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Eyeball controlled wheelchair using Raspberry Pi

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ABSTRACT

In the growing world of technological advancements, here comes another small uphill. The Eyeball Controlled Wheelchair (ECW). The major purpose of this concept is to make locomotion possible, not only to people who find it difficult to move with their legs but also people whose motor limbs are not functional. Thus controlling the wheelchair with just eyeball movement. The applications of the eye tracking and movement are more efficiently rather than controlling the wheel-chair with a Remote Control operated by motor organs.

Keywords— *Eyeball, Wheelchair, Raspberry Pi*

1. INTRODUCTION

The existing computer input devices such as a keyboard, mouse, and therefore the different input devices are accustomed move with digital instruments. In this paper, a computer input device by human eyes solely is planned for a handicapped person and also for wearable computing.

So, the only computer input devices are:

(a) Image Sensing: In this method, a particular image is being fed into the system and analysed and a very specific response is obtained as the feedback. This method has been very widely and extensively used in various fields ranging from black body radiation to astronomical accuracies.

(b) Bio-Potential: The human body as a conductor of electricity possesses some potential which can be recorded by finesse instruments such as the Electro Cardio-Gram, Electro Encephalo-Graph, EEG, EMG, EOG, etc. These inputs from the human body recorded through these instruments and methods are used for various purposes in computer loop feedback.

(c) Search Coil Method: This Search coil method is not that frequently used as it requires an external source of voltage to be passed through the body. Also, this method deals with a fair amount of getting information from eye contact lenses and then analysing the data with a computerised program like CAD (Computer Aided Detection).

(d) Voice input: The voice control of computerisation has been in existence for the past 3 decades. Starting from pager replies to SIRI and Cortana now. The system recognizes the voice commands and then verifies the pitch, tone, clarity for analysing and computerization. Noise is interference in most cases regarding vocal recognition in computers.

(e) Motion sensing: Motion sensors have been in use in a wide range of day-to-day applications and in almost every aspect of life. With the rising smartphone companies and their competitive aspects of innovation, the motion sensor took a leap into our daily lives. Where the difference of images from a different time with the least delay is notified is exactly how sensing motions works.

Everyone pupils are unique also the size and the image of the pupil is different for every person. Many researchers overlook that fact and thus end up with many common misconceptions resulting in an array of errors or incompetence. As we see the major chunk of work in this project is carried out by the pupil movement, so even the slightest miscalculation can cost tens of changes in the variables. Thus every action and the camera's sensitivity must be as precise as possible for the tracking of the pupil movement.

There are various ways in which the computer separates the pupil movement for better recognition; some of them in no particular order are eye colour, eye pattern, pupil width, etc. This is the primary step. If this step doesn't succeed, the second option is taken into consideration. Here comes the motion detection, this will be recognized as the motion and then would be tracked down to give the proper movement for the same. Following the right illumination, this thing has been tested over a wide range and variety of people from different parts of the world. The Wheelchair definitely works well, for all of mankind without any bias felt or whatsoever.

2. PROPOSED METHOD

The existing model though has its own working for a menial scale accomplishment; it cannot compete with the proposed method. The deterrent factors that the existing model has been that, the vibration as a factor where the system is not mounted and can be shaky. Thus resulting in an improper blur or false image recognition, thereby hindering with the overall performance of the wheelchair. On the other hand, the proposed method is a direct mount to the wheelchair which enables a fastened grip on the camera mount so that every movement or a shake is synced with the respective movement of the wheelchair. This reduces the shake factor by almost $1/100^{th}$ and gives data of accurate measures of up to 5 decimal points. Also, this technique does help in working for a wide range of people all around the world comprising of a different colour, robustness, eye shape, pupil movement, pupil dilation etc. We can see that, we've overcome one of the most major problems that are associated with pupil movement, this machine can work at ease despite excessive pupil dilation. This also enables controlling the wheelchair for people who suffer from excessive pupil dilation. Also known as Mydriasis (Excessive pupil dilation syndrome), thereby enabling almost anyone to practically use the system without facing any sort of hindrance at the time of working. These are the factors that are responsible for the better working of the eyeball controlled wheelchair compared to the existing method of the same. It can also be extensively used among a wide range of people from various races and backgrounds. Also helps people suffering from a variety of eye defects and restrictions to use the machine with ease. Thus these are some improvements made from the existing model of the Wheelchair.

