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Java Based Automatic Curriculum Generator for Children with Trisomy 21

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***Abstract*—**Early Intervention Program (EIP) is required to improve the overall development of children with Trisomy 21 (Down syndrome). In order to help trainer and parent in the implementation of EIP, a support system has been developed. The support system is able to screen data automatically, store and analyze data, generate individual EIP (curriculum) with optimal training duration and to generate training automatically. The system consists of hardware and software where the software has been implemented using Java language and Linux Fedora. The software has been tested to ensure the functionality and reliability. The prototype has been also tested in Down syndrome centers. Test result shows that the system is reliable to be used for generation of an individual curriculum which includes the training program to improve the motor, cognitive, and combination abilities of Down syndrome children under 6 years.**

***Keywords*—**Early intervention program (curriculum), Trisomy 21, support system, Java.

I. Introduction

THE incidence of Trisomy 21 in the world is 1 in every 770 live births. This means there are 40000 Down syndrome babies are born every year in this world. Often Down syndrome is associated with some impairment of cognitive ability, and physical growth. Although some of the physical genetic limitations of Down syndrome cannot be overcome, but education and proper care will improve their quality of life [1].

This requires an individual early intervention program, an appropriate medical care, and a positive learning attitude. Research results [1], [2], [3], [4] show that children with Down syndrome who were involved in an EIP, had significantly higher scores for the measures of intellectual and adaptive functioning than children of comparable ages with Down syndrome who did not participate in an EIP. However, the early intervention program is not widely applied yet. This is due to the lack of measurement instrument, lack of individual curriculum, insufficient information, and human resources limitation [3].

In order to overcome these problems, an early intervention support system has been developed. One of the most important parts in the system is the individual curriculum generator. It will be discussed further in this paper.

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II. Design and Implementation

We developed an early intervention support system, which can apply for user data management, curriculum generator, and training as well as screening. The configuration of the system is shown in Fig. 1. By using this system, the children can learn based on individual curriculum to improve the motor, cognitive, and combination abilities. This requires not only functional ability of system, but also the effectiveness and consistency.

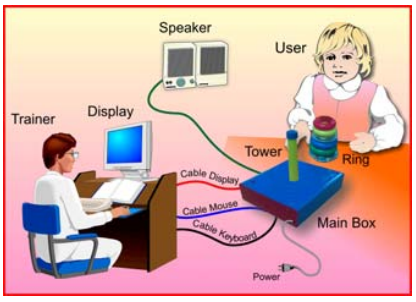

Fig. 1 System configuration

A. Data Processing System

The software has been developed to input, store, display, and update the user data; to generate the individual curriculum with optimal training duration; as well as to give instruction and analyze the result as part of screening and training.

Block diagram of data processing system can be seen in Fig. 2. The inputs of the data processing system are personal data, medical data such as ECG signal, ultrasound signal, and genetic data. Besides, the inputs are also include the abilities of child such as gross motor, fine motor, oral motor, cognitive data, and combination data which includes self help, communication, and social interaction.

The system will analyze the input data by comparing the data with the references data that are collected from literatures [4], [5], Down syndrome centers, trainers, parents, experts, and self-assessment. The system will screen data automatically, store, and analyze the data, as well as produce curriculum. The data processing is programmed using JAVA language. The outputs of the system are individual curriculum in print form, and memory data, as well as instrument based training program.

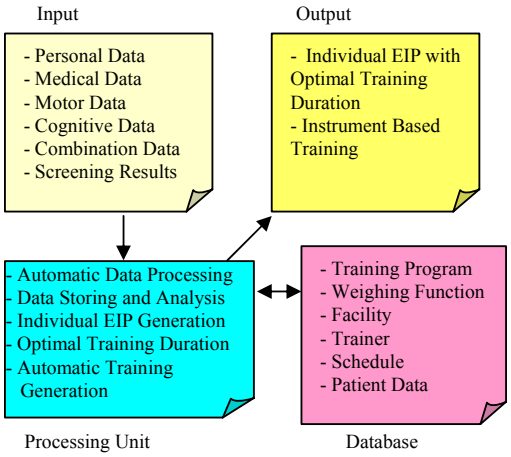

Fig. 2 Block diagram of data processing unit

Furthermore, the system can screen, and train the children with Radio Frequency Identification (RFID) device. The specification of developed software is listed in Table I.

