

Concentration Building System for Children with Attention Deficit Hyperactivity Disorder

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Abstract

Children with Attention deficit hyperactivity disorder (ADHD) experience lack of concentration. In learning process, the concentration power of the students with ADHD should be increased first. Concentration building systems for them are not available in market. This paper proposes a concentration building system for children with ADHD. It consists of three modules-Bird chirping module, Fish tank module and Alphabet learning module. At first the child is encouraged to press switch corresponding to bird chirping module; it soothes his hyperactive mind. This creates interest in pressing the switch related to next module, that is, fish tank module. The movement of different types of fishes makes the child to stare deeply into the screen and can learn counting them. This activity based learning further improves his concentration power. The third one, Alphabet learning module can be further used to enhance his alphabet learning skills. Individual modules are developed using the microcontrollers MSP430G2553 and PIC16F877A. The proposed system improves the concentration power of the child which in turn improves his cognitive skills.

Keywords: ADHD, Alphabet learning, cognitive skills, concentration building, attention deficit hyperactivity disorder, microcontroller

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is a psychiatric disorder in children and adolescents. ADHD symptoms may begin in the childhood and often persists into adulthood. Apart from genetics, premature birth, low birth weight, and the social environment play potential role in causing ADHD. Persons with ADHD cannot stay focused, unable to control behavior and are hyperactive. They lack concentration. This is the main reason for the child with ADHD not performing similar to other children.

1.1. Motivation and Problem Statement

Recently we visited a special school for mentally challenged children at Bhimavaram, Andhra Pradesh, India. The school consists of around 50 students belonging to different age groups and among them around 10 students are with ADHD. “Children with ADHD know what to do but they don’t do what they know” is what we felt when we have seen them.

Some of the problems faced by the children with ADHD in their daily life are

- They talk nonstop and are very impatient. It is very difficult for them to wait for things they want or to wait for their turn in games.
- They require special attention and assistance to help to improve their cognitive skills. It is very difficult to make children with ADHD to sit and learn things.
- Their teachers are facing problems with the existing devices which they have to

learn first thoroughly and then teach the children.

The visit to school for mentally challenged children motivated us towards doing something which is easy to operate and do not need any extra knowledge and any one can learn it and operate it easily. This motivation resulted in developing concentration building system (CBS) for the children with ADHD.

1.2. Existing Devices

Many online resources and books are available to help parents, clinicians, and educators to learn more about the children with ADHD.

- In the first method, the audio and video files for each letter are stored at database of the computer. Depending upon the key pressed, the computer will automatically play the files related to that letter.
- The second method is similar to the first method but touch screen is used instead of key pad. It displays pictures of the multiple alphabets and student has to identify the correct alphabet after listening to the audio instruction.

To use the above mentioned devices, child and caretaker should have computer knowledge. Also, their financial status may not support them to afford a computer. Even after the caretaker acquiring computer knowledge, we cannot give assurance to him on educating the child with ADHD. First and the foremost step in educating a child with ADHD is to improve his concentration skills. Our proposed CBS fulfills this requirement.

Rest of the paper is organized as follows. In section 2, we propose concentration building system for the children with ADHD. We discuss design and implementation of the proposed CBS in section 3. Section 4 presents hardware results of the proposed system, and section 5 concludes the paper.

2. Proposed System

The proposed assistive device for the individuals with ADHD mainly consists of three modules. They are

- Bird Chirping Module
- Fish tank Module
- Alphabet Trainer Module

All these 3 modules are combined and are placed in a box with three blocks. Three colored switches placed each in front of these blocks. Let the colors of switches be Red, Green and Yellow as shown in Figure. 1. Figure 1, describes the overview of the different modules in the project with a pictorial representation of how the output may be displayed.

2.1. Module-1: Bird Chirping Module

If the red color switch corresponding to Module-1 is pressed, bird chirping circuit in the block 1 gets activated and produces bird chirping sounds. These sounds attract the attention of the child and make him to sit there for some time.