Table 1: Nationalities of varying eye shapes and pupil sizes and their Adaptive threshold and template matching of the proposed method

User Type	Nationality	Adaptive Threshold (%)	Template Matching (%)	Proposed Method (%)
1	Indonesian	99.85	63.04	99.99
2	Indonesian	80.24	76.95	96.41
3	Srilankan	87.80	52.17	96.01
4	Indonesian	96.26	74.49	99.77
5	Japanese	83.49	89.10	89.25
6	Vietnamese	98.77	64.74	98.95
Average		**91.07**	**70.08**	**96.73**
Variance		**69.75**	**165.38**	**16.27**

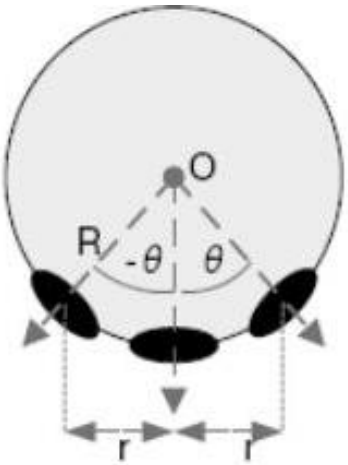


Fig. 2: The model of the eye

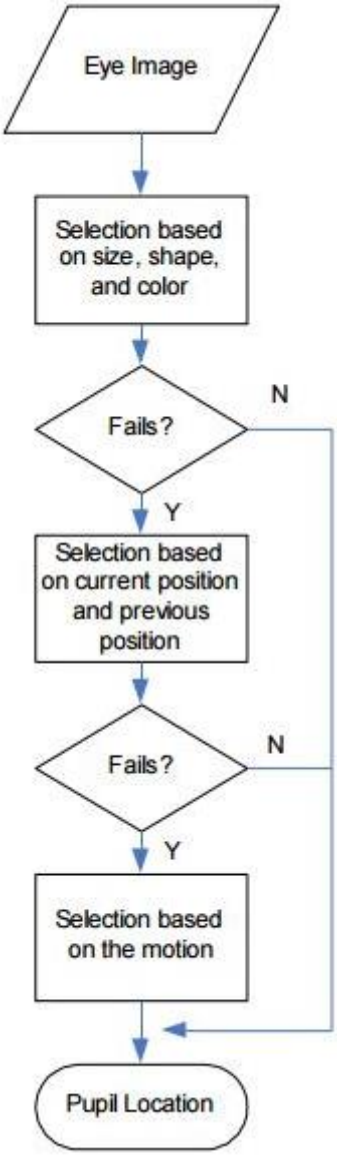


Fig. 1: Proposed method

These 2 pictorial representations are the basics of the working of the wheelchair. This is the adhering factor by which the proposed system works with maximum efficiency. Once these primary factors are a ready-to-go then the secondary factors are initiated.

Table 2: Degree of error table

Point	1	2	3	4	5
Error(degree)	0	0.2	0.2	0.2	3.12

The above-mentioned table is the degree of error table which corresponds to every point of scale moved.

These are rectifiable and are usually associated with TOR. Once the errors are fed into the system then the Raspberry Pi (miniature CPU) takes care of handling any error of up to 8 points maximum. Once the errors are rectified then the movement of the wheelchair based on movement is smoother than ever before, also the raspbian os collects the history of data and analyses for patterns and then collectively uses the factual data to interpret and solve further simple or complex errors from occurring. Even then if an error occurs then the os reads and updates its OS thereby making no space for errors.

