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Eye Blink and Emotion Detection System for Paralyzed Individuals

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ABSTRACT—

This project is focusing on mainly for helping paralyzed or disabled peoples who cannot talk or move properly. The system gives a simple way for them to communicate with others by just using their eye blinks or facial expressions. For this, we used Python and OpenCV with Haar Cascade algorithm to detect the eye and face movements through webcam. We also created a simple frontend using HTML, CSS and JavaScript, and the backend is handled using Python. There are two main options in the system – one is eye detection and other is emotion detection. If user chooses eye detection, they can blink or close eyes for few seconds to go through different options like Emergency contact, Food menu, and Predefined messages. If they want to select any option, they just have to open the eye after keeping it closed for some seconds. After selecting, the system will speak the selected option loudly and also send the message to caretaker's mail. This way, the user can ask for help easily. In emotion detection, user can smile (happy face) to move between options and sad face to select one. The same menu and options are used in this method also. This system can be very useful for people who are not able to use hand or speech. They can still send important messages or ask for food or medical help without touching anything. It does not need any costly device, just a webcam and laptop are enough. This project shows that with small tools and basic AI, we can make life easier for needy peoples. Still, it is a simple model, but in future more features like voice support and better accuracy can be added. Our main aim is to give freedom to such people to express their needs without depending others always.

Keywords— OpenCV (Open-Source Computer Vision Library), , Haar Cascade Classifiers (HCC), Eye Aspect Ratio (EAR),

1. Introduction

In our society a lot of peoples have deep physical problems such as paralysis or movement to their body. These individuals are not able to speak or control their hands or legs properly and they experience many difficulties in even completing their simplest daily requirements. These individuals always have to have a person with them to provide help which puts them in a helpless position, meaning they cannot do things that most people take for granted, putting them under extreme mental strain. One of the major obstacles these individuals face is communication. The individuals want to share their basic necessities, for example they are hungry or require medical assistance, but they have no way of doing this through communication. There are a few very expensive machines and tools available which offer communication capability, but these tools are not accessible for common people. In countries like India this has gone so far as to practically deny them communication freedom. Fast development in the area of technology means it is now possible to make use of computer vision and artificial intelligence to create communication devices through a plain old webcam or camera in a computer. There are so many examples of features available such as detecting a human blink of an eye or expressions which detect movements of your head to create input on the screen and these are ideas that can be developed even further. Technology has even developed the capacity to use brain signals and brain control to control objects but these are not very comfortable for the user or cheap. It is time to use technology and the Internet to benefit communication of the individuals listed. So in our project, we planned to make a simple and low-cost system that can help paralyzed people communicate better. We are giving two modes — one is through eye detection and other is through face emotion like smile or sad face. The user can close their eye for few seconds to move or select options, and after selection, the system will say the message loudly and also send an email to caretaker. This can include messages like medical emergency, food request, or intruder alert. Our main goal is to reduce the pain of such patients by giving them a small way to express their needs using basic technology, without depending on costly devices.

Related Work

[1] Ananda Babu J et al. (2022) – Eye Blink to Speech System In 2022, Ananda Babu J, Keerthi K S, Tejonidhi M R, Sangeetha S, and R. Kumar made a budget friendly system to help people with Motor Neuron Disease (MND) to talk using only their eye blinks. In this system, they used OpenCV and Haar Cascade Classifier to detect the blinks and Google Text to Speech (GTTS) to convert that blink into spoken words. This made the communication easy for those who can't speak or move their hands. One big thing about this project is that it not need any expensive hardware, just a normal webcam is enough. So, it becomes very useful for poor people also who are facing serious health conditions. But the system also had some drawbacks. It was not working properly when the lighting was low or when the user moved their head little bit. These things reduced the accuracy of blink detection and make

the system less reliable sometimes. They also didn't include any option to understand facial expression, so the communication is limited. For future improvement, the researchers suggested to use machine learning methods which can train the system to work in different lighting conditions and with head movements. Also, they said that adding facial expression detection can make the communication more natural and flexible. For example, if the system understands when user smile or frown, it can create more detailed messages. So overall this system is good and simple but need some updates to be more user friendly and accurate.