2.2. Module-2: Fish Tank Module

By pressing green color switch, fish tank circuit in block 2 gets activated and the motor in it rotates the roller. The two sheets attached to the roller create fish tank effect artificially. It appears to the child as if fishes are moving in the tank. We can encourage child to count the number of fishes in the tank. It appears as if it is a game to the child and gets interest in learning numbers.

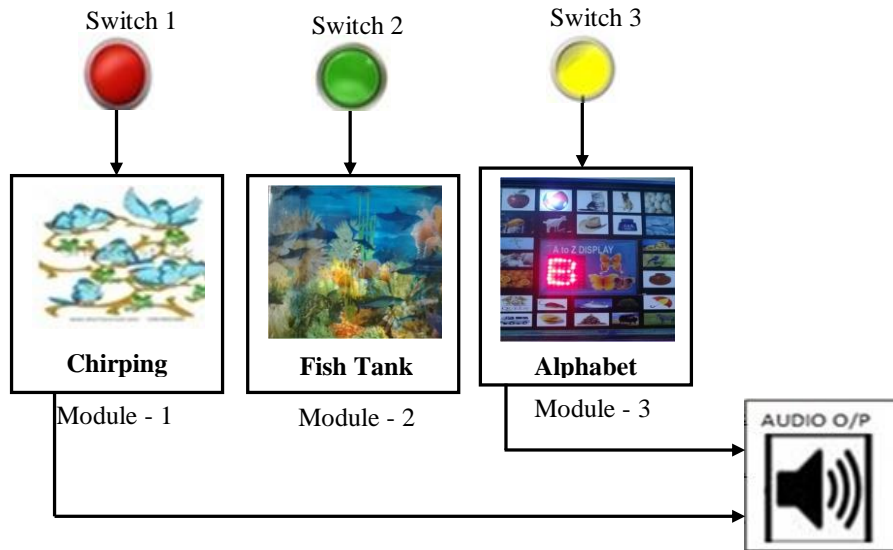


Figure 1. Pictorial View of Proposed CBS for Children with ADHD

2.3. Module-3: Alphabet Trainer Module

By pressing the yellow color switch, images of different alphabet are formed along with display of corresponding word images. Also, audio output corresponding the alphabet and image is played. Colored lights, images and audio encourage the child enjoy by sitting there.

Child sitting at some place is an indication of slowing down of hyperactive nature. This in turn improves the attention and we can encourage the child to learn the alphabet.

Design and implementation details of the proposed CBS are discussed in the section that follows.

3. Design and Implementation

Block diagram for the proposed system is shown in Figure 2. When switch is ON, power supply connects to the system. Separate switches are provided for individual modules. Whenever a switch gets activated, output from corresponding module is obtained. Transparent plastic sheet is placed on the display side of all the three modules.

For Module-1, microcontroller activates DC motor driver which runs the DC motor which in turn moves the birds placed on the stem attached to it and plays the recorded audio output of bird chirping. Similarly, DC motor in block 2 rotates the roller which in turn rotates the transparent sheets with undersea images. This arrangement creates an imaginary view of the fish movement in the fish tank to which the child gets attracted. By pressing the yellow color switch, different alphabet formations using LED matrix in block 3 get activated. Also, LED behind the image of the corresponding alphabet glows along with audio message. For example, if alphabet 'A' is formed on the LED matrix, the LED behind 'Apple' image glows along with audio output 'A for Apple'.

Now let us consider individual modules one by one.