TABLE I
SPECIFICATION OF DEVELOPED SOFTWARE

Input	(a) Manual input using keyboard, mouse and RFID card; (b) Automatic input using RFID ring (for screening / training)
Operation mode	(a) Stand alone (without monitor, keyboard, mouse, external speaker and voltage regulator); (b) Connected with external unit
Operating system	Windows 98, Windows XP and Linux Fedora
Output	(a) Sound for screening and training; (b) Display for user data, EIP print form and interactive training / screening (c) Screening and training result / data in USB memory
Application	Training and screening program for Down-syndrome children under 6 years old including for motor, cognitive and combination (self help, communication and social interaction) abilities

B. Generation of Individual Curriculum

In order to determine the individual curriculum, we consider the user data (age, medical data, motor data, cognitive data, and combination data), the reference data (target, training program, and training requirement) as well as availability of facility, trainer, and schedule. The general flow chart to calculate the individual curriculum for motor, cognitive, and combination abilities is shown in Fig. 3.

In order to calculate the deficit level of child, the equation (1) has been used.

$$F_x = \frac{(R_x - I_x)}{R_x} \quad (1)$$

where F = deficit level, R = reference level and I = current ability level, x = ability control parameter like head control and sitting control.

The curriculum has been determined by compare the level of deficit in a group. For example, in gross motor group, ability control parameters (head control, rolling control, sitting control, crawling control, standing control, walking control, and jumping control) will be compared among themselves.

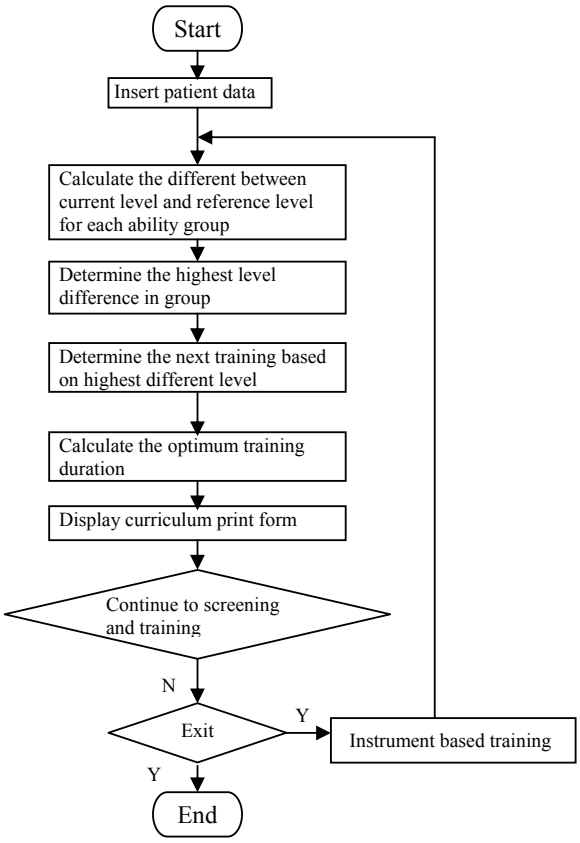

Fig. 3 Flow chart of curriculum generation

C. Calculation for Optimal Training Duration

Due to the importance of training duration, we calculated the optimal training duration, T with the equation (2).

$$T_x = \frac{W_x \frac{(R_x - I_x)}{R_x} B_x}{\sum_{i=0}^{n} W_i \frac{(R_i - I_i)}{R_x} B_i} D \quad (2)$$

where W = weighting factor = F (age), R = reference level, I = current ability level, B = maximum training duration / day = F (age), D = total training duration / week = F (age), F (age) = function of age, and n = number of weighting function.

The weighting function determines the priority of training. It depends on the age. Figs. 4-8 shows the weighting functions for gross motor, fine motor, communication, cognitive, self help, and social interactive abilities of average Down syndrome children.