[2] K. Kausalya et al. (2024) – Gazecon: Eye Gaze Assistive Systemin 2024, Kausalya, Rajaraman, Nandhakumar, Surya and Shrayas came up with a sophisticated system called Gazecon, which helps people with physical disabilities. Gazecon integrates modern computer vision and machine learning inventions, Convolutional Neural Network (CNN), Haar Cascade and Histogram of Oriented Gradients (HOG). The implementation method primarily tracked the eye movement of the user to control devices such as computer and home appliances. Therefore, to it help people who were physically unable to use their hands or legs, Gazecon enabled them to control systems with their eyes. Gazecon appeared quite good in terms of real-time performance and accuracy. It aided and supported people to be more independent. It resulted in improved accessibility and faster interaction without human physical contact. One significant limitation is that the system only utilizes eye gaze tracking. In other words, if the person cannot move his or her eyes appropriately, or if he or she is physically weak in their eye muscle control, it does not give that person access at all to the system. The researchers similarly acknowledged this issue and recommended that the system support a wider variety of input options in future iterations. For instance, head movement, voice command and facial expressions. The objective being to enhance the usability of system by a larger number of people who have a variety of disabilities through finding a balance between multiple input methods.Also, it will increase the reliability of the system if one input method will fail. Overall, Gazecon is a strong step in making technology accessible for the disabled community. But it should not only depend on one feature like eye gaze. If multi-modal input is added in future, it will become more flexible and can be helpful for a large number of users. Also, the deep learning models can be used to make detection faster and more accurate even in different lighting or head angles.

[3] Md. Ashiqur Rahman Apu et al. (2019) – Smart Wheelchair Using Eye Blinks In 2019, Md. Ashiqur Rahman Apu, Imran Fahad, S. A. Fattah and Celia Shahnaz created a smart wheelchair system which can be controlled just by eye blinks. They used OpenCV and Haar Cascade Classifier for blink detection and Arduino Uno to control the wheelchair. This was a very creative and useful idea because many disabled people are not able to move their hands and this system give them freedom to move without help of others. Also, the system was designed to be low-cost, so common people can afford it. The system worked by detecting intentional eye blinks and then sending commands to the wheelchair to move in a particular direction. But since it only used eye blinks, the number of commands were limited. For example, you can blink once to go forward, twice to stop etc. But in complex environment like turning or avoiding objects, this method becomes more and more difficult. Also, there is chance that system may detect unintentional blinks as a command, which can lead to wrong movements. To solve this issue, the researchers suggested that in future, gesture-based controls can be added like head movement or facial expressions to provide more command options. Also that they said using deep learning models like CNN will help in identifying the difference between normal blink and intentional blink. This will reduce error and make the system smarter.

This project shows that even with basic tools like Arduino and webcam, powerful assistive technologies can be made. But to make it suitable for real-world use, it needs more flexibility and accuracy. So that it is a good base, but more features should be added for safer and better experience.

[4] Dr. Hema Malini B H et al. (2024) – Eye and Voice Controlled Wheelchair In 2024, Dr. Hema Malini B H, Supritha R C, Venkatesh Prasad N K, Vandana R, and Yadav R developed a wheelchair system that can be controlled using both eye movement and voice commands. It uses OpenCV, Haar Cascade, Arduino controllers, and also Viola-Jones algorithm. This system is designed to provide full hands-free operation for people who cannot move or speak properly. It was a big improvement compared to only eye blink systems, because it provided more options for the user to control. This system made the movement easier and more accessible for users who have multiple physical disabilities. The use of both eye and voice control gave better flexibility. But still, the system had a big drawback. It did not include any real-time feedback, so the response time was little bit slow. Sometimes, user may give a command but the system take time to act or doesn't show if it accepted the command or not. The team suggested some ideas for future work like using deep learning-based eye tracking which can be more accurate. Also, multi-modal interaction can be added — combining eye tracking, voice commands, and hand gestures. This will improve user experience and make the system smarter. Smart sensors can also be added for obstacle detection and path planning, which will make the wheelchair more independent. Therefore, this project is good for mobility improvement, but still needs few upgrades to perform well in real time. Also adding more natural feedback like sound or display messages can help users to know if the system is working properly or not.

