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The Framework for Adaptive Games for Mobile Application using Neural Networks

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***Abstract*—**The rapid development of the BlackBerry games industry and its development goals were not just for entertainment, but also used for educational of students interactively. Unfortunately the development of adaptive educational games on BlackBerry in Indonesian language that interesting and entertaining for learning process is very limited. This paper shows the research of development of novel adaptive educational games for students who can adjust the difficulty level of games based on the ability of the user, so that it can motivate students to continue to play these games. We propose a method where these games can adjust the level of difficulty, based on the assessment of the results of previous problems using neural networks with three inputs in the form of percentage correct, the speed of answer and interest mode of games (animation / lessons) and 1 output. The experimental results are presented and show the adaptive games are running well on mobile devices based on BlackBerry platform.

***Keywords*—**Adaptive games, neural networks, mobile games, BlackBerry.

I. Introduction

NOWADAYS, the application of games on mobile devices is growing rapidly and in great demand by students for entertainment or just increase their knowledge. Drastic increase occurred in the use of games for a fun and educational tool for students and effective discussion about the use of adaptive games to enhance interested learning and entertaining to various aspects of education [1]. The best known of the games-based learning is to increases the motivation of learners [2][3] and the relationship between games and constructivist theory [4], because the games are well made can have pedagogical value of learning to produce a satisfactory outcome, because the student can cope with issues, work / play together and learn from previous experience [3][4].

A crucial factor for adaptivity is challenge. It can result from adapting the level of difficulty of the tasks to the learners' ability level so that a constant challenge is felt. Not only the level of difficulty of the tasks is adjusted to the learners' ability level, but also the system reacts to personal learning styles and preferences [10]. The entertaining videogame industry has grown and it is a mature industry that caters for all ages and genders. Driven by a commercial pressure to entertain different player profiles, successful games have developed sophisticated adaptation mechanism. Most games adapt their behavior to suit different levels of proficiency, adjusting the difficulty of the game [1].

There have been many studies on the development of education-based games for mobile applications such as [4][5]. But in the study, there is no comprehensive mechanism of how to identify the ability of users (students) who have a genuine interest in games or games that comes with a lessons and quizzes, as well as not using a Neural Network-based intelligence to input the percentage of correct answers, speed of answer and interest mode of games (animation / lessons). In addition, research on the development and use of adaptive educational games on mobile platforms in Indonesian language for students has not been touched at all.

One of the well-known providers of mobile games applications that are used in Indonesia is BlackBerry devices from Research in Motion (RIM). However, the application of adaptive educational games using Indonesian language is not a lot; this is a new challenge in the development of mobile games in Indonesia. BlackBerry Operating System enables the developers to develop open source Java-based applications that can be easily commercialized [6][7]. Advantage in developing applications of mobile games based on BlackBerry platform is still the lack of games for the application that is widely used in Indonesia, because given applications of BlackBerry tend to be focused on business. This is an important point for our research in developing games at low cost and reliable.

State of the art of this research is that we propose a framework for adaptive educational games on mobile application where the system will be able to identify the level of ability and interests of learners (students) on one of his/her favorite games using Neural Networks. So based on such identification, information obtained from student's interest and the ability level and the mode are to offer games that are adaptive so that students do not feel bored. The proposed adaptive system uses the method of introduction of the profile and level of understanding of the material field of interest. Where the proposed model of educational games in the form of pure games, mathematics lessons/quiz based on artificial intelligence using Neural Network with 3 inputs and 1 output. The final result of this research is a framework and prototype of adaptive educational game using neural networks.

II. Neural Networks For Adaptive Games

Neural Networks are computational algorithms that mimic the way nerve cells work. All of the incoming signal is multiplied by the weights on each input, the neuron cells, all the signals are summed and then multiplied by the weight plus a bias. The sum is entered into a function (activation function) produces the output of the neuron (here used a linear activation function). During the learning process, the weights and bias are always updated using a learning algorithm if there

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are errors in the output. Network function is determined by the connections between elements. We can train a neural network to perform a particular function by adjusting the value of connections between elements.

Neural network is generally adjusted / trained so that a certain input produces a specific output destination. Network is adjusted based on the comparison between the output and that output objectives in accordance with the target network. For the identification process, the weights are the direct weighing are called the input as a search parameter, as shown in Fig. 1, the parameter is the price you are looking for w_1, w_2, w_3 and w_4. We use back propagation method used for training the networks.

