EYE BLINK BASED PATIENT ASSISTANCE SYSTEM

[1]Krishan Gupta, [2]Rajneesh, [3]Dr. Bhoomi Gupta

[1]Student, [2]Student, [3]Assistant Professor

[1]Department of Information Technology,

[1]Maharaja Agrasen Institute of Technology, Delhi, India

Abstract : In this research paper, we present an eye blink-based patient assistance system based on image processing tools and the human Eye Aspect ratio (EAR). The motivation of this research is the inability of a medically paralyzed or physically injured or physically disabled person to self-assist during his treatment in a medical organization as a patient or in the absence of any caretaker or assistant. The research focuses on allowing the patient to assist itself using eye blink-based assistance system. With the usage of this system, the patient's eye blink pattern can be used to determine the service demanded by the patient without needing to press any physical button or voice commands. The system allows controlling electricity-based equipment like tube light, fan by turning them ON/OFF with the help of signal transmitted by assistance system after determining the eye blink pattern of the patient as input to the system.

INTRODUCTION

We can refer the three types of patients with either one of following i.e. paralysis, physical injury and physical disability causing the same problem to all the patients. During the bed rest or bedridden stage of the patient, the self-assistance of the patient for routine works like Tube Light and Fan ON/OFF even becomes challenging tasks. To overcome this problem, we analyze the eye blink pattern of the patient to assist the patient.

Bed rest, it is also referred to as the rest-cure, it is a medical treatment in which a person lies in the bed for most of the time to try to cure an illness or disease. Bed rest refers to voluntarily lying in bed as a treatment and not being confined to bed because of a health impairment which physically prevents leaving the bed.

If a person is bedridden it is not a form of immobility that can present as the inability to move or even sit upright. It differs from bed-rest, a form of non-invasive unique treatment that is usually part of recovery or the limitation of activities.

These conditions will prevent the patient from daily activities and sometimes prevents from speaking and movements.

Thus, we propose a smart system which works as an interface between patient and caregiver. The patient can communicate as the system detects eyeblink of the medical patient and interprets the eye blink pattern to various actions required to be done for the assistance of the patient.

IMPLEMENTATION METHODOLOGY

Following steps were undertaken to complete the project:

1. Image Extraction from Camera module using OpenCV tool using Python.

2. Analyzing of Image using predefined conditions and statements on data using Python.

3. Generation of data using eye Image analyses tools - dlib.

Creating a Dashboard, using PyQt5 tools, for End Users to view the results.

ALGORITHM

We broke down the whole set of problems into the following set of tasks:

1. Building Hardware and software connection between camera and application.
2. Extracting image from camera using 3rd party tools.

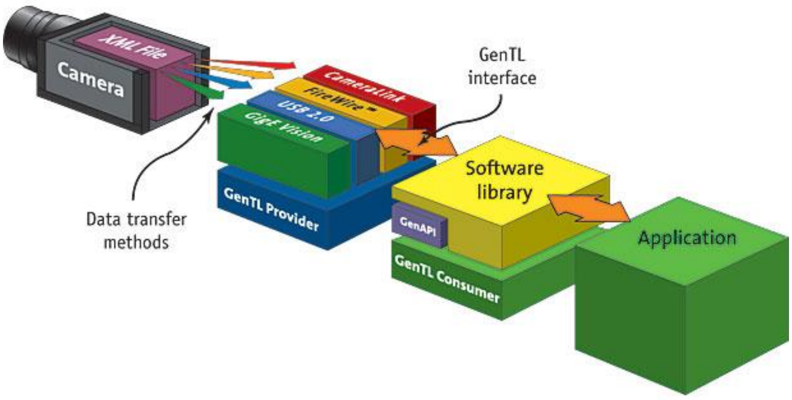

Figure: data transfer to application
Reference : https://www.qualitymag.com/articles/90872-meet-the-machine-vision-standards