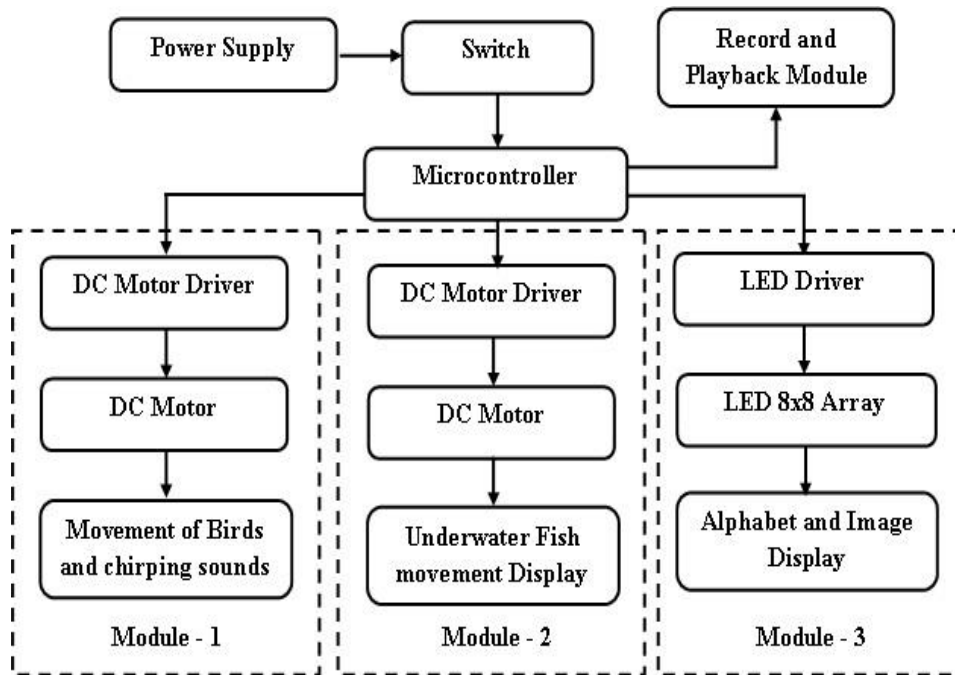


Figure 2. Block Diagram of the Proposed CBS for Children with ADHD

2.4. Module -1

Block diagram of bird chirping module is shown in Figure 3. Switch represents the Red color switch shown in Figure 1. If the red color switch is pressed, microcontroller gets high input voltage (+5 V) and produces a sequence of 2 second pulses with amplitude 5 V with pulse repetition period of 2 seconds.

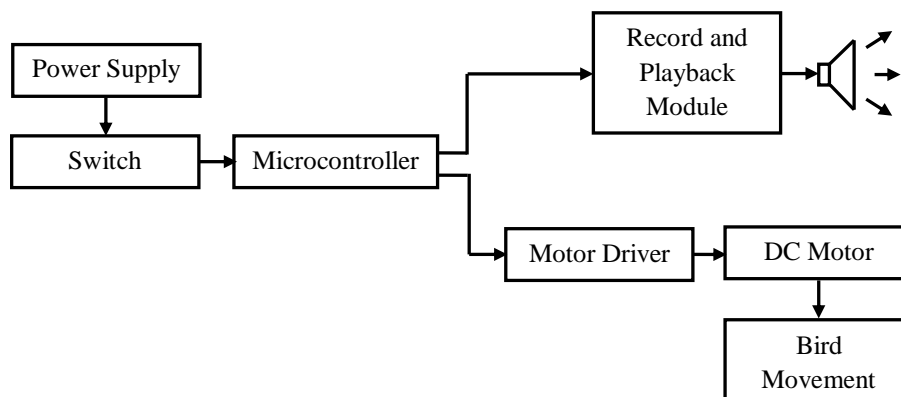


Figure 3. Block Diagram of Bird Chirping Module

Motor driver circuit provides sufficient current to the DC motor. Motor driver circuit is designed in such a way that the DC motor rotates in one direction during pulse ON period and rotates in other direction during pulse OFF period. The beak, wings and tail parts of the bird are connected to DC motor such that they create an impression that the bird is moving and chirping.

2.5. Module -2

In this module we have fish tank circuit. Whenever the switch present in front of the module is pressed, fishes rotate in anti-clock wise direction. DC motor with MSP430G2553 microcontroller is used in the design of this circuit. Connections are made

as shown in Figure 4.

