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An Enhanced Virtual Reality Method for Diagnosing Autistic Children

Rajiv Vincent, V Vijayakumar

Abstract: ***Autism Spectrum Disorder (ASD) is a neurodevelopment condition that influences substantial children and adults. Currently the identification of this disorder is carried out by specialists who follow regular questionnaires and lookout for definite behavioral indications over physical monitoring. These approaches for the identification are not only particular, but hard to reiteration, expensive and also tremendously time taking. This paper talks about a procedure to support the likelihoods of the existence of ASD in children by automated optical and pulse analysis. This paper focuses on the differentiating abilities of the autistic kids, especially with colours. We investigate the colour perception and cognition of kids with ASD who have preference to certain colours. In comparison with the former approaches, our methodology is ideal to predict ASD in children by using the infrared and pulse rate sensor which helps to analyze the colours that they are not comfortable with. The design we have modelled is envisioned for investigation and treatment of autism and tests included contributors with this condition.***

Index Terms: Autism SpectrumDisorder (ASD), Arduino Nano, Bluetooth Module, Infrared Sensor, NodeMCU

I. INTRODUCTION

In order to diagnose Autism Spectrum Disorder (ASD), individuals must have deficits in socialization, communication, imagination and learning deficiencies before they are three. In the last 5 years there has been a steady progress in detection of these kids with the help of automatic approaches like tracking of faces, recognition of facial muscles and head pose estimation. In this paper we use infrared sensor for eye movement analysis and a pulse sensor for pulse rate study to aid in the analysis of Autism Spectrum Disorder (ASD).

Autism is not a disease, it's a developmental disorder that impairs the ability to communicate and interact. It is usually found in children between the ages of 1-3. It can only be detected through observation.

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***** Correspondence Author
Rajiv Vincent, Assistant Professor, SCSE, VIT University, Chennai, India.
V Vijayakumar, Professor, SCSE, VIT University, Chennai, India.

Children need to be trained with respect to their particular disorder. Therefore, this paper intends to find the solutions for the problems to help children with autism to absorb, recognize, understand, and use emotive information and outspread these expertise in a socially suitable, flexible, and adaptive situation.

In this paper we propose to make the investigative method for ASD hassle-free, more effective and more impartial by means of automated examination of an individual's behaviour.

We extract high level features from IR based sensing unit which consists of transmitter and receiver that helps to know the opening and closing of the eyes and a pulse rate sensor which records the pulse rate on seeing the colour to learn and identify the kids who are diagnosed with this disorder and from which colour they are not comfortable with or the character they might have a problem learning about. The data is stored in a NodeMCU processor through a Wi-Fi module. The mobile device is used as a display screen, fitted to the Virtual Reality (VR) box through which the children can able to see the colours displaying on the device with the help of Unity tool. The data is send to the cloud and using ThingSpeak platform and then we analyse, visualize and act on the data.

The study presents the initial stride in understanding the fundamental mechanisms, reasons and concerns of colour likings and learning difficulties in ASD. It is proposed method offers a foundation for upcoming large scale investigations with ASD children.

II. RELATED WORK

The usage of computer based contemporary methods for diagnosing people for autism is in its early stages and restricted investigation has been recorded in this area. Here we discuss the present mechanisms that target spontaneous recognition of some indicators that could aid in the identification of ASD.

Revolutionary research in ASD was done by Hashemi et al. [1]. This effort implemented computer visualization centred approaches to recognise some developmental indicators centred on Autism Observation Scale for Infants (AOSI) associated to optical responsiveness and motor outcomes. For evaluating optical responsiveness, authors concentrated on three key developmental indicators, they are expressing curiosity, optical monitoring and extrication of attention. These developmental indicators are identified by approximating the head posture in the up-down direction (pitch) and in the left right direction (yaw).

The head posture was assessed by monitoring the location of some facial features (eyes, nose, ear, etc.). In [2], authors investigated colour liking in kids with autism spectrum disorder. Out of 6 colours, participants were asked to pick a colour and the preference was then noted. For the numerical examination, the likeness score was calculated for the colour by deducting its likeness rank from the number of the provocation colour. The outcomes from the evaluation conclude that children have a preference for primary colours rather than secondary colours.

