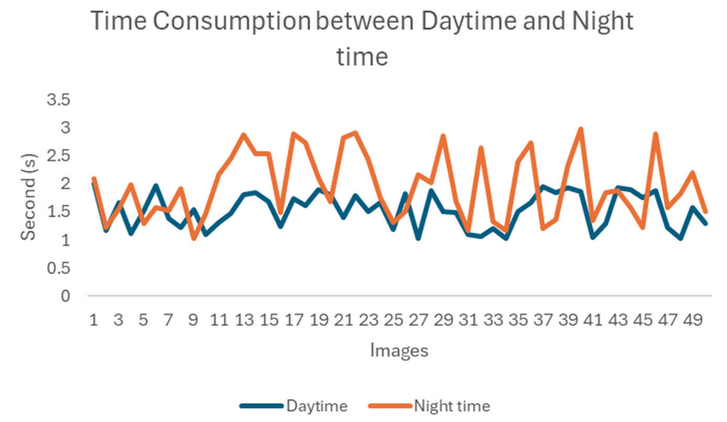
RESULTS & EVALUATION

Table 1: Results of Face Detection with Straight and Tilted Angles (Daytime)

	Straightedge			
	Bright enough		Lack of light	
	There are glasses	No glass	There are glasses	No glass
Aim	39/50 = 78%	40/50 = 80%	30/50 = 60%	31/50 = 63%
Open	40/50 = 80%	42/50 = 84%	35/50 = 70%	37/50 = 74%
	Tilt angle			
	Bright enough		Lack of light	
	There are glasses	No glass	There are glasses	No glass
Aim	37/50 = 74%	40/50 = 80%	30/50 = 60%	31/50 = 63%
Open	39/50 = 78%	42/50 = 84%	31/50 = 63%	33/50 = 66%

Table 2: Results of Face Detection with Straight and Tilted Angles (Night time)

	Straightedge			
	Bright enough		Lack of light	
	There are glasses	No glass	There are glasses	No glass
Aim	80%	86%	62%	33/50 = 66%
Open	84%	88%	34/50 = 68%	37/50 = 74%
	Tilt angle			
	Bright enough		Lack of light	
	There are glasses	No glass	There are glasses	No glass
Aim	38/50 = 78%	41/50 = 82%	33/50 = 66%	34/50 = 68%
Open	40/50 = 80%	43/50 = 86%	35/50 = 70%	38/50 = 78%



CONCLUSION

Achievements:

- Face Detection
- Mobile Integration
- Data Management

Future works:

- Multi-user recognition
- Improve the delay and accuracy

ACKNOWLEGDEMENTS

We would like to express our sincere thanks to Dr. Le Quoc Huy and Mr. Nguyen Huynh Nhat Thuong for their support and guidance throughout our career and our second home, University of Danang - University of Science and Technology for providing us different opportunity for exhibiting our talents.

REFERENCES

[1] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," in *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, Kauai, HI, USA, 2001, pp. 511–518.

[2] Raspberry Pi Foundation. Voltage specifications for Raspberry Pi. [Online].