L293D is a dual H-bridge motor driver IC. It acts as current amplifier since it takes a low-current control signal and provides a higher-current signal which is used to drive the DC motor in Fish tank module. DC motor is connected to input logic at pins 2 and 7 of L293D. Enable pin 1 is made high so that the associated driver gets enabled. As a result, motor starts functioning in phase with its logic input. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state. Logic '10' is applied to get motor rotation in forward direction.

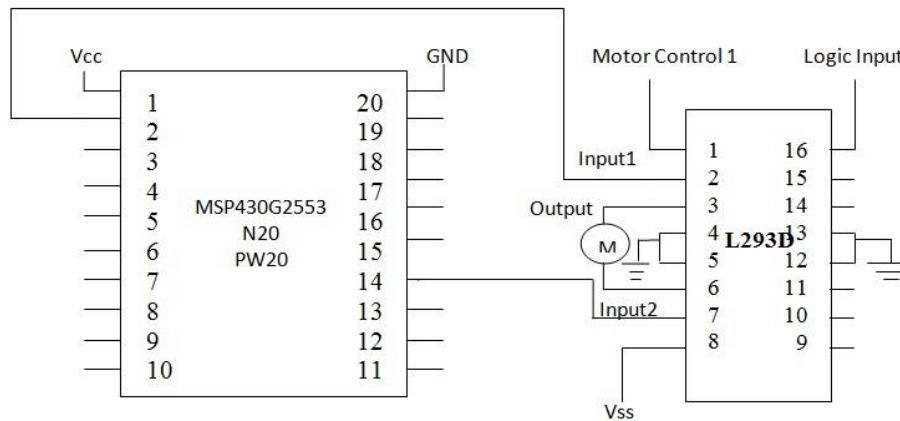


Figure 4. Fish Tank Circuit Diagram

Therefore, when the switch corresponding to module 2 is pressed, MSP430G2553 gets activated and applies logic '10' to L293D motor driver. L293D IC drives the motor to rotate in forward direction. Hence, the fishes printed transparent sheet on the rollers attached to DC motor rotate in the forward direction. One empty transparent sheet is placed below the sheet with fishes print to give the impression of water. A bunch of white LEDs are connected as strip and is placed behind the transparent sheet. It provides the glow to the sheets and creates underwater atmosphere. Empty transparent sheet is rotated at lower speed as compared the sheet with fishes print. This arrangement creates the impression that water is very slowly moving where as fishes are moving fast. All these efforts are made to grab the attention of child with ADHD, and make him sit there and enjoy for sometime without getting distracted frequently.

2.6. Module -3

In this module we have two main parts: LED Alphabet formation unit and Image Display unit along with voice module. The picture display unit displays the image corresponding to the alphabet displayed by the LED alphabet formation unit. In voice module section, recorded voice is played back for the respective alphabet displayed. All these parts are integrated to get the output of the Module - 1.

3.1.1. Alphabet Formation Unit: In LED formation, alphabets are displayed in 8×8 LED matrix with 4 sec of delay between two successive alphabets. As 8×8 LED dot matrix available in the market is very small in size, we developed 8×8 LED matrix using 64 LEDs. Transistors are used in LED driver circuit as shown in Figure 5. LED matrix is interfaced to PIC16F877A microcontroller. As shown in Figure 6, eight rows of the matrix are connected to PORTC (RC0, RC1, ..., RC7). Similarly, eight columns of the matrix are connected to PORTD (RD0, RD1, ..., RD7). Alphabet formation related coding is done in MPLAB IDE v8.92, a free integrated development environment and HI-TECH PIC C LITE Compiler and the program is written to PIC microcontroller using

ICPROG software. Alphabet formation circuit is placed in a box with a name A to Z Display. Then the Alphabet Display box is inserted in to the module 1 box in such a way that alphabets are displayed through the transparent plastic display window of module Alphabets A to Z are displayed sequentially with a delay 4 seconds between any two successive alphabets.