In [3], the authors inspect colour visualization perception in ASD kids and youths without knowledgeable disability. Outcomes exhibited that colour judgement was reduced about 30% of the kids/youths with ASD. In [4], the author has inspected whether colour observation is atypical in kids with autism. In trial 1, precision of colour recall and exploration was examined for kids with autism and typically developing kids mapped on age and non-verbal intellectual ability. Kids with autism were considerably less precise at colour recall and examination than controls. In trial 2, chromatic discernment and definite observation of colour were evaluated using a target recognition task. Kids with autism were less precise than controls at sensing chromatic goals when offered on chromatic backgrounds. Similarly in [5], a process identifying self–trigger activities, an evident developmental indicator in persons with autism is proposed. The motion indicator was calculated using governing gesture flow in the identified physique parts, to construct an exemplary for recognizing self-trigger behaviour in videos.

Most of the said mechanisms have focused on identifying definite pre-defined developmental indications which are more related with ASD in kids. In these initial mechanisms the efficacy in foreseeing the definite ASD identification still to be determined. Our work proposes the diagnosis of ASD directly as an IOT centred method. Our approach tries to understand prototypes for steadfastly prophesying circumstances such as ASD using eye tracking and pulse rate features which can be dependably calculated nowadays.

III. METHODOLOGY

In this work we have examined the colour observation of kids with autism in 2 phases. This system tells us the preference of the colours they are comfortable with by detecting the pulse rate and the eye blink detection. The first application over VR has the kid in an environment with options to choose between four different coloured boxes- Blue, Green, Yellow and Red. The colours are shown in a mobile phone which is fitted in front of the VR box. At that instant the pulse rate and eye movement is detected by a pulse rate sensor and an infrared sensor. The data extracted from the sensors are stored in NodeMCU, which then sends back the data to cloud with the help of an inbuilt Wi-Fi module. The data are analysed, visualized in the ThingSpeak platform. Using the R-software, we perform the anova on this data with another dataset consisting of information on children with autism. Thus, after performing the calculations we were able to tell whether there is a difference between the autistic kids and control group with respect to colours.

We used NodeMCU and Arduino as primary micro controllers in this work. NodeMCU has a built in Wi-Fi module, that helps in transmitting the data into the cloud and can be used to implement IOT and Machine learning ideas onto the same. We also used Arduino board to provide the necessary power output. In terms of sensors we used a pulse rate sensor, to check the spike in the pulse rate of theparticipant. We used infrared sensors to check the eye blinking mechanism.

We connected the NodeMCU to three basic components.

- Pulse Rate Sensor
- Infrared Sensor
- Camera Module

The NodeMCU works as the input for all the sensors to give clear indications of the child's emotions. It has a built in Wi-Fi Module (ESP8266) connected to the cloud that will help move every data to the cloud.

IV. DESIGN APPROACH OF PROPOSED SYSTEM

A. Virtual Reality Application

There are reasons behind using the Virtual Reality Box. Using a Virtual Environment, the participant will be confirmed of a few things.

- He/she will be able to distinguish between 3D and 2D images.
- Colours will be far more realistic.
- Will experience a better user interface.
- Can learn more about colours using alphabets, numbers or their daily usage things.
- Other VR settings will express and teach social norms involving social awareness and also help increase physical and social safety across a wide range of scenarios like crossing roads, coping with traffic, etc. thus helping them to manage the expectations and behaviours in potentially sensitive situations.

B. Sensors

Here two sensors are used

1) Infrared Sensor: An infrared sensor is a device that senses infrared emission dropping on it.

2) Pulse Sensor: The pulse sensor shows the blood flow by using a fastener engaging a laser beam that produces light via the skin and defines the real reflectivity of the laser beam because of the flow of the circulatory structure.

C. Data Processing Unit

1) NodeMCU: This system is grounded on the NodeMCU board that is an open source IOT platform with built-in support for Wi-Connectivity. The Wi-Fi module in-built helps in transmitting the data on to the cloud and can be used to implement IOT and Machine learning ideas.

2) WIFI Module: It helps in transmitting the data into the cloud and can be used to implement IOT and Machine learning ideas.

3) Mobile Device:

An android or smart phone is fitted on the VR box through which the children can see the coloured boxes through the Unity tool.

This software helps to build 3D coloured boxes, alphabets or numbers which is shown to the children for the extraction of the preference of the colours using a Software Development Kit (SDK) tool that will create the Android Package (APK) i.e. turning this program into an Android app that is launched on a phone and that is how they'll be able to see it on this device.

4) ThingSpeak Cloud:

ThingSpeak is an Internet of Things (IoT) that collects and stores sensor information in the cloud and helps in developing IoT applications. The ThingSpeak IoT platform offers apps that allow examining and envisaging your information, calculating new data, or interacting with social media, web services, and other devices. Sensor data can be sent to ThingSpeak from Arduino, Raspberry Pi, BeagleBone Black, and other hardware.

