

Pattern Identification Training System for Children with Autism

PITS

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Abstract

Autism is characterized by impairment in communication, social interaction, emotional expression, and emotional recognition. Visual supports can alleviate these challenges by juxtaposing communication with visual cues. Children with autism and school-based teaching staff use paper based visual supports to complete tasks, manage daily routines, and engage in social interactions. However, it is becoming very difficult for the teachers to rely on these paper based visual supports because these can easily be lost or damaged. To address these challenges, a "Pattern Identification Training System (PITS)" for the students with autism is developed. The "PITS" is a computer based training system that can be used for training the students with autism to learn basic shapes, colors, flowers, animals, and find the odd man out etc., from a given set of patterns. It not only eases the teacher's effort but also motivates the child to learn the patterns by providing incentives via audio signals.

1. Introduction

Autism is characterized by impaired development in social interaction, communication, and behaviour [1]. The optimal treatment of autism involves an educational or vocational program that is suited to the developmental level of the child or adult, respectively [2]. Children with autism have difficulty in understanding and establishing meaningful social relationships. They can also become overwhelmed with too much sensory input, and communication is difficult for them. Students with disabilities often lack the necessary skills to be successful in doing simple social tasks like boarding a school bus or getting engaged in the school work. Visual supports can alleviate these challenges by juxtaposing communication with visual cues. Children with autism and school-based teaching staff use paper based visual supports to complete tasks, manage daily routines, and engage in social

interactions. A variety of strategies have been used to help children with autism acquire functional communication skills. The Picture Exchange Communication System (PECS) is a unique communication training program meant for training communication skills for autism students. Children using PECS are taught to give a picture of a desired item to a communicative partner in exchange for the item. By doing so, the child initiates a communicative act for a concrete outcome within a social context. Certain augmentative or alternative communication systems involving the use of pictures have avoided some of the issues associated with initial attempts to teach eye contact and imitative skills (Reichle et al., 1991). These picture-based systems have required the student to point to pictures (or touch and/or tap them). Traditionally, pointing to pictures has followed a matching-to-sample format, wherein the child is taught to match objects to objects, objects to pictures, and then pictures to objects (Carrier & Peak, 1975). Training generally involves teaching children to respond to verbal prompts such as "Point to the picture of the cup," or "Show me the cup." This type of responding may be relatively easy for typically developing children or children with non-socially based handicaps because these actions are primarily rewarded and maintained by social reactions. However, such consequences are weak motivators for preschool children with autism.

Extensive work has been done in assistive technologies, technologies for autism, and educational technologies. In this section, we first provide some background information on visual supports in classrooms and then outline those research projects in autism and educational technologies most relevant to our work.

Visual supports can be therapeutically effective for children with autism. These techniques may present clear advantages with regard to ease of use and intelligibility for communication patterns [3]. In one survey, 51% of classrooms reported using visual supports "most of the time", and 29% of classrooms

“some of the time” [4]. Visual supports typically include the exchange or display of a variety of images, drawings or photographs on laminated cards to represent tasks, needs, goals and rewards as shown in Fig 1. These visual supports are a type of aided, augmented communication common to special education classrooms used to provide support for learning and socialization [5].



Fig1. Examples of Paper Based Visual Support

There are many ways to use visual-graphic cards to assist children with autism, and often one large set of cards is used across a number of practices. Here we describe three common classroom tools in more detail:

- 1) Visual schedules,
- 2) Choice boards, and
- 3) Token-based rewards.

Visual schedules display planned activities in symbols (words, pictures, photographs, icons, and actual objects) that are understood in the order in which they will occur [6]. Schedules act as reminders of the day’s events, preparing students for activities and transitions and providing students with structure to reduce anxiety and support better self-organization as shown in Fig 2. Schedules can represent an “in task sequence”, in which each step of a procedure is displayed, or, a “between task” sequence, in which the cards represent the day’s activities [7]. In classrooms, “between task” visual schedules act as reminders of the day’s events, preparing students for daily activities and transitions between activities



Fig 2. Visual Schedule Display

Choice boards or communication boards allow students with verbal language deficits to participate in multiple choice assessments, voice personal preferences, carry out functional communication, and participate in classroom activities [8].

In *token-based reward systems*, students earn tokens for desired classroom behavior, such as staying on task and completing activities [9]. Once a set number of tokens are earned, the reward, often tangible, is delivered and the tokens are removed, resetting the count.