3. Detecting human face in an image captured from the camera.

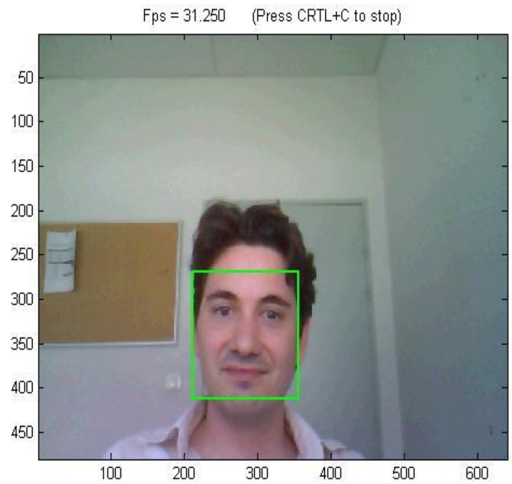

Figure: face detection
Reference : http://arorehe15.pitstop.ru.net/90081/650640-634c9152555d2b2e8ee7d5cac4d2e4e9-344284

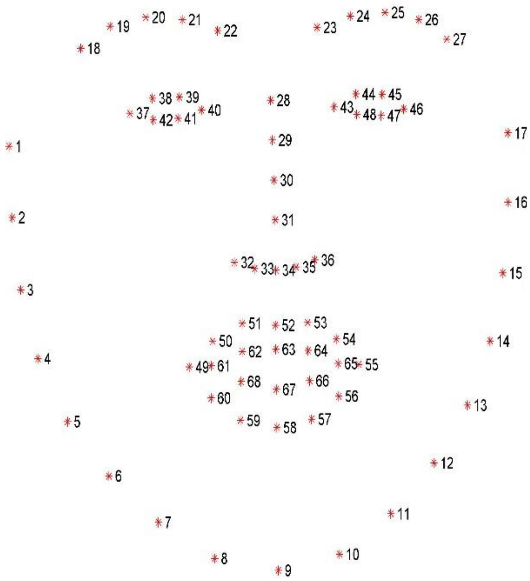

Figure: face landmark points for detection
Reference : https://medium.com/@aaditya.chhabra/install-dlib-python-api-for-windows-pc-97fe35e01cd

The accuracy of the landmark detection for a face image is measured by the average relative landmark localization error, defined as usually:

e = (100/kN)*∑||xi-x^i||2 from i =0 to N

where xi is the ground-truth location of landmark i in the image, xˆi is an estimated landmark location by a detector, N is a number of landmarks and normalization factor κ is the inter-ocular distance (IOD), i.e. Euclidean distance between eye centers in the image.

4. Detecting Human eye as part of the face.
5. Detecting eyelids, cornea, iris and other eye components for finding eye landmarks(p).

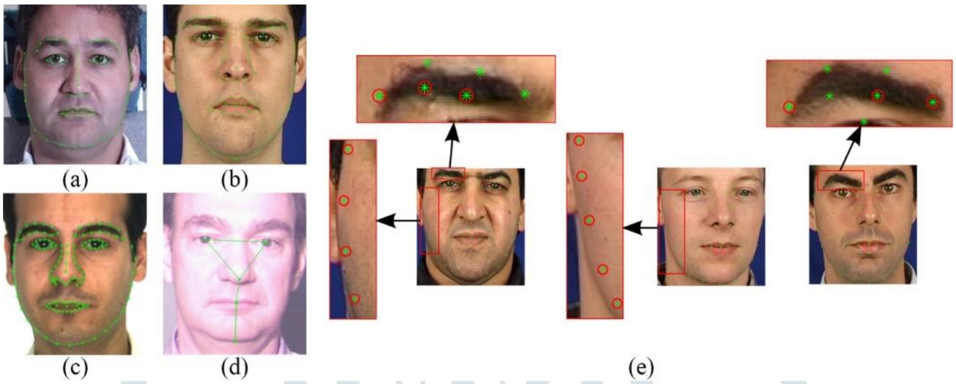

Figure: Different faces for detection
Reference: https://stackoverrun.com/tr/q/9959113

