Interactive Cognitive Assessment and Training Support System for Special Children

YEO KEE JIAR, EKO SUPRIYANTO, HAIKAL SATRIA, TAN MENG KUAN, YAP EE HAN
Department of Electronics Engineering
Universiti Teknologi Malaysia
81310 UTM Skudai Johor
MALAYSIA
kjyeo_utm@yahoo.com, eko.supriyanto@gmail.com, edmundmeng@hotmail.com, yap_8089@yahoo.com

Abstract: **-** Special children are children who experience learning difficulties. Special children include those under Down syndrome, autism, global delay, epilepsy and slow learner. In this study, the special children are referring to children with Down syndrome. Early intervention program is a systematic program with therapy, exercises, and activities which designed to help special children. Cognitive development is the construction of thought processes, including thinking, problem solving, concept understanding, and decision-making, from childhood through adolescence to adulthood. It is one of the most important skills that have to be developed for Down syndrome children. This study is focused mainly on development of the cognitive ability support system. The aim is to help them improving their logical thinking and memory skills. In brief, this study is about the development of software system for the cognitive ability. This includes the implementation of the radio frequency identification (RFID) reader and graphical user interface. The complete system is then test to ensure the accuracy of result, user acceptability and reliability of the system. The results show that the system can generate result in graphical form and training for improving the cognitive ability of the children. In conclusion, the system can be used in order to help trainers or parents to improve the cognitive ability of children with Down syndrome.

Key-Words: **-** Support system, cognitive ability, special children, RFID, Early Intervention Program, Assessment and Training

1 Introduction

Down syndrome causes a set of mental and physical limitations that resulted from having an extra copy of chromosome 21. It is one of the most common genetic birth defects, affecting approximately from one in 600 to one in 1,000 babies [1]. According to National Down Syndrome Society, there are more than 350,000 individuals with Down syndrome. The chance of a woman having a child with Down syndrome increases as she is getting older.

People with Down syndrome experience delays of cognitive and physical development, but the effect is usually mild to moderate. Research has shown that educational and therapeutic interventions such as early intervention services can greatly benefit learners with Down syndrome. In the other words, supports and early planning are often necessary to facilitate employment and community life.

Although some of the limitations of Down syndrome cannot be overcome, early intervention program is proven to be able to improve quality of their lives.

2 Literature Review

Cognitive assessment is a scientific attempt to study cognition and measure human behavior [2]. Measurement of human behavior involves giving the participant an opportunity to "behave" and measuring it.

A measurement tool should be reliable and valid, sensitive, safe and should offer the assessor full control over the data collection process. Allowing the participant "to behave" involves the presentation of stimuli which trigger recordable reactions by the participant [3]. Many classic, paper-pencil cognitive assessment tests offer very limited stimuli, little freedom to behave and low ecological validly (that is,

little relevance to normal, everyday human behavior in the real world) [4].

In this study, the cognitive ability will be emphasized as compared to other developmental abilities due to the mentioned problem in the status quo previously.

Adaptation is the main basis of cognitive development. Jean Piaget states that there are five fundamental stages of cognitive development of a child. The stages are stage of sensory-motor thinking, pre-conceptual stage, and stage of institutive thought, stage of concrete operation, and stage of formal operation. From birth up to the stage of two years is the stage of sensory-motor actions. Sensation caused by sound is a common experience to a child and makes him utilize his power of thinking.

The second stage is called pre-conceptual stage where child can form some pre-concepts based on his past experiences. Pre-conceptual stage takes a complete change with a purpose of placing the base of concepts on solid foundations and making them practical and more expanded.

The next stage is called stage of intuitive thought. This stage expands from 4 to 8 years old. The difficulties of thinking which exists at pre-conceptual stage get eliminated and active realistic thoughts develop.

The next stage of cognitive development expands from 8 to 11 years, and this stage is called period of concrete operation. When the children make synthesis in the fundamental thoughts, their active or rational thinking begins. A child, when he reaches at the stage of concrete operation, forms concepts facing realities. The last stage of cognitive development is the period of formal operation which from 11 to 15 years. At this stage, the thoughts of a child are not controlled by his practical experiences or personal observation but acquire power of abstract thinking [5].

TABLE 1
The stages for cognitive development according to Jean Piaget

Stage	Name of stage	Range of age (years)
1	sensory-motor thinking	0-2
2	pre-conceptual	2-4
3	institutive thought	4-8
4	concrete operation	8-11
5	Formal Operation	11-15

In this paper, we present an interactive support system for cognitive assessment and training for special children. Several aspects for example the age and ability of the children are considered while the assessment and training for cognitive ability is being done. This support system does not only serves as cognitive assessment and training system, but also important in managing the children data effectively and providing scientific information about Down syndrome to parents and trainers.