[5] Sharon Mathew et al. (2019) – Eye Controlled Home Automation In 2019, Sharon Mathew, Sreeshma A, Theresa Anitta Jaison, and Varsha Pradeep developed a smart system that allows people to control a computer cursor and home appliances using just eye movements. They used Haar Cascade and Convex Hull Detection method for tracking the eyes. This system was mainly made for users who had serious motor problems and can't use their hands. It helped them operate household devices without any physical movement. The system could turn on/off devices, operate computer applications, and was also used for simple automation. It gave good result in normal condition, but it faced some problems like it didn't work well under different lighting or with users having different eye shapes. Because of that, the accuracy was not stable always and user experience became frustrating. To solve this, the researchers suggested to use more advanced technologies in future. For example, combining multiple eye tracking methods like pupil tracking, infrared sensors, or using deep learning models to make gaze estimation more accurate. These can help in reducing the errors and improve system performance. Another improvement they said was to add emotion detection. This means the system can recognize if the user is sleepy or tired and give friendly warning or messages. This can also help in driving or important work where attention is needed. For example, if user looks sleepy, the system can alert them or their caretaker. So, this project was innovative and gave a good solution for home automation using eye. But still, to make it usable for all types of users and situations, more smart methods should be added in the future.

2. Implementation

This system has two main features: Eye Detection and Emotion Detection, which is made to help paralyzed people communicate in a very easy way, just using their eye movements or facial expressions.

A. Eye Detection Mode

When the user click on "Eye Detection," a new screen will pop up showing different options. To see these options, the user just need to partially close their eyes for around 4 seconds. Once the options are shown, they can pick the one they want. For example, if they want to choose Emergency Contact, they will again need to partially close their eyes for 4 seconds. Then the system will show a list of emergency options like:

- Medical Assistance
- Emergency Help
- Fire Emergency
- Intruders or Suspects

When they select any option, the system will announce what was selected and also send the same information to the caretaker's email. This way, the caretaker will know what is needed and they can take the action right away. There is also an option for the user to choose pre-built messages like "Help Needed" or "Food Request". When one of these is selected, it will be announced aloud and sent to the caretaker's email as well. The system also have a Food Menu option, where the user can pick food items using the same eye detection method. The request will be sent to the caretaker's email, and the user will get the food they want without much effort.

B. Emotion Detection Mode

The second feature is Emotion Detection. Here, instead of eye movements, the system uses facial expressions to pick the options. If the user shows a happy face, they can move through the different options. If they show a sad face, the system will select the option they are looking at.

Just like in the Eye Detection mode, the system will announce what option was selected, and it will send the info to the caretaker's email. This helps the caretaker know what is needed immediately.

C. System Summary

In short, this system is made to make communication easier for people who can't move much. They just need to use their eyes or facial expressions to select what they want, like emergency help or food, and the system will send the message to the caretaker. Whether it's help needed or food request, the caretaker gets it in their email quickly, and there can be a rapid response. So, the system is simple, effective, and super helpful for anyone with paralysis or limited mobility. It uses the simplest and most natural means—like eye gestures or facial gestures—to help users communicate without having to press buttons or use complex devices.