As mentioned in the previous section, all these systems are prone to damage by means of aging or because of the unpredictable behavior of the autistic students. To face some of these challenges, a PIT system developed is presented in this paper.

The “PITS” is a computer based training system that can be used for training the students with autism to learn basic shapes, colors, flowers, animals, and find the odd man out etc from a given set of patterns. It not only eases the teacher’s effort but also motivates the child to learn the patterns by providing incentives via audio signals.

The layout of this paper is organized as follows: Section II deals with the functional description of the system, section III discusses the software programming details, section IV describes the hardware interface and design and finally, section V concludes the paper

2. The Pattern Identification Training System

The functional block diagram of the Pattern Identification Training System is shown in Fig 3.

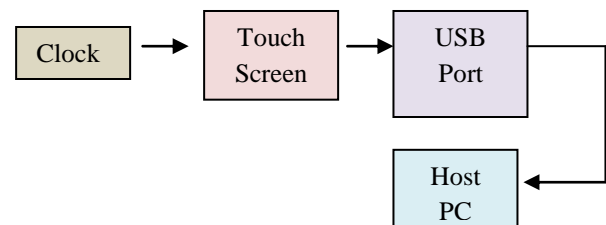


Fig 3. Functional Block Diagram of PITS

The main components of the proposed system are:

1. Touch Screen Controller
2. Microcontroller
3. The Pattern Identification Training System

The touch screen controller interfaced to a microcontroller is used to control the four wire resistive touch screen. The touch screen is interfaced with the host PC by means of USB port. This is the hardware interface part of the system and the actual training is implemented by the software in the personal computer. The software is developed by using NI Labview. The main reason for using a touch screen in the system is that the autism children cannot show dexterity in operating the mouse by clicking it. Instead, if they are made to just touch a screen it will provide a lot of ease for them in operating it which in turn creates interest for them to use the training system. The working of the whole system can be understood with the help of Fig 4.

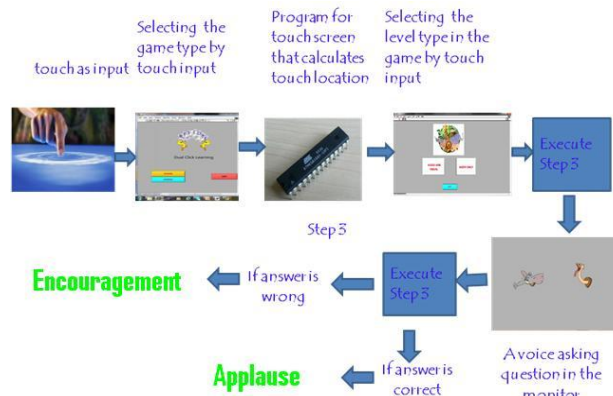


Fig 4. Illustration of Working of PITS

The PIT System will have a number of patterns placed at different levels. The first level has basic shapes and colors. The second level consists of animals, vegetables, flowers etc and the third level trains to identify the odd man out of the given set of patterns. According to the students IQ level a particular level should be selected by the teacher. Then, the student chooses one of the patterns set like colors or shapes from the display screen on the monitor by touching the monitor. The touch screen is a four wire resistive device controlled by the touch screen controller interfaced to the microcontroller. Then according to the potential drops that are developed at the point of touch the microcontroller decides if the student has identified a correct pattern or not. If the answer is correct an audio signal that indicates applause like “Claps” or his

favorite song is output otherwise, an encouragement voice motivates the child to repeat it again. The PITS system is user friendly and the trainer can select a language of his choice and that is understandable to the autistic kid.

The total system is a hardware software co-processing. The hardware implementation part of the system is presented in the next section

3. Hardware Implementation of PITS

The hardware implementation of the PITS depends on interfacing the touch screen with PC through the microcontroller. The block diagram for interfacing the touch screen with microcontroller is shown in Fig5.

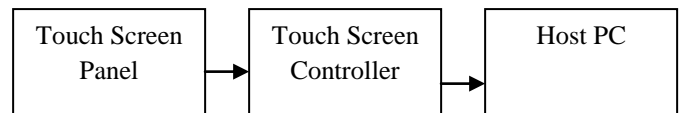


Fig5. Block Diagram for Interfacing Touch Screen with PC

The touch screen panel is divided into four quadrants namely, X- and X+ along horizontal direction, Y- and Y+ along the vertical direction. The X+, X-, Y+ and Y- co-ordinates of the touch screen panel are connected to the touch screen controller. The touch screen controller is interfaced with the Host PC by means of USB port.