6. Detecting eye landmarks p1-p6 for finding EAR value.

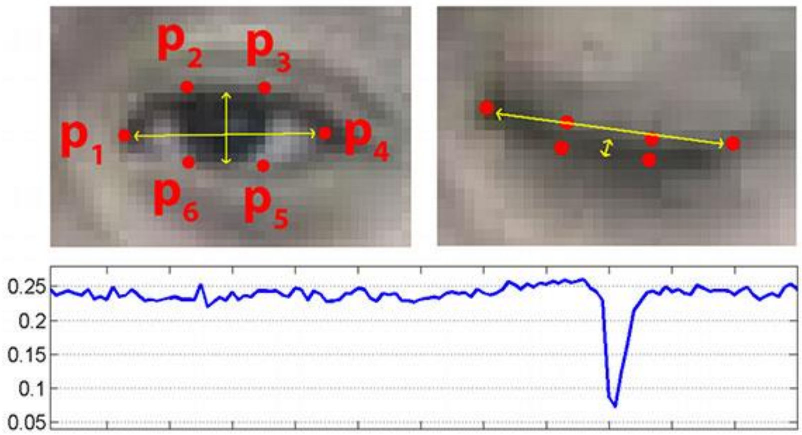

Figure: Open and closed eyes with landmarks pi automatically detected. The eye aspect ratio EAR is plotted for several frames of a video sequence. A single blink is present.
Reference: https://vision.fe.uni-lj.si/cvww2016/proceedings/papers/05.pdf

7. EAR value is calculated using eye landmarks(p1-p6).

EAR = (||p2 − p6||+ ||p3 − p5||)/(2||p1 − p4||)

8. Change in EAR value from constant to approximately 0 is observed and triggers the event function.

9. Eyeblink detection is notified on the screen.
10. An Alert message is shown to Patient Staff for Assistance to Patient.

The project was carried out using general EAR values collected from different researches based on human eye blink detection and tries to capture eye blink detect for a person meeting average EAR value.

