2017 2nd International Electrical Engineering Conference (IEEC 2017)
May. 19th -20th, 2017 at IEP Centre, Karachi, Pakistan

Edutainment System For Autistic Children

Asma Yousuf[1], Rida Irfan[2], Iqra Siddiqui[3], Syed Saad-ul-Hasan[4] and Hashim Raza Khan[5]

[12345] Department of Electronics Engineering, NED University of Engineering and Technology, Karachi, 75290, Pakistan

[1]asmayousuf95@gmail.com,[2]rida.irfan68@gmail.com,[3]iqrasiddiqui36@gmail.com,[4]saadulhassanis@gmail.com, [5]hashim@neduet.edu.pk

Abstract: Special education nowadays is being redefined. Since technology makes things easier for human beings, a worthy way to utilize engineering skills as addressed in this work is to develop learning system for the people with special needs. This work is all about edutaining the autistic children making use of the technology in an efficient and cost effective way. Autistic Children tends to be different from one another in many ways. The design and implementation of Edutainment System for Autistic Children helps to improve their fine and gross motor skills, eye-hand coordination, their focusing capability, playful skills and decision making capability using an imaging technique. The system includes a camera, a customized car, a thematic maze and a personal computer. The child performs hand gestures in front of a box containing a USB camera and in response of the backend processing of MATLAB and Arduino, the car moves in the particular directions on the particular signals received, capturing the attention of the autistic children. For the children to remain attracted and motivated, a sound is played as the feedback on receiving the signals. The enthusiasm and excitement observed at the Centre for Autism while testing the developed system with the autistic children proved the system to be constructively effective if introduced as their learning system.

Keywords: assistive technology, embedded system, image processing, functional play, edutainment system

I. INTRODUCTION

Autism refers to autism spectrum disorder (ASD) where the individuals suffering from autism varies greatly with age and ability that may lie somewhere in the spectrum. Autism is a social stigma that mainly affects the social interaction and communication skills, behavior, interests or activities of individuals. On the global level, about 1 in every 150 children suffer from autism [1]. Developed countries like U.S.A and European block are already working on the development of smart gadgets, toys, and edutainment related stuff to improve the quality of life of autistic individuals. Since autism is the fastest growing neuro-developmental disorder, the country like Pakistan is in need to properly address this issue. Autism is a lifelong condition and has no cure but there are some interventions that can improve the quality of life of autistic individuals [2]. Since researches showed that the children suffering from autism are more likely to be friendly and interactive with a robot than any human, so, instead of adopting the conventional method of teaching, teachers of Autistic children use robots as learning system. Robots like Keepon, Hanson Robokind, Bandit, Kaspar, NAO and Probo have already been very successful in aiding autism's diagnoses and relevant therapies [3]. However, in developing countries, these robots are unaffordable and costly to maintain.

At this University, a Kinect Based Edutainment System for Autistic Children [4] is under development since 2015 which was continued by us in 2016. The earlier system had the following limitations:

- The children needed assistance of an instructor to control the car via their hand gestures but the Kinect was programmed for tracking single skeleton only. As a result, the device was suitable only for autistic children in high spectrum and older age.
- The hardware of the project included Kinect in it, which approximately costs 14,499 Pakistani Rupees, making the hardware cost exorbitant [5].

To overcome these limitations, MATLAB based imaging technique and algorithms based on multiple body detection were implemented using better and less costly peripherals resulting in an improved and cost efficient Edutainment System.