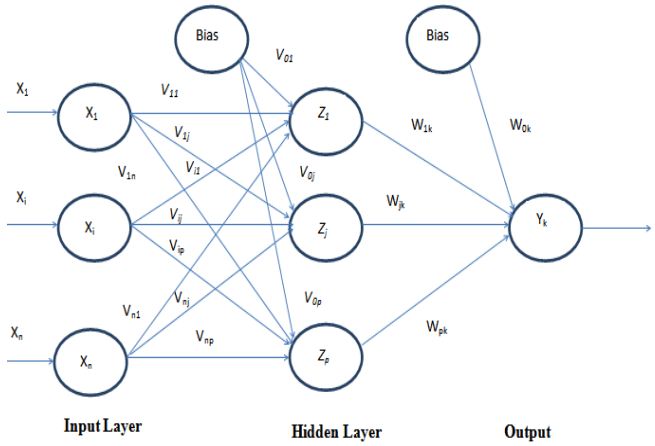

Fig. 1 Neural network with 3 inputs and 1 output

Based on Fig. 1, every input unit (x_i, $i = 1,..., n$) receive the signal input x_i and forward it to all units in hidden layer. Each hidden unit (z_j, $j = 1,\ldots,p$) summing the weighted input signal :

$$Z\_in_j = V_{0j} + \sum_{i=1}^{n} X_i V_{ij} \quad (1)$$

Then we use the activation function to calculate the signal output, where the activation function is using binary sigmoid generally by the following formula:

$$f\left(z_{in_j}\right) = \frac{1}{1+e^{-z\_in_j}} \quad (2)$$

Every output unit (Y_k , $_k = 1,..., m$) calculate signal inputs:

$$Z\_in_j = V_{0j} + \sum_{i=1}^{n} X_i V_{ij} \quad (3)$$

Then using activation function to calculate the signal output:

$$Y_k = \text{f}(Y\_in_k) \quad (4)$$

III. Proposed Method

A. The Framework

Research In Motion (RIM) has developed a world-class development tools to aid the development of BlackBerry applications with ease. Tools for developers at no charge and are constantly updated to include the latest features. One of the tools provided by RIM is the BlackBerry JDE Plug-in for Eclipse that allows developers to build Java applications on BlackBerry using Eclipse. Application Programming Interface (API) is a set of rules and specifications that software programs can communicate with each other. API serves as an interface between different software programs and facilitates their interaction, similar to the way the user interface facilitates interaction between humans and computers. API can be created for applications, libraries, operating systems, etc., as a way to define their vocabulary and a way to ask for resources (eg function-calling conventions). API may also be included in the specifications for routines, data structures, object classes, and protocols used to communicate between the consumer and the program implementers API.

The BlackBerry wireless device was first introduced as a mean for instant, secure, mobile access to email. Today, it is becoming an integral tool of many business users and consumers. Not only can it be used as a cellular phone, it also provides organizer functionalities and is capable of executing applications based on Java ME (Java Platform, Micro Edition). More recent models are even equipped with built-in-digital cameras, media plungers, Bluetooth and Wi-Fi. With so many features, it is not surprising to see the BlackBerry as one of the most popular mobile devices today.The blackberry is continually evolving with more innovative models released every year. And while RIM has thousands of third party vendors developing applications for this device, with this growth and expansion of subscribers more developers will be needed to create the applications for this platform. Learning about mobile devices in today's classrooms will be beneficial to the students as well as industry.RIM provides tools that software developers may use to program for the BlackBerry[12].

The process of designing the framework uses a workflow of Software Development Life Cycle(SDLC)[8]. Development IDE used is Eclipse Helios in it supports the BlackBerry Java Plugin 1.5 for BlackBerry mobile application development and the BlackBerry Simulator. The connection to the BlackBerry device uses BlackBerry Desktop Manager Software. Fig. 2 is our general framework shown using use case diagram that describe the actor and the important action in the games such as input name of the user, view high score, set the sound/voice, and playing with one/multiplayer.