The touch screen is the heart of the hardware of the design and is shown in Fig 6.

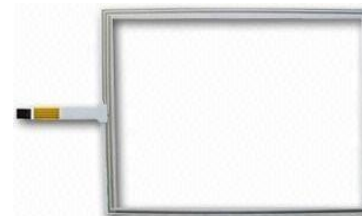


Fig 6. Touch Screen

A touch screen is an electronic visual display that can detect the presence and location of a touch within the display area. The term generally refers to touching the display of the device with a finger or hand. Touch screens can also sense other passive objects, such as a stylus. Touch screens are common in devices such as game consoles, all-in-one computers, tablet computers, and smart phones.

The touch screen has two main attributes. First, it enables one to interact directly with what is displayed,

rather than indirectly with a pointer controlled by a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device that would need to be held in the hand (other than a stylus, which is optional for most modern touch screens). Such displays can be attached to computers, or to networks as terminals. They also play a prominent role in the design of digital appliances such as the Personal Digital Assistant (PDA), satellite navigation devices, mobile phones, and video games.

The touch screen used in this paper is a 4 wire analog resistive touch screen. A resistive touch screen panel comprises several layers, the most important of which are two thin, transparent electrically-resistive layers separated by a thin space. These layers face each other, with a thin gap between. The top screen or the screen which experiences our touch has a coating on the underside surface of the screen. Just beneath it is a similar resistive layer on top of its substrate. One layer has conductive connections along its sides, the other along top and bottom. A voltage is passed through one layer, and sensed at the other. When an object, such as a fingertip or stylus tip, presses down on the outer surface, the two layers touch to become connected at that point: The panel then behaves as a pair of voltage dividers, one axis at a time. By rapidly switching between each layer, the position of a pressure on the screen can be read. This means by touching the screen at one point, a resistance between each edge is formed for both the x and y axis. As you move your finger or stylus across the screen the resistance changes between opposing sides of each axis. By applying a voltage across each axis, a changing resistance results in a changing voltage. Thus a simple ADC on a microcontroller can be used to find x and y positions.

3.1. Configuration of Touch Screen

The circuit consideration for calculating the X and Y positions of the touch screen is shown in Fig 7. To get the "X" touch position, the controller sets X+ to +5V and X- to GND (0V). Y- is left unconnected. The controller uses Y+ to read the voltage where the top layer meets the bottom layer. The controller converts the voltage to a number (data) and sends it to the host computer. To get the "Y" touch position, the controller sets Y+ to +5V and Y- to GND (0V). X- is left unconnected. The controller uses X+ to read the voltage where the top layer meets the bottom layer. Again, the controller converts the voltage to a number (data) and sends it to the host computer.

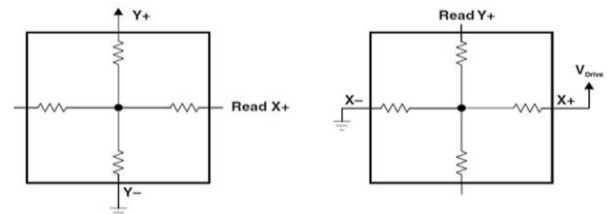


Fig 7. Circuit considerations while calculating X & Y positions

The circuit diagram for interfacing the touch screen with microcontroller is shown in Fig 8. The bottom contact of the Y surface and left contact of the X surface are connected to the microcontroller's A/D converter. The X and Y coordinates are determined by measuring voltage on these contacts, respectively. Once the coordinates are determined, it is possible to decide what we want the microcontroller to do.

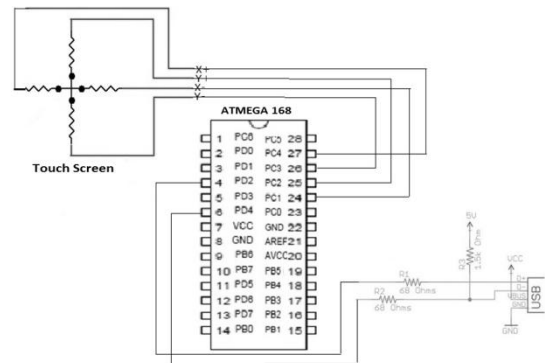


Fig 8. Touch Screen Interfacing with Microcontroller Circuit

4. Software Implementation of PITS

The flow chart for the software implementation of the PITS is shown in Fig 9. The input to the software implementation is received by the touch as sensed by the USB port of the host PC. Then the software implementation gets initiated. Then a popup window opens to choose among the available modes. The available modes are:

