



University of Zanjan

Faculty of Engineering

Dissertation to receive a bachelor's degree

Computer Engineering

**New approach for eye movement detection on Raspberry Pi using Deep  
Learning and FSM**

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Summer ۲۰۲۲

## **Abstract**

Nowadays, Artificial Intelligence is helping human in almost every aspect of life. In this research, using Deep Learning and FSM and computer vision, we tried to make an optimal model to detect eye movement in order to execute commands using eye movement. To capture frames, there is a camera in front of a user's face. Pictures are sent to the MobileNet neural network, which is run just one time at the beginning of the program. This neural network predicts four coordinates, representing a rectangle around the eyes. Then, to detect the type of eye movement, there is another neural network, which is specifically designed in this research, to predict coordinates of the iris of the eye. The input of this neural network is the picture inside of the rectangle, which is predicted by the first neural network. To identify the movement correctly, we need to process ten frames per second and as Raspberry Pi cannot run a model with a large number of parameters ten times in a second, we designed an optimal model with a low number of parameters to be run ten times per second. The design of this neural network is inspired by the design of Inception and ResNet neural networks. Our neural network only tracks the movement of the right eye and finally, by subtracting the current coordinates of the eye and the primary coordinates of the eye, we could identify whether the movement was towards left or right or up. Finally, since a user might suddenly look at right or left without intention of sending commands by moving his or her eyes, one FSM is designed to identify whether the eye movement was for sending commands or it was an accidental movement. This means that in order to send commands by eye movement, a user has to first look at upside to put machine at ready state and then if he looks at right or left, command would be executed.

**Keywords:** Artificial intelligence, Deep Learning, computer vision, Raspberry Pi, Neural Network, Inception network, ResNet Network, FSM