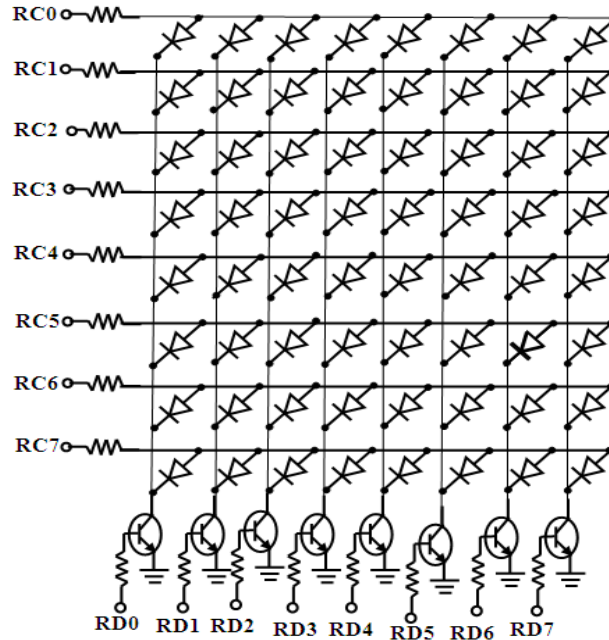


Figure 5. 8x8 LED Matrix Circuit Diagram

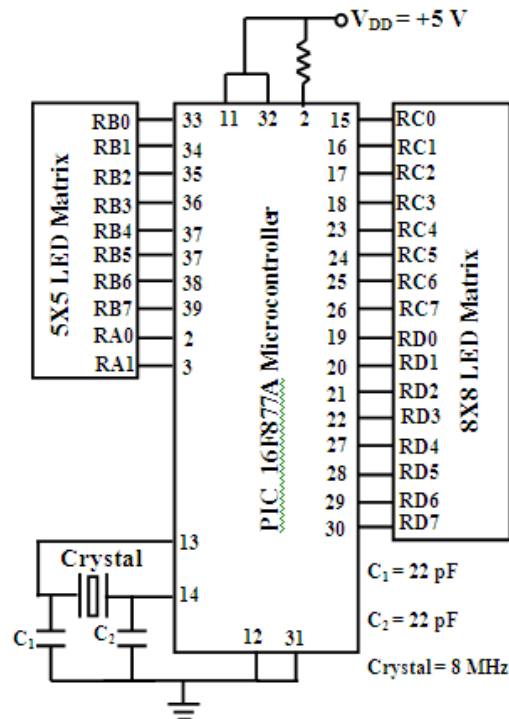


Figure 6. Alphabet Trainer Circuit Diagram

3.1.2. Image Display Unit: English alphabet has 26 letters. But PIC16F877A

microcontroller is a 40 pin IC with 4 I/O ports PORTA, PORTB, PORTC and PORTD covering 32 I/O pins. 26 images related to Alphabet are placed below the transparent plastic display board in such a way that they appear around the A to Z Display unit. LEDs are fixed behind each image. To activate them we need 26 pins of PIC16F877A microcontroller. Already PORTC and PORTD *i.e.*, 16 I/O pins are allocated to 8×8 LED matrix. Therefore, we developed 5×5 LED matrix and hence Image display unit requires only 11 I/O pins of PIC16F877A microcontroller.

Image display unit is interfaced with PIC16F877A microcontroller as shown in Figure 6. In 5×5 LED matrix, each LED glows for 4 seconds. For example, when alphabet A is displayed by A to Z Display unit for 4 seconds, the corresponding image APPLE brightened by the LED behind it getting ON for 4 seconds.

Hardware results of the proposed CBS are presented in the section that follows.

4. Hardware Results

Results are presented module wise.

2.7. Module -1

When the switch is pressed, the output from the DC Motor creates the bird movement and the output from the play back module produces the chirping sound. These sounds attract the attention of the child. After construction, bird chirping block appears as shown in Figure 7.