3 Design and Implementation

In this section, the procedure, and the methods used for cognitive assessment and training support system will be described.

In order to train the cognitive ability of special children, a support system for cognitive assessment and training is developed by using the C Sharp programming language in Visual Studio together with the implementation of Radio Frequency Identification (RFID) technology in the program. The database of the support system is easily updated and reliable as it follows the standards of internationally recognized curriculum.

The basic block diagram of the support system is mentioned as below.

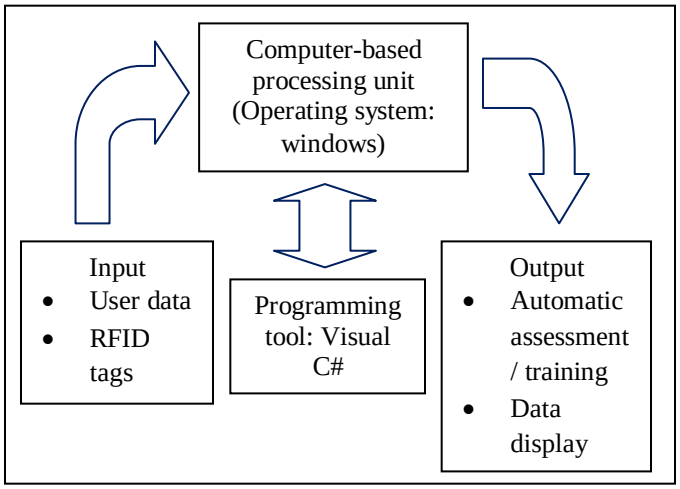

Fig. 1 Block diagram of the interactive cognitive ability support system.

According to the block diagram in Fig. 1, the data is inputted into system by user or RFID tags. Then, the program will read the inputs and produce the output and displayed through GUI application.

The system configuration of the whole cognitive support system is described as in Fig. 2. The assessment and training for cognitive is done by using user input and cards with RFID tags, in which is RFID tags can be

read by RFID reader connected to the computer by using communication line and USB power source. The identification process is performed in the computer and the results are shown through the monitor of the computer.

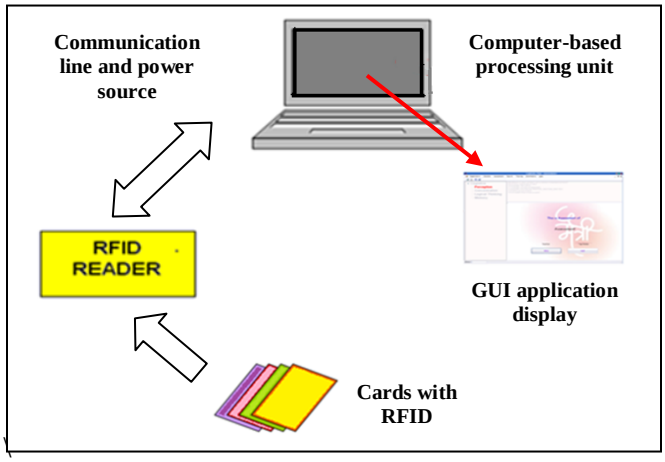

Fig. 2 Configuration system for the cognitive ability assessment and training support system.

Software Implementation

Visual C# programming is used to be an easy reference for interfacing with the user of the cognitive ability support system. Fig 3 shows part of visual C# programming language that has been developed for GUI application of cognitive assessment.

```
private void listBox1_SelectedIndexChanged(object sender, EventArgs e)
{
    int ItemsSelected = listBox1.SelectedIndex;
    this.tablechilddataTableAdapter1.Fill(elissadbDataSet.tablechilddata);
    foreach (DataRow thedata in elissadbDataSet.tablechilddata.Rows)
    {

        //if (Convert.ToBoolean(thedata[9]))
        if ((int)thedata[0] == ItemsSelected + 1)
        {
            idTextBox.Text = Convert.ToString(thedata[0]);
            childName.Text = (String)(thedata[1]);
            childBirthplace.Text = (String)(thedata[2]);
            childBirthdate.Value = Convert.ToDateTime(thedata[3]);
            String genderText = (String)thedata[4];
            if (genderText.Equals("Male"))
                gendercomboBox1.SelectedIndex = 0;
          else
                gendercomboBox1.SelectedIndex = 1;
            childNickname.Text = (String)thedata[5];
```

Fig. 3 Source code for GUI application

The algorithm of the cognitive ability support system can be seen through the flow chart in Fig. 4. There are three main parts in the cognitive ability support system. First part includes user data which consists of input storage and update data. Second part is the assessment generation and lastly report and training guidance generation.