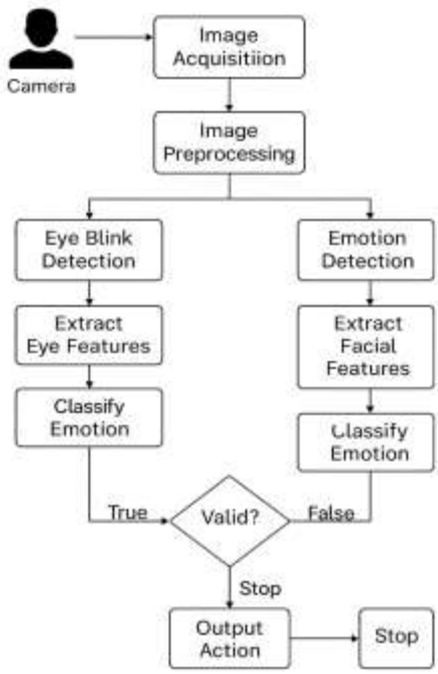

Fig. System Architecture

V. Result

In this project, we tested both eye blink detection and emotion detection method. We conducted total 50 tests for each module. The eye blink system correctly detected 47 out of 50, which give accuracy of 94%. In emotion detection, it detected 44 correctly out of 50, so the accuracy was 88%. This result show that eye detection method is more accurate than emotion method in our system. But still both are giving good result above 85%, which is acceptable for basic communication system. Accuracy also depends on lighting condition and proper face alignment. So for better result, user should sit in proper light and in front of camera. Overall, system is working fine with good accuracy for paralyzed people to select emergency and communication options.

Accuracy= (Total Samples /Number of Correct Predictions) ×100

For eye blink detection, out of 50 trials, system detected 47 correctly. So the accuracy is 94%. For emotion detection, it detected 44 out of 50, giving 88% accuracy. This show that eye detection is slightly better in accuracy than emotion one. But both are working well for helping paralyzed people to make choices.

Method Used	**Number of Tests**	**Successful Detection**	**Accuracy (%)**
Eye Blink Detection	50	47	94
Emotion Detection	50	44	88

Table1**:** Acuracy Comparison Table

Bar Graph – Accuracy of Each Module

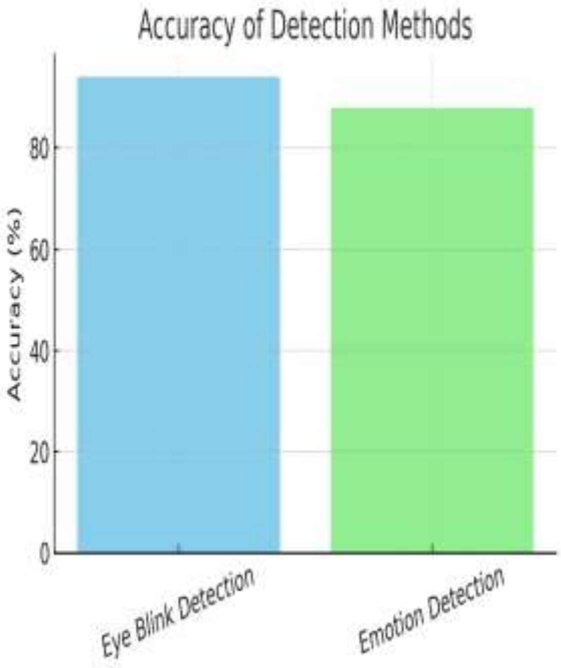

Fig. Bar Graph – Accuracy of Each Module

Here I've created a bar graph to compare the accuracy of both modules used in our system. On X-axis, we put the two detection methods – Eye Blink Detection and Emotion Detection. On Y-axis, we showed their accuracy in percentage. From the graph, we can see that Eye Blink Detection is having higher accuracy (94%) than Emotion Detection (88%). This means eye-based control is working more correctly for our system. The bar graph clearly show the difference between both method, so it is easy to understand which one is more reliable. Bar graph help to visualize result in better way, especially when we are comparing different techniques.

VI. Challenges & Limitation

The proposed eye-controlled system will bring a remarkable advancement in assistive technology but it may also encounter various challenges and limitations that must be resolved for the effective real-world use. These issues mainly start from environmental conditions, hardware limitations, and the different nature of users. One major challenge in recognizing eye and facial expressions is the effect of lighting. The performance of computer vision models, especially those using OpenCV and Haar Cascade Classifiers can suffer in dim light settings. lighting can reduce the contrast between facial features and the background; it makes complicating the detection of eye blinks and head movements. Utilizing infrared tracking or improving the algorithm's ability to adopt to varying lighting could help overcome this issue. Another key limitation is the risk of misinterpreting involuntary that means intentional ones and unintentional one's eye blinks. Blinking is a common and natural behavior, making it difficult to differentiate between voluntary and involuntary blinks. If the system incorrectly identifies a regular blink as a command, it may trigger unwanted actions. Here the system learns the user's usual blink patterns and differentiates them from intentional commands, could enhance its reliability. Tracking head movements can be tricky when it comes to user comfort and accuracy.