1. Audio Visual Mode
2. Audio Only Mode

In the Audio Visual mode, the user has to select among the number of events which may be one among the following:

1. Shapes
2. Animals
3. Colors

4. Vegetables
5. Flowers
6. Birds
7. Traffic Signals
8. Kitchen Utensils
9. Drawing Room Objects

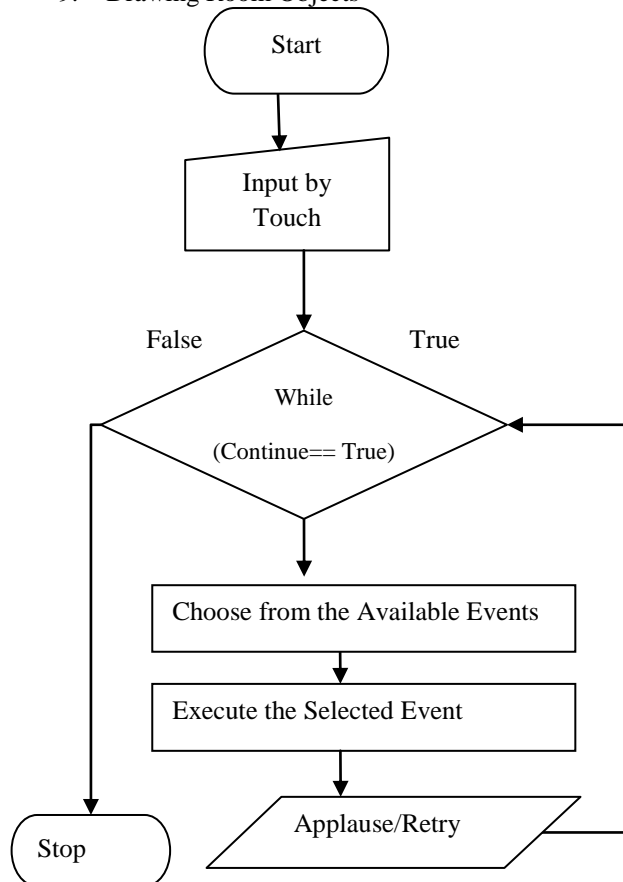


Fig 9. Flowchart for Software Implementation of PITS

Let us say for instance, the event “Shapes” is selected. Then the visual of a “Square” shape is displayed and a voice asks the question “Identify the Square”. Then, two different shapes one of which is a square and the other one which is not a square are displayed. The next step in the algorithm is to choose between the shapes to identify the square. If the person is able to rightly identify the square, he will listen to an applause sound; otherwise a voice encourages him to try again. The same procedure is repeated for the Audio only mode except for the difference that the user listens only to the question but cannot see the problem figure. This mode is like a test session for whatever pattern identification

he has learnt in the Audio-Visual mode. The process repeats until the user wants to exit.

5. Results

The results obtained by implementing the software and hardware discussed in the above sections are presented in this section.

The initial snapshot of the training system for the sake of selection of mode between Audio-Visual and Audio only mode is shown in Fig 10.

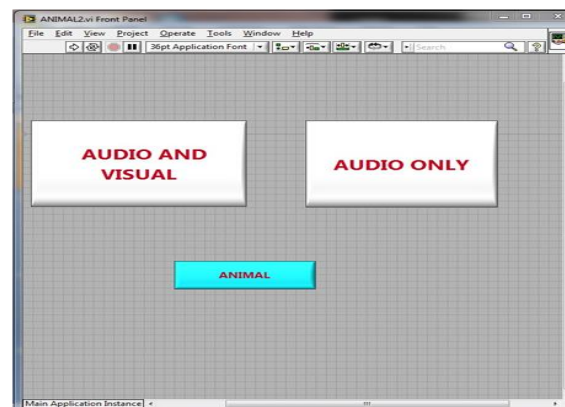


Fig10. Mode Selection

The next step is selection of mode. For instance, say that the user has selected the “Audio-Visual” mode. The screen shot for the Audio-Visual mode and the choices in that mode are shown in Fig 11.