5) Anova:

The two-way ANOVA relates the mean variances among groups that have been divided on 2 autonomous variables (called factors). Here, it checks the two independent variables - pulse rate and blink rate i.e., beats and blinks per minute.

Fig. 1 shows the overview of the proposed system. The flow diagram below is a simplified representation of our work.

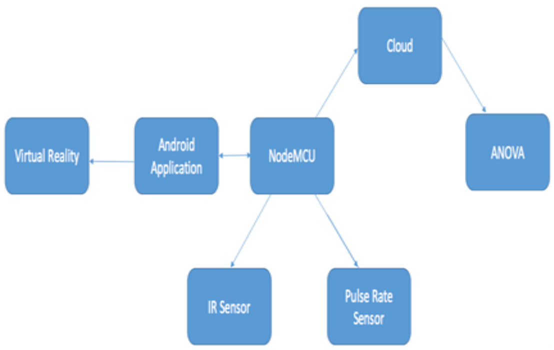

Fig. 1. Overview of the Proposed System

V. CONFIGURATION OF HARDWARE COMPONENTS

A. Position of Sensors

The sensors are fitted very discreetly in the highly modified VR headset. The two main sensors used in this project are connected as follows:

• Pulse Rate Sensor: The pulse can be sensed where an artery is near to the surface of the skin. Sensor is fitted to the side of and behind the eye. The skinny sheet of fat and muscle helps in detecting pulse easily. It takes the pulse rate every 5 seconds and the Beats Per Minute (BPM) of the participating kid is recorded.

• IR sensor: This sensor is fitted in the middle of the headset. IR sensor is positioned considering the nasal and temporal aspects of one eye, causing the infrared beam to pass horizontally across the central portion of the opening and closing of the lids. It measures the number of blinks per minute and gives a clear indication of comfort levels of the participants.

B. Pin Connection

1) Connect Infrared Sensor to NodeMCU as follows:

- S to D1
- \+ to 3V3
- \- to GND1

2) Connect Infrared Sensor to NodeMCU as follows:

- OUT to D0
- VCC to VCC1
- GND to GND1

3) Connect the USB cable with the power supply to get the readings of pulse and blink rates. Upload Pulse Rate Sensor and Infrared Sensor data to Thingspeak from ESP8266 Module (NodeMCU). Fig. 2 depicts the hardware configuration.

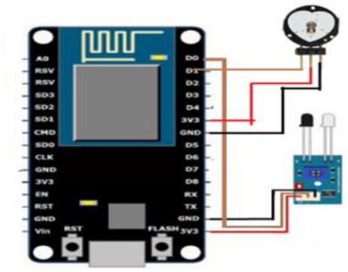

Fig. 2. Hardware Configuration

VI. RESULTS

We performed one way and two anova tests on eye blink and pulse rate readings to check which colour is preferred by the children and if there is a significant difference between the autistic kids and control group with respect to colours. Table 1 shows the one way anova for eye blink. Table 2 represents the comparison between colours. Table 3 gives information on one way anova for pulse rate. Table 4 gives the data on comparison between colours. Table 5 emphasizes on two way anova for eye blink. Table 6 talks about two way anova for pulse rate.

Table 1. One Way Anova for Eye Blink

	Sum of Squares	Degrees of Freedom	Means of Squares	F
Between	26.1	3	8.7	4.0675
Within	77	36	2.1389	
Total	103.1	39		

Table 2. Comparison between Colours

Comparison pair	Mean Difference	Difference Significance
Yellow-Green	0.6	Insignificant
Yellow-Blue	0.3	Insignificant
Yellow-Red	1.5	Insignificant
Green-Blue	0.3	Insignificant
Green-Red	2.1	Significant
Blue-Red	4.24	Significant

Table3. One Way Anova for Pulse Rate

	Sum of Squares	Degrees of Freedom	Means of Squares	F
Between	1325.475	3	441.825	5.2617

Within	3022.9	36	83.9694	
Total	4348.375	39		

Table 4.Comparison between Colours

Comparison pair	Mean Difference	Difference Significance
Yellow-Green	0	Insignificant
Yellow-Blue	2.4	Insignificant
Yellow-Red	13.9	Significant
Green-Blue	2.4	Insignificant
Green-Red	13.9	Significant
Blue-Red	11.5	Significant