Although head gestures offer a different way to control, using them for long periods of time may lead to discomfort for sure, for those with restricted neck movement. Some users might have slight or irregular head movements, which can affect detection accuracy an issue. To address this, allowing users to customize sensitivity settings could help them to set a movement thresholds that suit their needs. Enhancing physical capabilities can improve usability of the system. One major concern is the processing power needed for real-time deep learning facial expression recognition. Although convolutional neural networks are really very accurate, they also need strong computer power to run the system well on low power devices like microcontrollers they become slow to overcome this we can use a light models like support vector machines or mobile net based CNNs which work faster and also give a good result. The next problem is making the system work well for all kind of people sometimes the facial recognition may does not work as well 4 different age groups or different phase types because of the training data it is limited we can solve this problem using more trained data and testing the system with more users. Weather also some privacy concerns are raised since the system uses a camera for all the time it can raise ethical issues especially that we are using private places like hospitals or in homes we will doing all the processing on the devices instead of sending the data to the cloud it can protect the privacy by keeping the personal information as local. Finally, it is important that to make the system easy to carry and connect with other assistive technology or devices right now it uses a normal webcam but using infrared cameras or light wearable sensors can make it more useful and user friendly and reliable and thus it making the system work well with the smart home devices will also improve the overall function of the system.

VII. Conclusion and Future Scope

The Automated Eye Controlled System for Paralyzed Persons project has now been successfully implemented, to aid in easier and independent communicative opportunities for those physically disabled. This system permits the user to select emergency contacts, request assistance, and perform other necessary actions, allowing for the integration of facial expression recognition and eye-blink recognition. Not only does it ease the way of life for those who may not communicate in traditional ways, it has provided an opportunity to allow for independence and independence. Options can be indicated by eye movement or emotions, thanks to the user interface's non-complexity and simplicity. The system has also been designed to allow accessibility by mobility challenged persons. The project embraces an ideology focused on providing a cost-effective solution to address systemic barriers to knowledge and technology access, providing user study and analysis that describe an inclusive solution for social environments with limited resources. In the future, the system could be further enhanced and expanded even more. One way would be to use voice commands in order to promote more interactive communication to be able to communicate in a more social mode. Another option could be expanding the capabilities of the system to add more functions and to also utilize some tasks with household appliances or communicating/controlling other smart devices. Finally, possibly improving the detection algorithms for emotion and eyes for more accurate actions could be a future improvement. Given there are improvements in technology and continued feedback from the users, this system can be improved to offer greater independence and support to the ones who need it most. In future recommendation Integration of Voice Commands: The introduction of voice recognition could make the system more valuable for users. Given the opportunity to control the system using voice commands, this will provide another option for those users that cannot consistently use eye movements or facial gestures. Improved Detection Accuracy: Detection of eye blinks and facial expressions is currently paramount in ensuring the system is usable. The next iteration of the system should begin exploring ways to improve data from the algorithms, especially when users and the algorithm may not be successful due to difficult environments (e.g., dark conditions) or limited abilities to perform facial movement gestures. More Options for Users: The system could improve even more simply by providing additional options for the user to customize, e.g., for controlling more household appliances or messaging other users in addition to users emergency contacts (family, friends, wider audience). Offline Capability: This brings into view offline capability to consider to help with reliability, when the user may have poor and/or unreliable internet connectivity. It would therefore be useful to give users an experience where they can access the system all the time. Customized Learning: With the addition of machine learning, the system could recognize the user's patterns over time, which would customize the interface to the user's particular need for an interface that is more responsive. Improved Interface: Making the interface simpler, with larger icons and more intuitive navigation, would help users with greater physical limitations. Adding voice feedback to every action to help the user navigate the system would also help the user move through the system more intuitively.

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