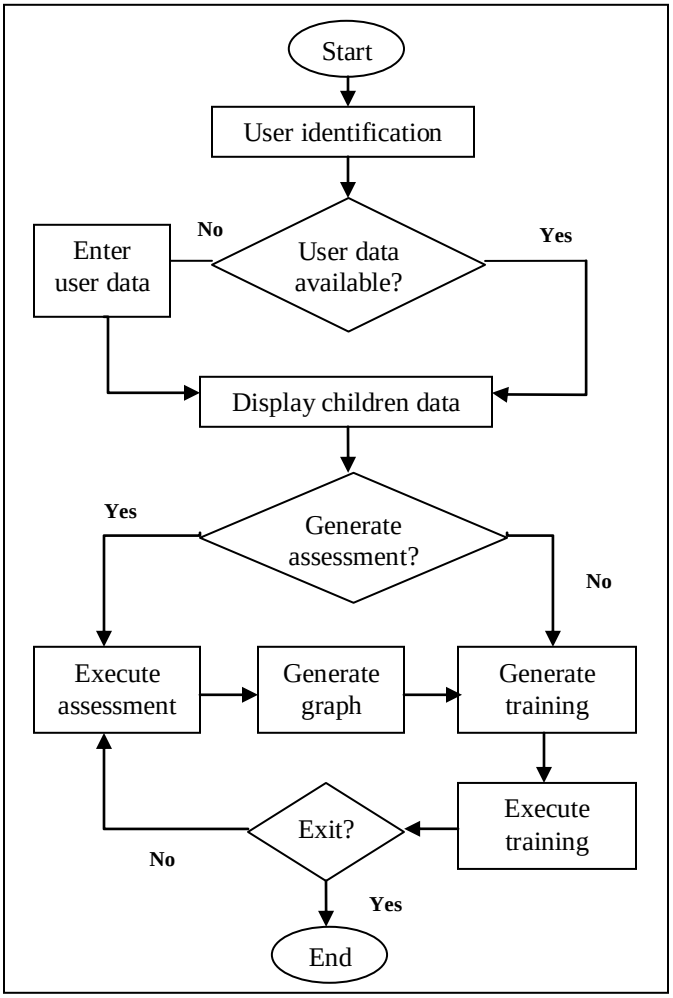

Fig. 4 Software algorithm

The Assessment and Training Method

The method of assessment and training for special children in cognitive ability is to locate the level of the children and give appropriate training to them. In order to train the children effectively in cognitive ability, this support system uses images which special children can see or identify in real situation. The support system will assess and train the children in cognitive ability by using related cards with RFID tags and also other training tools.

This support system is designed in simple and attractive interface as shown in Fig 5. It has been designed with a necessary log in page in order to ensure that the children data is secure from access by others. The display of GUI application also has interactive sound display to interact with the children.

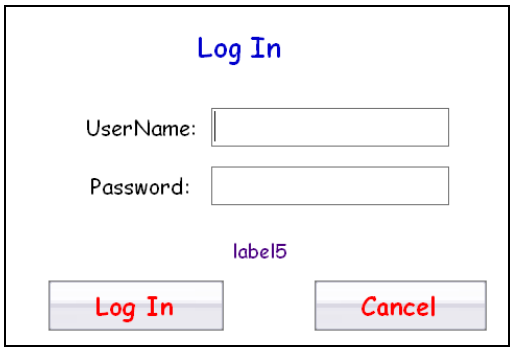

Fig. 5 GUI for cognitive ability support system

The trainers or parents are required to fill in the children data form before they proceed to the assessment part. The data of children will be saved in Microsoft Access so that the children data will be saved and manage automatically in computer.

Next, they will go to assessment part of the support system. The trainers or parents have to rate the children ability regarding to the name of assessment by clicking yes or no and also by using cards with RFID tags.

After trainers done the assessment, the result in graphical form will show as in Fig 6. The result shows the level of achievement of the children in each particular group. The graph shows the result of the children in each group.