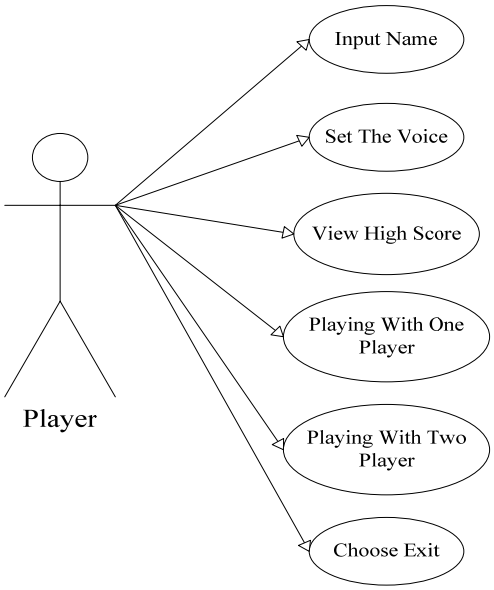

Fig. 2 Usecase diagram for adaptive games

Fig. 3 shows the proposed class diagram for the adaptive educational games. To store the data used by user, we use SQLite with very fast and compact for mobile games. SQLite is a software library that implements a self-contained, serverless, zero-configuration, transactional SQL database engine[9].

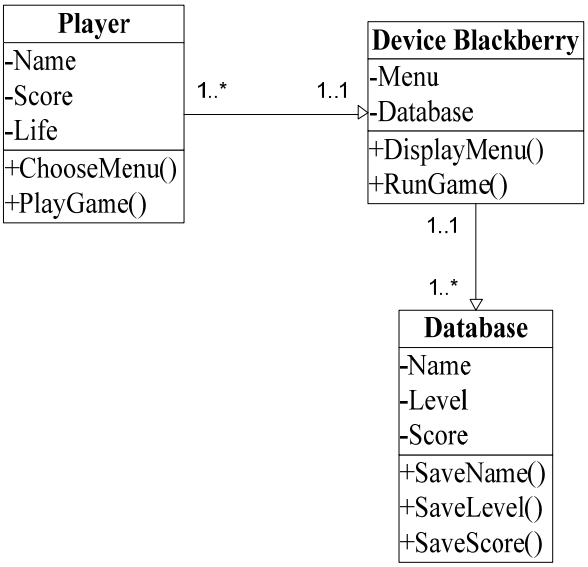

Fig. 3 Class diagram of the adaptive games

B. Neural Network Implementation

The design of neural network is shown in Fig. 4 with 3 input X_1, X_2, X_3 and output Y. In the training phases, we implementing back propagation method using feed forward and backward algorithm.

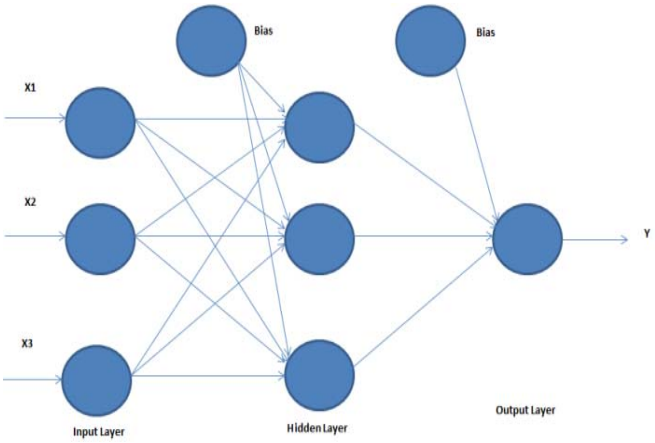

Fig. 4 Neural networks for adaptive games

Explanation of input and output in Fig. 4:
X_1: The time it takes the user to resolve questions.
X_2: Comparison between the frequency of correct answers and wrong.
X_3: Comparison of the frequency of the type of game played by the user (math / games).
Y: Adjustment of the level of difficulty based on the input.

With the training data input and output as follows, where for the input, a value of 0 indicates the game by the student less OK, and 1 is OK, while the output is 0 denotes the next group of questions more easily, whereas a much more difficult.

TABLE I
TRAINING DATA USED IN THIS RESEARCH

Input			Output
X_1	X_2	X_3	
0	0	0	0
1	0	0	0
0	1	0	0
0	0	1	0
1	1	0	1
1	0	1	1
0	1	1	1
1	1	1	1

IV. EXPERIMENTAL RESULTS

Experiments performed on the Simulator and the BlackBerry Bold with OS 7.0 with the results shown in Fig. 7:

Fig. 5 Result of simulation using BlackBerry Simulator, Main form for starting and choosing games animation/mathematics(a), question in mathematics games (b) and example of ball games(c) and the best scorer stored in SQLite (d).