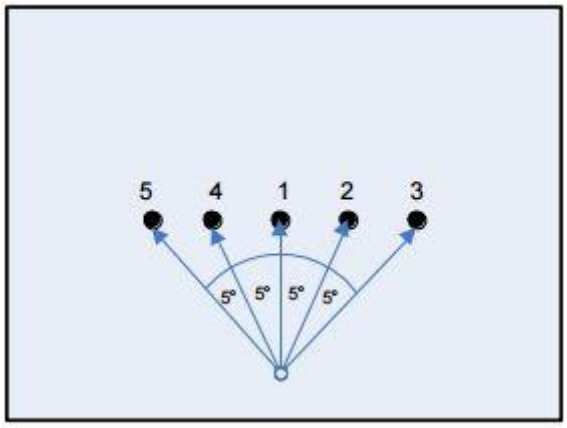


Fig. 3: Degree of separation scale

The above-mentioned scale is the degree of separation for a 5 point system of the eye. This is used to measure the accuracy of the image captured and thus can be used for precision manoeuvres using the wheelchair movement for locomotive purposes.

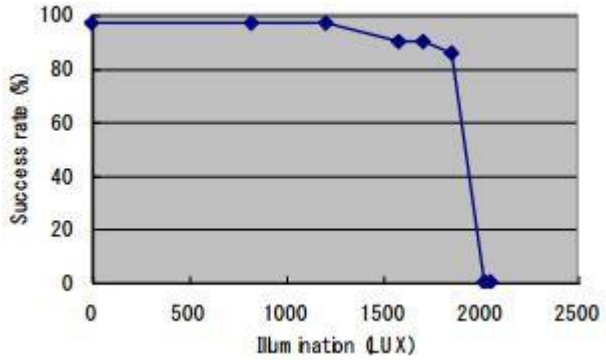
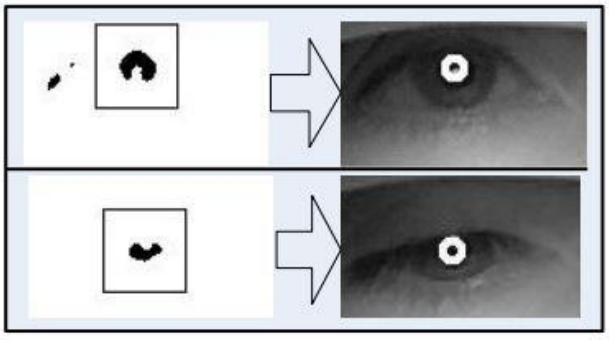


Fig. 4: Illumination factor to that of the success rate of movement with the wheelchair

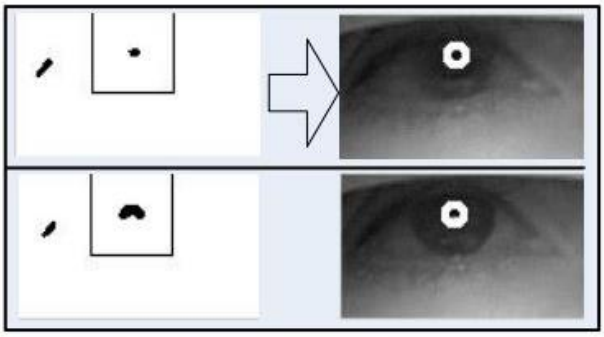
The Graph above represents the Illumination factor to that of the success rate of movement with the wheelchair, the higher the illumination the better the recognition of pupil movement. But still, there are saturation points of illumination after which practically the system cannot possibly read or recognize any image as a matter of fact.

It is not always required to be in a bright environment, but a certain amount of brightness is always required. This also comes with an adaptive flash which can increase brightness up to a certain extent without crossing the prescribed saturation point for maximum functionality and efficiency. Thus this is how the success rate majorly depends on the saturation of illumination and how it adversely affects the recognition both before and after the saturation point.

3. EXPERIMENTS



(a) Case 1, Pupil clearly appears



(b) Case 2, Pupil clearly appears with some defect by eyelids

Fig. 5: Experimental results

Fig. 6: Wheelchair

4. CONCLUSION

- The freedom of movement, the person can move freely without any disturbance to his perception.
- The whole process is a self-calibrated process and doesn't require calibration every time the device starts.
- Works for a wide range of races, inclusive of different eye colour, pupil size, etc.
- The accuracy is impeccable where the machine is capable of recognizing movement accuracies to 3/10 of the normal existing model.
- The last one is if in case the pupil detection doesn't properly recognize the pupil. It has a built in system which locks particular eye parameters and approximates the centre which has a very negligible error rate.

5. REFERENCES

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