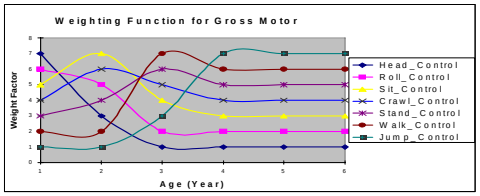

Fig. 4 Weighting function for gross motor

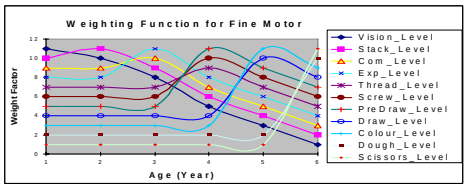

Fig. 5 Weighting function for fine motor

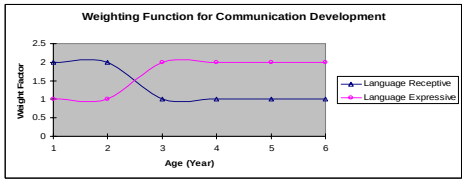

Fig. 6 Weighting function for communication development

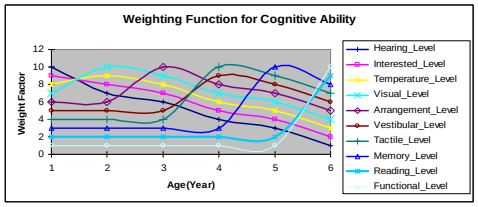

Fig.7 Weighting function for cognitive ability

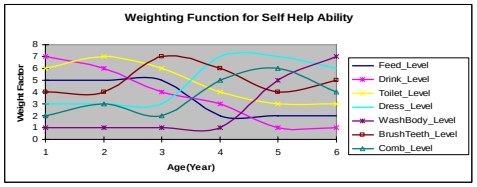

Fig. 8 Weighting function for self help ability

From Fig. 4 we can see that for a 1 year old child, the greatest weighting factor is head control. Due to the increasing of age, the priority of head control decreases. When the child is 6 years old, head control has the lowest priority while jump control has the highest priority.

D. Software Implementation

For implementation of the algorithm, we used free software in order to minimize the cost of system. The main programming has been done using JAVA. The data base has been saved in local host and managed using MySQL. The JAVA is connected to MySQL by using Java database connection (JDBC). We implemented the software in LINUX and WINDOWS environment. The used tool and software are listed in Table II.

TABLE II
IMPLEMENTATION TOOL AND SOFTWARE

Function	Tool and Software
Programming language / GUI	JAVA J2re 1.4.2_12
Database connector	JDBC
Database editor	PHPMYADMIN
Database management	MYSQL
Operating system	FEDORA LINUX, WINDOWS 98, WINDOWS XP
Driver development tool	C
Java development tool	ECLIPSE

III. TEST AND RESULT

In order to ensure the quality and reliability of the software, we have done functionality, compatibility, GUI, and stress (graphic user interface) testing. The test results are listed in the Tables III, IV, V, and VI.

TABLE III
FUNCTIONALITY TESTING

Group	Parameter	Results
Input Data	Medical data, motor , cognitive and combination Data	More complete than standard diagnostic
Age	Under 6 years old	Passed
Disability	Down-syndrome	Passed
	Blindness	Passed, except for visual training
	Physical impairment	Passed, limited for gross motor training
	Deaf	Passed, limited for hearing training
	Dumbness	Passed, except expressive language skills training
	Normal	Passed, to improve the learning ability
Language	English and malay	Passed

TABLE IV
COMPATIBILITY TESTING

Hardware Platform	Operating System	Status
Intel Pentium IV, 1.73 GHz 795 MHz FSB, 760 MB RAM	Windows XP	Passed
Intel Pentium II 367 MHz , 256 MB RAM	Windows XP	Passed
Intel Pentium III, 933 MHz, 256 MB RAM	Windows 98	Passed
Intel Pentium 4, 2.1 GHz, 768 MB RAM	Fedora Linux	Passed