RESULTS

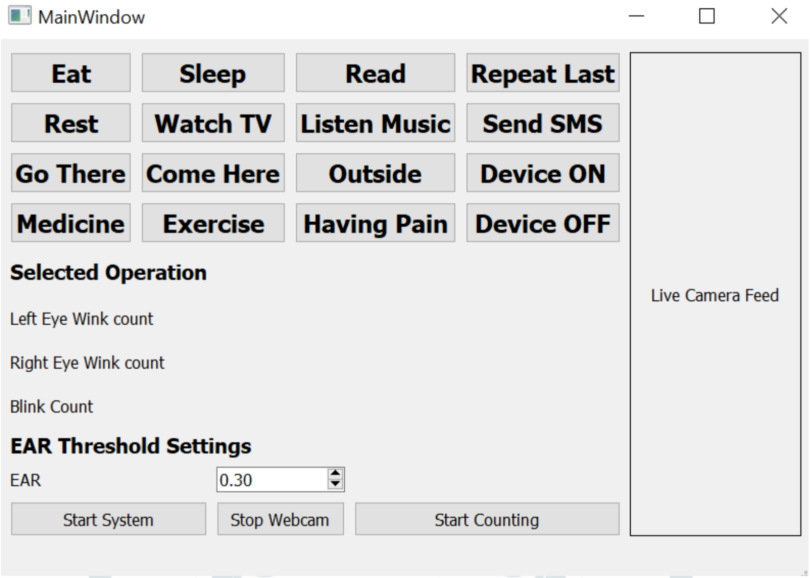

Figure: Initial Window after Launch

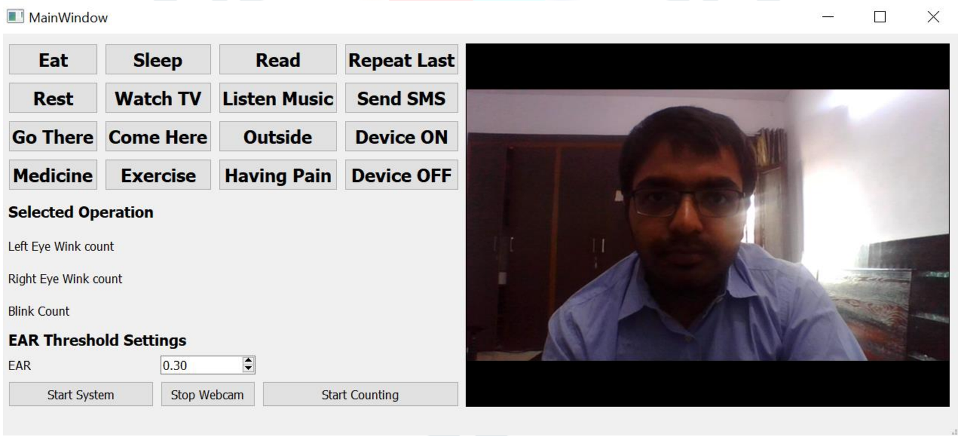

Figure: Loading Image from Camera in Application

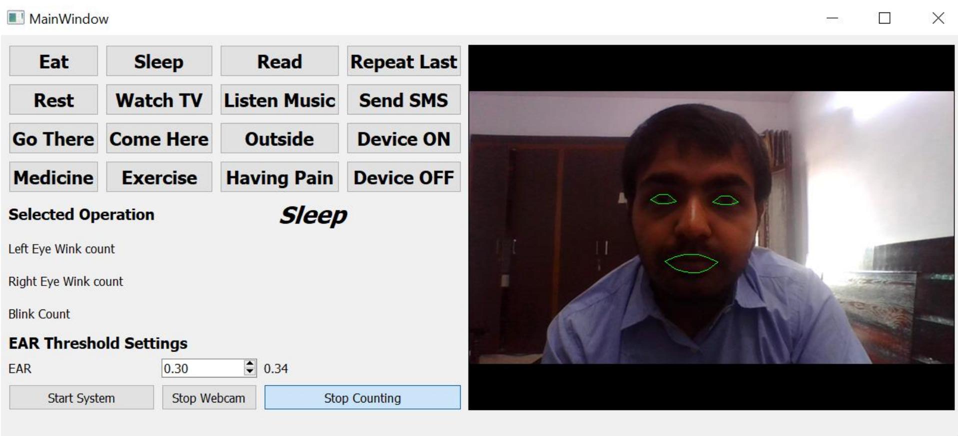

Figure: Detecting Eyes of Person

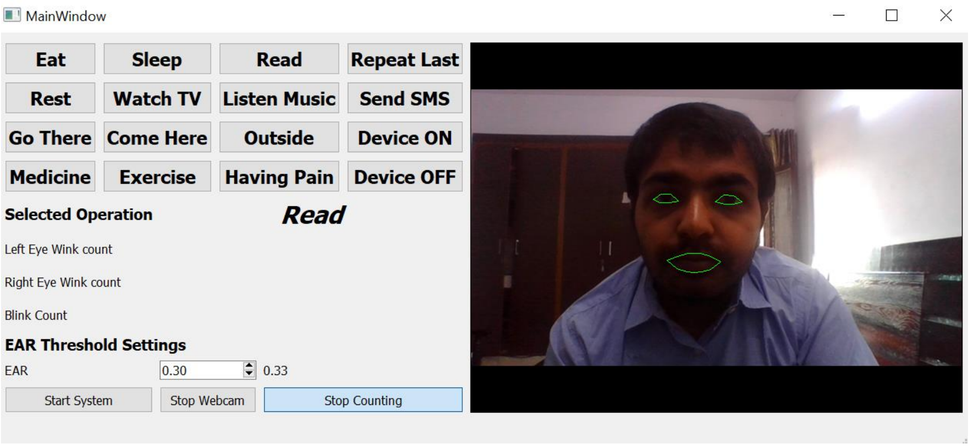

Figure: Detection of Eye Blink of Person

DISCUSSION AND CONCLUSION

The benefits of the project are that the system allows hassle-free assistance to the injured and paralyzed patient. It also provides faster assistance to the patient. This can be useful to most paralyzed and injured patients. This system is great for patients without family or alone at the bed in injury state. The system is a long-term cost-effective solution to the medical institutes.

The demerits of the project are that the initial cost of setup is very high. The maintenance cost of the system is also very high. The system is error-prone due to its initial stages and development phase. System failure at a large scale in any medical institute can cause panic and chaos in the medical institute and among the patients. The system is initially difficult to understand by the patient and the medical staff.

Concluding the project, we have built a system, which can be used to improve patient assistance system for the medical staff, injured patients, paralyzed patients. This is a step towards the automation of medical assistance and can be further automated to a great extent. This can be a breakthrough keeping patients away from visitors, family and for those who are admitted alone without any caretaker of his/her.

Future research should consider designing of a model where the patient can fully self-assist itself without any means of external assistance for routine tasks like changing the position of the bed of the patient, controlling lighting, air conditioning, and heater.

In addition, it might be interesting to see if reducing product's cost and allowing medical institutes to automate the routine tasks of these patients in the institute can allow decreasing the overall cost of the medical institute spent in the assistance of the patients.

Future initiatives may also include remodeling of the structure of the program to reduce the line of code and improve the efficiency of code and working.

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