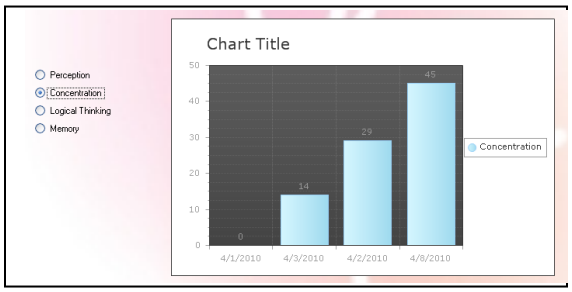

Fig. 6 Result in graphical form

The suggested training table will be shown after the trainers proceed to the next part. Suggested training table is design to help or as a guidance for the schedule of training for the children.

The suggested training table consists of date and time that suitable for the trainers to train the children. The trainers can determine which group of training should be given to the children from the graph and then choose the suitable training table.

Every time when a new child is registered in this support system, the database will detect the information entered by the user. Fig 7 shows the children data that has been stored in database. The database for children data is saved in Microsoft Access in table form. It is bounded to the program so that the software can retrieve data from Microsoft Access when it is required. The main advantage of using Microsoft Access for children data management is the ease to be retrieved and organized.

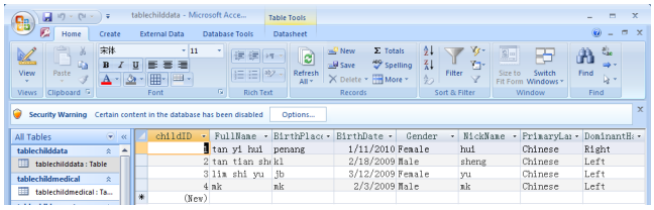

Fig. 7 Children data that have been successfully saved in database

Note that in Fig 8, the database for cognitive assessment list and training guidance are saved in XML format document. Very similar to Microsoft Access, he XML file is also bounded to the program in order for the program to retrieve and display the list when necessary. The main advantage of using XML format is the capability and ease to update the assessment list and training guidance list. This feature is important to ensure updated database of training guidance and assessment is being done to maximize the impact of the cognitive ability training.

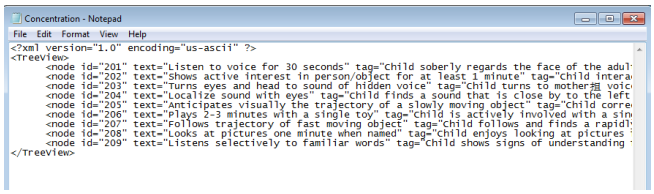

Fig. 8 Database for updating assessment and training data

Several user acceptability tests had been done on the display of the layout, font size of the contents, contents, use friendly application, transaction time to detect RFID card and also sound display. The feedback and comments were collected, analyzed and the support system is improved and revised. After that, it is shown to experts in both engineering and educational fields and the positive comments were obtained.

4 Conclusion

The cognitive assessment and training support system has been developed in order to help children with Down syndrome to improve the cognitive ability with the use

of RFID technology. The support system also used for user data management in Early Intervention Program.

The cognitive ability is divided into four sub-groups which are perception, concentration, logical thinking, and memory. The system is mostly focus on the software development for the support system. The graph for each sub-group in cognitive ability has been developed after the assessment to detect the level of achievement of the children and provide training guidance for parents or trainers.

The advantages of this system include the simplicity of the system and the utilization of conducive method to train children in cognitive ability. It is interactive and able to attract the attention of children.

For future works, it would be beneficial to develop a support system that consists of modules for other different developmental abilities, for example, for gross motor skill and fine motor skill. The system also should be designed to improve by using more RFID tags for more accurate result.

References

[1] Siedfried M Puesschel, *What is Down syndrome, Brown University. unpublished.*, 1992

[2] A. A. Rizzo and J. G. Buckwalter "*Virtual Reality and Cognitive Assessment and Rehabilitation: The State of the Art,*" in Virtual Reality in Neuro-Psycho-Physiology: Cognitive, Clinical and Methodological Issues in Assessment and Rehabilitation, G. Riva, Ed. Amsterdam: IOS Press, pp. 123-146, 1997

[3] Julia Bradley and Anita Millspaugh "Programming in Visual C# 2008" , 2008

[4] D. Patterso.. The integrated map of human chromosome 21. In Etiology and Pathogenesis of Down Syndrome, Wiley-Liss, p 43-55, 1995

[5] Karnes, M. B., and R. C. Lee. Early Childhood. VA: The Council for Exceptional Children. Reston. Unpublished,1978