Table5. Two Way Anova for Eye Blink

	Sum of Squares	Degrees of Freedom	Means of Squares	F
Functioning	0.9	1	0.9	0.4237
Color	26.1	3	8.7	4.0941
Interaction	8.1	3	2.7	1.2705
Error	68	32	2.125	
Total	103.1	39		

Table 6. Two Way Anova for Pulse Rate

	Sum of Squares	Degrees of Freedom	Means of Squares	F
Functioning	384.4	1	384.4	3.2554
Color	175.4	3	58.47	3.4951
Interaction	59.8	3	19.94	0.1688
Error	3778.8	32	118.08	
Total	4398.4	39		

VII. DISCUSSION

ASD isn't really a disease but a mental condition that can be worked upon based on the suggestions and researches put forth by the esteemed researchers. We have done an innovative method for making ASD children foresee colours through automated data examination. This work unfavourably examines these recent inspective studies on autism, not only expressing the above-mentioned problems in these studies but also mentioning ways to improve the shrewd methods to use in ASD with respect to conceptualization, execution, and information. With this experiment, we would like to make the idea of diagnosing the children with ASD a tad bit simpler. Thus, from the study it was concluded that kids with ASD reacted more to colours than the control group. Misinterpretation of colours was also seen in kids with ASD. Colours like red were mistaken with similar shades like pink, orange, purple etc. This was a major observation. Pulse rate differed with higher pulse rates for brighter colours and relatively normal pulse rates for lighter colours. Control group pulse rate remained normal in both the cases.

VIII. CONCLUSION

We have done an innovative method for making ASD children foresee colours through automated data examination. Eye tracking like blink detection and pulse recording are used in analyzing models which can precisely foresee ASD. The pulse rate as a probable factor for grouping of people with these conditions from fit controls was examined. The use of NodeMCU was the main component through which the information regarding colour preference of autistic children is developed which was a major contribution. Other major contribution is of the ESP8266 Wi-Fi module which sends the data to ThingSpeak on which the pulse and blink rates is stored which is further used to identify the difference in perception of colours between high functioning and low functioning autistic kids. Forthcoming studies in relation to machine learning in autism investigation are significantly helped by such proposals.

REFERENCES

1. Jordan Hashemi, Thiago Vallin Spina, Mariano Tepper, Amy Esler, Vassilios Morellas, Nikolaos Papanikolopoulos, and GuillermoSapiro . Computer vision tools for the non-invasive assessment of autismrelated behavioral markers. CoRR, abs/1210.7014, 2012
2. Marine Grandgeorge and Nobuo Masataka. Atypical Color Preference in Children with Autism Spectrum Disorder,2016
3. Elaine C. Zachi, Thiago L. Costa, Mirella T. S. Barboni, Marcelo F. Costa, Daniela M. O. Bonci and Dora F. Ventura. Color
4. Vision Losses in Autism Spectrum Disorders,2017.
5. Anna Franklin, Paul Sowden, Rachel Burley, Leslie Notman, Elizabeth Alder. Color Perception in Children with Autism,2008
6. Shyam Sundar Rajagopalan and Roland Goecke. Detecting selfstimulatory behaviours for autism diagnosis. In 2014 IEEE International Conference on Image Processing (ICIP), pages 1470–1474. IEEE, 2014
7. Shashank Jaiswal,Michel F. Valstar,Alinda Gillott,David Daley, Automatic Detection of ADHD and ASD from Expressive Behaviour in RGBD Data, 2017 IEEE 12th International Conference on Automatic Face & Gesture Recognition
8. Iftekhar Uddin Ahmed, Nazia Hassan, Humayun Rashid, "Solar Powered Smart Wearable Health Monitoring and Tracking Device Based on GPS and GSM Technology for Children with Autism," 2017 4th International Conference on Advances in Electrical Engineering
9. M. A. Volker, C. Lopata, D. A. Smith, and M. L. Thomeer, "Facial encoding of children with high-functioning autism spectrum disorders," Focus Autism Develop. Disab., vol. 24, no. 4, pp. 195–204, Dec. 2009.

AUTHORS PROFILE

Rajiv Vincentis an Assistant Professor in the School ofComputing Science and Engineering VIT University, Chennai. Hisresearch interests include image processing, cyber physical systems, web technologies and programming languages.

Vijayakumar Varadarajan is a Professor in School of Computing Science and Engineering at VITUniversity, Chennai, India. He has published many articles in national and international level journals/ conferences/books.He has initiated a number of international research collaborations with universities in Europe, Australia, Africa and North America including University of Missouri.