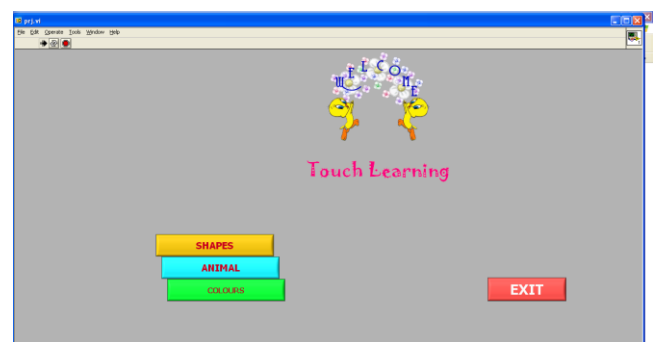


Fig 11. Event Selection

Say, for instance, the pattern “Animals” is selected from the choices. Then the questions pop up as shown in Fig 12.

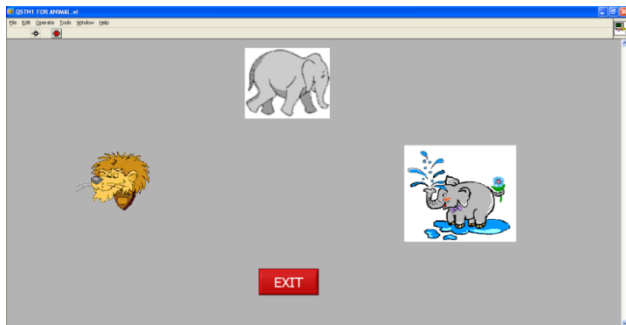


Fig12. Question to Identify Elephant

Now, a voice asks the question “Identify the Elephant”. The person has to identify the elephant by touching his finger on it. If he is able to identify the correct figure he will receive applause. Otherwise, he receives an encouragement to try it again as shown in . The audio only mode for this PIT system is shown in Fig 13.

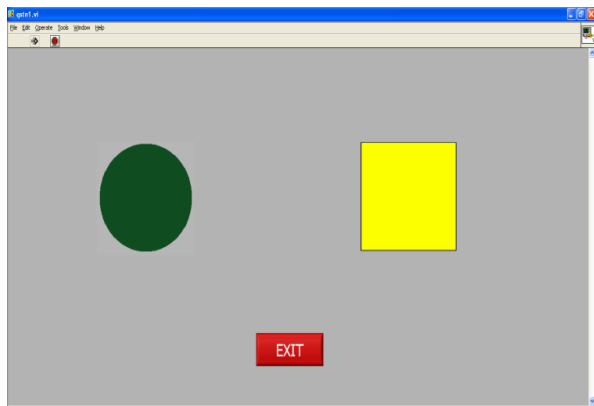
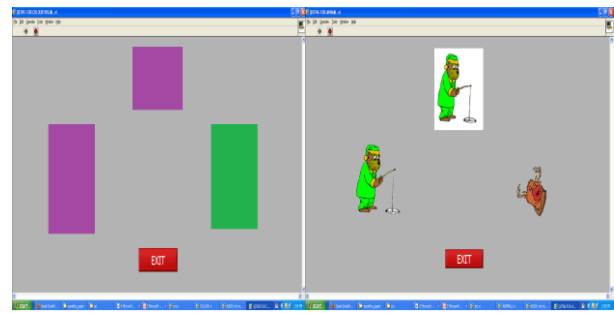


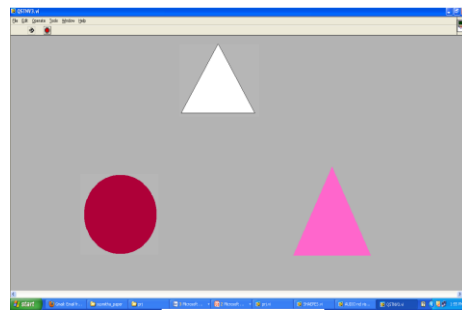
Fig 13. Audio Only Mode Problem Figure

As can be observed from Fig 13, the problem figure of “Audio Only” mode does not show the question figure. Only a voice asks to identify the correct shape. Based on the previous training the user has to pick up the correct shape. In this manner, the training goes on for number of levels, so that the autistic student can well be trained to identify patterns in easy and joyful fashion.

Some more pattern identification training figures are shown in Fig14.



(a) (b)



(c)

Fig14. (a) Identification of Colors (b) Identification of Animals (c) Identification of Shapes

6. Conclusion

Therefore, a “**Pattern Identification Training System (PITS)**” is developed for the students with Autism. The “PITS” which is a computer based training system can be used for training the students with autism to learn basic shapes, colors, flowers, animals, and find the odd man out etc from a given set of patterns. It not only eases the teacher’s effort but also motivates the child to learn the patterns by providing incentives via audio signals.

7. References

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