Figure 7. Output Block of Module-1

2.8. Module -2

By pressing the switch in the module-2, the motor gets activated and rotates the rollers and ultimately produces the imaginary view of the fish movement in the fish tank. The child gets attracted to the movement of fish as in the aquarium and at the same time the LED strip inside the module glows and brightens sheet with fishes and underwater plants in order to create the underwater environment. Output block of module-2 appears as shown in Figure 8.



Figure 8. Output Block of Module-2

2.9. Module -3

When switch in front of module-3 is pressed, the control signal from micro controller produces different alphabet formations. Figure 9(a), shows the alphabet 'B' formation on 8×8 LED matrix. After delay of 4 seconds alphabet 'B' changes to alphabet 'C'.

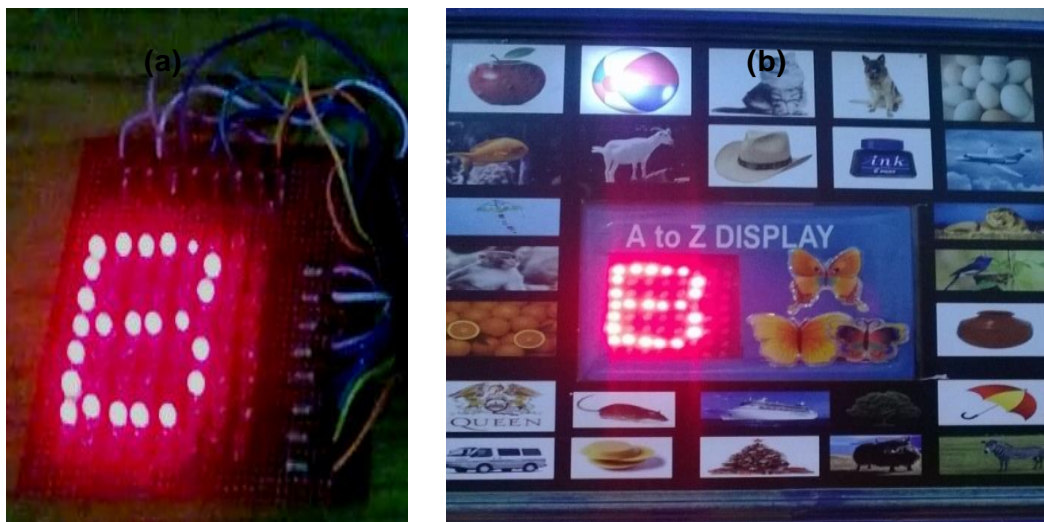


Figure 9. Alphabet Formation Using 8×8 LED Matrix

One LED in addition to 5×5 LED matrix is used to connect 26 LEDs below the display images corresponding to alphabet. After integrating alphabet display and image display, we get the display as shown in Figure 9(b). It shows display of alphabet 'B' and LED brightens the corresponding image 'Ball'. At the same time audio message 'B for Ball' results. In the similar way alphabet A to Z are displayed along with display of their corresponding images and audio messages at a regular interval of 4 seconds.

2.10. Prototype of Proposed CBS

The prototype of the proposed concentration building system is shown in Figure 10. It consists of three modules: chirping bird module, Fish tank module and alphabet learning module. As we could not get big switches, we placed small pushbutton switches in front of block of each module as shown in Figure 10.



Figure 10. Prototype of Concentration Building System

5. Conclusion

The main goal of the proposed CBS is to make the child to sit for some time without burdening his mind. Keeping this goal in mind, three modules of CBS are selected very simple. Also it includes birds, fishes, lights and audio to which child attracts more. Bird chirping module and fish tank are developed using microcontroller MSP430G2553. MSP430G2553 is not suitable for alphabet trainer as it is a 20 pin microcontroller. 8X8 LED matrix and 5X6 LED matrix along with PIC16F877A are used to generate alphabet and to brighten the corresponding image. The proposed CBS is a low cost system and is very simple to use. Due to the flexibility and easy approach to personalization inherent in the modularity, it is our belief that our proposed CBS can act as a playful rehabilitation to the children with ADHD and also it can help in improving their concentration and cognitive skills.

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