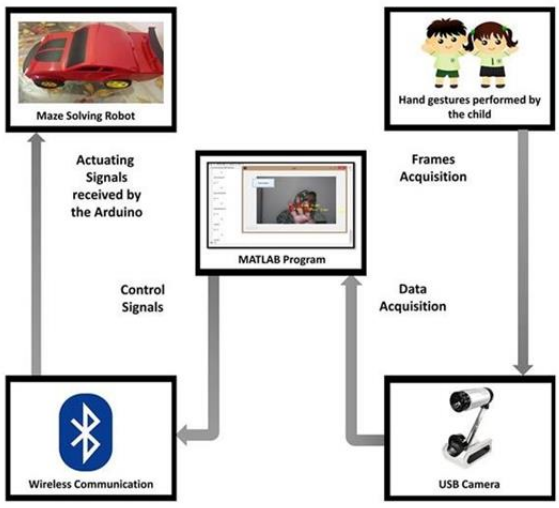

Figure 1: Flow Diagram of the Project

Keeping in mind the difficulties and affected areas of the autistic children at Centre for Autism (CfA), a maze game was planned for the children. The game consisted of a customized toy car which has to follow a track to reach the final line. The car is directly controlled by the hand gestures of the child and that requires the child to wear a customized glove and stand in front of a camera while performing some specific gestures to control the movement of the car on the track. If the child does not wear gloves as many autistic children feel uncomfortable with wearing anything new, the car can also be controlled by holding a dice in hand. The child has to stand in front of a camera and show different faces of dice to control the movement of the car on the track in different directions in order to reach the final line. The frames captured by the camera are fed to the MATLAB code for processing. Colored Object Detection algorithm is implemented in MATLAB to generate a particular signal for particular number of red color objects. These control signals are then sent to the Arduino Board mounted on the customized car to control the state of the output pins wirelessly through Bluetooth. As a result of which the car moves in particular directions capturing the attention of the autistic children. For the children to remain attracted and motivated, a sound is played as the feedback on receiving the signals.

This activity would help to improve fine motor skill, eye-hand coordination, playful skills, focusing capability, learning directions and decision making capability of the child.

The next section elaborates the working and the technicalities of this project which is followed by the results obtained while testing the system with the autistic children at CfA. Then conclusions drawn from the results are presented along with the future improvements that can be made to make the system more effective.

II. METHODOLOGY

The entire procedure can be divided into two sections. The first section is hand gesture recognition through the detection of the colored object using MATLAB image processing algorithm. The second part includes communication of MATLAB with Arduino mounted on the Maze Solving Robot (MSR) wirelessly through Bluetooth.

A. Color Object Detection Using MATLAB

First of all, video input function in MATLAB is used to capture video frames. A video input object is created which represents a connection between MATLAB and the imaging device. Then Image Acquisition Toolbox is launched which is used to determine the installed adapters available on the system, the serial number of the imaging device communicating with the MATLAB and the particular format supported by the imaging device.

Once the video object is created, some properties i.e. Frames per Trigger, Returned Color space and Frame Grab Interval are set.

After that **"Bounding Box"** Algorithm is implemented on the captured images. This algorithm is explained below[6, 7]:

- The image grabbing function runs inside a while loop.
- Image subtracting function is applied on RGB images to extract out the desired colored components from the captured images. The selected color for detection which is the color on gloves and dice is red. Therefore, the threshold for red color is set for detection in this case which can be varied.
- Most of the time, digital images get easily interfered by noise. Therefore, Median filter is applied to cancel out the noise without affecting the shape of the image.
- The image is then converted to black and white form as most of the image processing tools can only be applied on the black and white images.
- Then 'regionprops' function of the MATLAB is implemented to get the detail of all the components of the images. An array structure is created here which gives the number of red colored objects present in the black and white images.
- Further, a unique character is generated for a particular number of red colored objects which is sent wirelessly through Bluetooth to control the movement of the car.

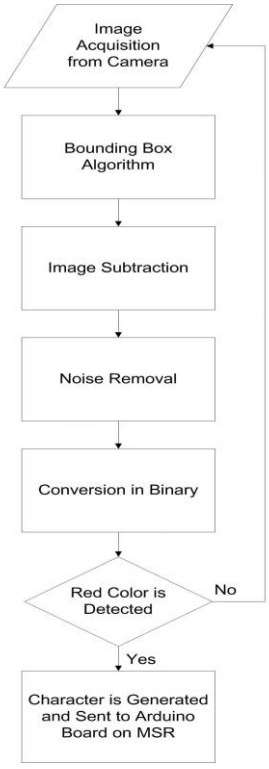

Figure 2: Flow Chart of the Project

B. Wireless Communication through Bluetooth

The control signals generated from MATLAB using image processing are transmitted wirelessly to the Arduino Mega Board which is mounted on the Maze Solving Robot (MSR). Bluetooth has been used as a medium to send the controlling signals to MSR.

HC-05 Bluetooth Module has been operated in data mode in order to transmit the signals generated from MATLAB to Arduino Board. This is done by sending characters over a Baud Rate of 115200 bps. Bluetooth serial object is created in MATLAB which in turn communicates with Arduino Mega Board serially [8].