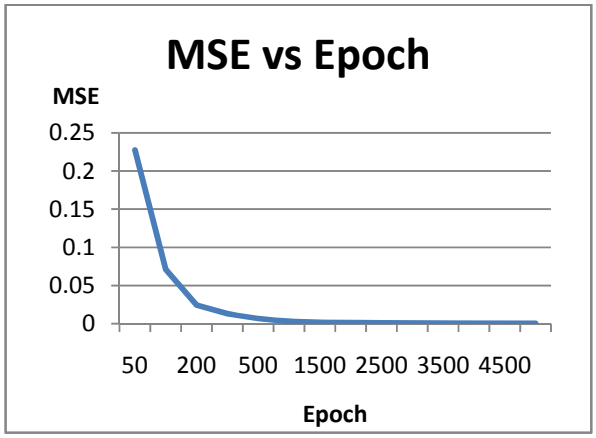

Fig. 6 Result of MSE vs Epoch

The training process does not require a long time, with the number of epoch determines the minimum error is obtained. Animation program created by the sound also can be run quickly. It should be noted that the handset is used must comply with the support of the OS used on the Development IDE used. Fig. 6 shows the MSE vs Epoch in our experiment.

Fig. 7 shows the results of the required time at various values of hidden unit/nodes. It shows that if number of the hidden units increase, the required time also increased.

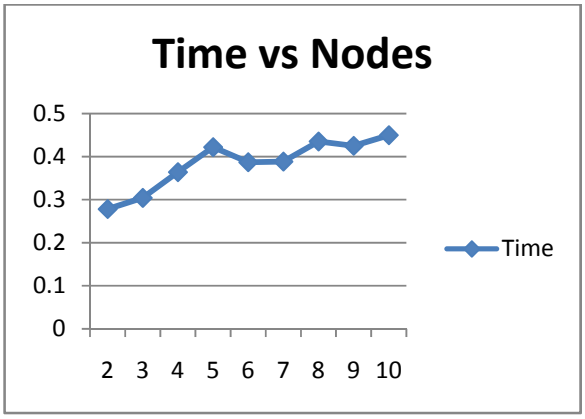

Fig. 7 Result of time vs hidden nodes

The number of hidden units determines the epoch required to get the minimum error as shown in Fig. 8. Based on the Fig. 8, system needs a longer time because the time needed per epoch longer because there are 10 hidden unit/nodes.

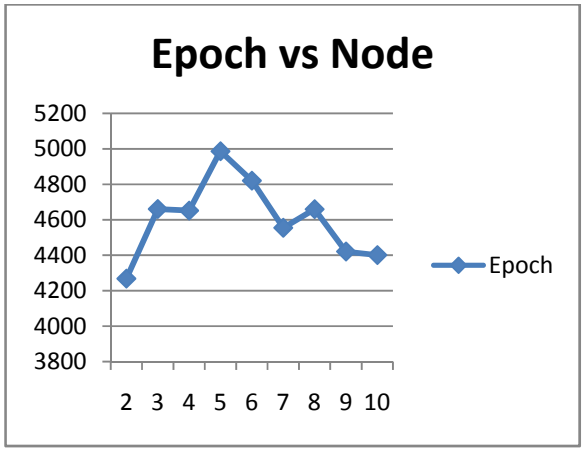

Fig. 8 Result of epoch vs number of nodes

V. Conclusion

This research has developed a framework for adaptive educational games using the back propagation algorithm in neural network with 3 inputs and 1 output. In addition, the training algorithm does not take much time so the time needed to start loading this game is quite fast. With a little training data, using the back propagation algorithm can handle noisy data and still be able to predict the correct output. The epoch value of 10 hidden units is lower, because the error falls off faster but it needs a longer time because the time needed per epoch longer because there are 10 nodes in the hidden units.

On the other hand, the system trained neural network can also make decisions accurately and quickly. Games are made successfully achieve the goals to be played with multiplayer mode and able to determine the level of the user and adjust the difficulty level in the animation / next question. In the next

study, the model will be proposed adaptive educational games that can be run based on Internet connection.

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