TABLE V
GUI TESTING

Events	Status
1. Make sure all windows fit the main application (nothing is cutoff if windows are resized)	Passed
2. Make sure all data/ information accessible	Passed
3. Check documentation for grammar and spelling	Passed
4. Same screen appears each time application is launched	Passed
5. Consistent and logical navigation flow	Passed
6. Uses standard GUI features (e.g. pull-down menus, dialog boxes)	Passed
7. Interface recovers gracefully from anticipates user errors (e.g. invalid input)	Passed
8. Information and error message are useful, accurate, and correctly spelled	Passed
9. Unnecessary warning do not appear	Passed

TABLE VI
STRESS TESTING

Events	Status
1. Run example problems to make sure all the results in application match exactly with the results in the documentation.	Passed
2. Stress Test	
• Look for input fields accept only numeric values	Passed
• Follow the test cases, but then skip a step or do them in a different sequence.	Passed
3. Check print feature	Passed
4. Enter invalid login information for each field	Passed
5. Check error messages for clarity. Check to make sure error messages come up when they are supposed to.	Passed
6. If there is database, make sure all connection through the application are valid when accessing data.	Passed
7. For databases, make sure single quotes are tested to verify they do not corrupt the database.	Passed
8. Check all buttons to make sure they work	Passed
9. Check save feature	Passed
10. Check open file feature (save to thumb drive)	Passed
11. Check open file features (open from thumb drive)	Passed
12. Check to ensure applied formula gives correct output.(Age calculating, priority calculating)	Passed
13. Check for spelling within the application	Passed
14.Check all menu items to make sure they work	Passed

IV. APPLICATION AND EFFECTIVENESS

The software is ideally be used by the children with Trisomy 21 who is under 6 years old. The child can be trained according to the curriculums that generated by the software. In addition, the child can also do training by using the system. The instrument based training includes training for gross motor, fine motor, cognitive, and combination ability. The curriculum and training that generated by this system can be shown in Table VII. It shows the current condition for a 3 years old child and the individual curriculum as well as the instrument based training.

TABLE VII
APPLICATION OF SYSTEM

Type of condition		Gross motor	Fine motor	Oral motor	Self help	Social interaction
Condition of a 3 years old child		Walk 1 step then stop (sit)	Inability to hold spoon	Open mouth	Inability to feed himself	Can not recognize parents
Individual curriculum	**Program**	Child walks sideway 5 steps while supporting by himself	Child makes reaching swiping movements directed towards theobject	Child makes laughing and squealing sounds	Child holds a toothbrush and puts it in his mouth	Child reaches to familiar person
	Duration	23 minutes	441 minutes	14 minutes	94 minutes	13 minutes
Instrument based training	**Program**	Child walks 3 meters	Thread big and small buttons into a lace	Recognize face pictures	Recognize feeding tool	Recognize parents photo
	Duration	5 minutes	10 minutes	5 minutes	5 minutes	5 minutes

The effectiveness of developed system compared to the manual system is listed in Table VIII. Currently, in the manual system, child's data are stored and analyzed in log book. This depends on trainer's ability and takes more time to record and find data. Furthermore, trainers are human beings that have emotion, so they are not consistent and patient enough. So the manual system has limited ability to generate individual curriculum.

TABLE VIII
MANUAL VS AUTOMATIC SYSTEM

Parameter	Manual	Automatic
Data management	Manual in log book.	Automatic by system. Easy to save, edit, update and search.
Training program	Common or less precise.	Individual and precise. Consider all of data
Time for formulate EIP	Many time (depend on infrastructure)	Less time (less than 5 minutes)
Teaching strategy	Problem with patientness, consistency, conducive environment	No limit for patientness, consistent, interactive
Trainer requirement	Required special training for trainer	Not required special training for trainer

Different from manual system, the automatic system can store and analyze data automatically as well as to generate individual EIP within 5 minutes. This system can always consistence and run for more than 2 hours.

V. CONCLUSION

An automatic curriculum generator for Down syndrome children under 6 years has been successfully developed. The software has been implemented using Java and other open source software. The software has been tested in laboratory for technical specification and Down syndrome centers for user acceptability. Test result shows that the system is effective and reliable to be used as well as applicable to improve the developmental ability of Down syndrome children.

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