C. Maze Solving Robot (MSR)

The customized toy car that was built up for this particular activity is named as Maze Solving Robot. This car has minimum turning radius, its speed is controllable and it has features of lights and feedback sounds as well. The signals generated from MATLAB which are wirelessly sent through Bluetooth are received by the MSR. MSR has an Arduino Mega microcontroller board having a Bluetooth module HC-05 connected to it that receives the signals generated by the PC. A particular signal is dedicated to the movement of the car in a particular direction. When one red object is shown by the child, the MATLAB pro cesses the image, sends a character to the Arduino Mega connected to the MSR. This in response actuates both the motors in clockwise direction pushing the car forward with controlled speed. To control the speed of the motors, an L298 motor driver module is connected to MSR. In the same manner, the car moves;

- Backward when 2 red objects are shown by the child.
- Left when 3 red objects are shown by the child.
- Right when 4 red objects are shown by the child.

For each of the above cases, the car plays a sound for interacting with the children in a better way. This is done by an SD card module for Arduino mounted on the car along with amplified speaker to play up sounds.

Figure 3: Maze Solving Robot

III. TESTING AND RESULTS

.

Having advantage of the link already established with Centre for Autism (CfA), Karachi, several visits to CfA were made and each visit proved to be more fruitful than the former. The planned activity was successfully executed by the Autistic Children. Since autism is a spectrum which greatly varies with age and ability so the responses varied from individual to individual according to the spectrum in which they lie. We observed responses of 9 children out of which 3 children drove the car to the final destination. Some of the children were very excited by the car, some were fascinated by the maze on which the car had to run, and some were attracted to the sound which was being played as a feedback of the signals received. A few children had difficulty to focus on the two things at the same time i.e. controlling the car through their hand gestures as well as observing its motion at the same time.

Table: Observations at CfA

Attributes	Child 1	Child 2	Child 3	Child 4
Age	8	10	7	6
Able to converse	yes	yes	no	yes
Completes activity	yes	yes	no	yes
Uses gloves	yes	yes	yes	no
Uses dice	no	no	no	yes

Figure 4: Testing at Centre for Autism

IV. CONCLUSION

A less costly hand gesture controlled car using colored object detection technique was designed which proved to be an effective way to interact with the

children in order to improve their affected areas. The major success of the project was full execution of the activity with the children due to the following enhancements in the existing system:

- No technical error i.e. now the children can have as many assistants in performing the activity as they need. The problem of single skeletal detection is now solved with better and improved algorithm.
- Laptop screen that caused the attention diversion from the main activity in the existing system is now hidden i.e. the children are not distracted towards the laptop screen as it is now removed from their line of sight.
- Feedback generated for each signal in the form of sound became the main attraction for the children that captured their attention and motivated them to drive the car.
- The thematic maze created on which the car had to run, appealed the children and excited them to enter the game zone properly.

However, it was observed that the difficulty level of the activity was higher than the functionality level of the children, so dice and gloves can be replaced by some other suitable thing for colored object detection. Further enhancements that can be made in this system are:

- The Maze Solving Robot can be enhanced further by adding more features in it or it can be replaced by Humanoid Robot so that it is more fascinating and appealing to the children.
- On board Computer can be used to completely remove the Laptop Screen from the Project and make the system more cost effective.
- For better and quick response, C++ can be used for the backend processing instead of MATLAB.
- A mobile application would be easier for children to handle in order to control the car.
- Certain other set of activities can be planned making use of this system.

ACKNOWLEDGEMENTS

We extend our sincere gratitude to Mrs. Roohi Maroof, the Principal of Centre for Autism and the whole staff of CfA for their help and support throughout the research and allowing us the access to the autistic children.

REFERENCES

[1] Fact Sheet Available from: www.educateiowa.gov/sites/files/ed/documents/Parent-Factsheets_April2010_Autism.pdf

[2] Behind the Autism Spectrum. . Available from: http://www.scienceinschool.org/2012/issue24/autism.

[3] How Robots could improve Social Skills in Kids with Autism. Available from: www.forbes.com/sites/emilymullin/2015/09/25/how-robots-could-improve-social-skills-in-kids-with-autism-disorders/#178d2e3f6463.

[4] Kinect Based Edutainment System for Autistic Children. Available from: http://iepkarachi.org.pk/ieec/papers/IEEC2016-47.pdf.

[5] XBOX 360 KINECT SENSOR. Available from: http://shoprex.com/electronics/games/consoles/xbox-36

[6] Implementation of MATLAB based Object Detection on Arduino Board and iROBOT. Available from: http://www.ijsrp.org/research-paper-0114/ijsrp-p25107.

[7] Video Input. Available from: www.mathworks.com/help/imaq/videoinput.html.

[8] . HC-05. Available from: www.or97.com/hc-05-bluetooth-module.