Using Hardware based Course Projects to Reinforce Java Programming

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Abstract - **The paper proposes teaching Java programming with hardware based course projects using LEGO NXT Mindstorms kits, Lejos mini OS and Eclipse. The aim of this combination is to reinforce Java programming for non-computer science students. A brief description was given to students about Lejos mini OS and its API documentation. Basic project like red line following robot with color sensor was built using NXT Mindstorms kit, uploaded a colour line following Java code and demonstrated it to students. Each student team was provided with a LEGO Mindstorms kit to freely build a robot and test their Java program on that robot. This type of teaching enhances Java learning, as actions performed in real-time by the robot, allow students to quickly identify their mistakes.**

Key words: LEGO NXT Mindstorms, Lejos OS, API, course project, robot.

1. INTRODUCTION

A Java is a simple, object-oriented, distributed, robust, secure, platform-independent, portable, scalable, high performance, multi-threaded and dynamic programming language [1]. Java language is suitable for object-oriented software systems' development, and many features of it bring a new design concept to programmers. During the teaching process of Java language, teachers are required to have a good standard method of teaching, and students are required to have a good capability of logic designing [2]. In present Java curriculum theory and practice of teaching can't integrate closely, so students are lacking of enthusiasm and motivation. Therefore, the present teaching method has been refined by introducing hardware based course project by using LEGO NXT Mindstorms kits, Lejos mini OS and Eclipse IDE to motivate students to learn Java effectively. So that students can really apply what they have learned.

1.1 The problems of the traditional teaching method of Java programming

The purpose of Java programming course is to help students to build object oriented programming ideas, master the basic syntax of Java and to be equipped with certain procedures design capabilities. The traditional teaching method begins with understanding the background, influence and development history of the programming language. Then, it puts forward the concept of object-oriented and starts the process of learning. Teachers make the learning of data operation, flow control, arrays, classes, packages, interfaces, exception handling and multi-thread as a sequence to explain, and then do some experiment on the computer to help students understanding what they teach [2].

Students in the learning process generally felt that the programming language is abstract and difficult to understand. They just complete the validation of the experiments in the classes, it lead to losing interest and confidence on the programming. This shows that the traditional teaching methods are not suitable for teaching of programming languages. We need to reform and explore the teaching mode of Java programming.

1.2 The teaching philosophy of teaching method using hardware based course projects to reinforce Java programming

During the design process of the "**using hardware based course projects to reinforce Java programming**" teaching mode, we followed some principles: The implementation process of the teaching method is divided into three stages, namely, project design, create learning resources and collaborative learning environment, and guide students to complete the project [3].

1) The project design is the key to learn. Project design is based on the availability of parts within Lego Mindstorms kit which is available in our department. Within the available resources students had to decide the project.

2) Students were provided a plenty of online resources and offline resources to students related to Lego NXT kit, Lejos mini OS and Eclipse plug-in for writing programs and uploading it to NXT brick.

3) During the implementation process of each module of the project, students may encounter new problems in addition to original knowledge and skills. So they should

think about how to achieve it by studying API documentation of Lejos mini OS. If they are having difficulty in achieving it we used to guide them. Students should exchange the development experience and the difficulties encountered and solutions in each stage of the project development. The completion of project is the key to evaluate learning effect.

2.OBJECTIVES

1) To create interest in students to about Java by relating theory with hardware projects.
2) To develop confidence among students by boosting practical skills.
3) To make students understand Java programming, with hardware interface.
4) To enhance students programming skills.

3. METHODOLOGY

Java programming concepts were covered in theory classes. Students were given Lejos API documentation, study materials of Lego mindstorms kit, NXG software to virtually build robots. Students were taught construction of robots using Lego kit and setting up of Eclipse IDE to write programs for Lego robot. Colour line following robot was built for demonstration, program to follow red colour line was written and uploaded to NXT brick. Three colour lines, blue red and green paths were built and demonstrated the robot to students which follows red line. Students were given simple assignments on Lego kit and Lejos programming to familiarise with Lego kit and Lejos APIs. Finally students were asked to do the projects.

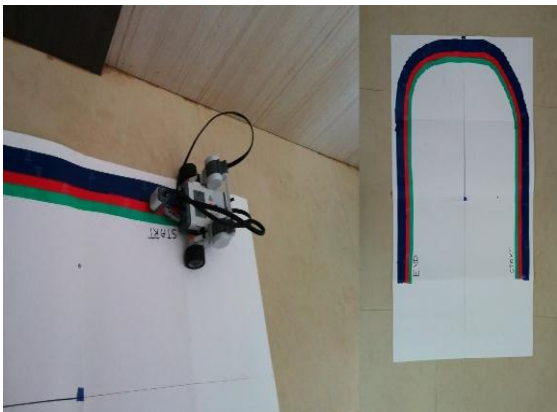Snap shot of demonstrated red line following robot with path:

Fig. 3.1 Red line following Robot with path

4. RESULTS

Students got exposure regarding various skills like
   a. Lejos Java programming.
   b. Building robots using Lego mindstorm kit.
   c. Making them to think beyond their curriculum.
   d. Difference between graphical programming and Lejos Java programming.

Snap shots of student's projects:

Team 1:

Fig. 4.1 Shooter Robot

Team 2:
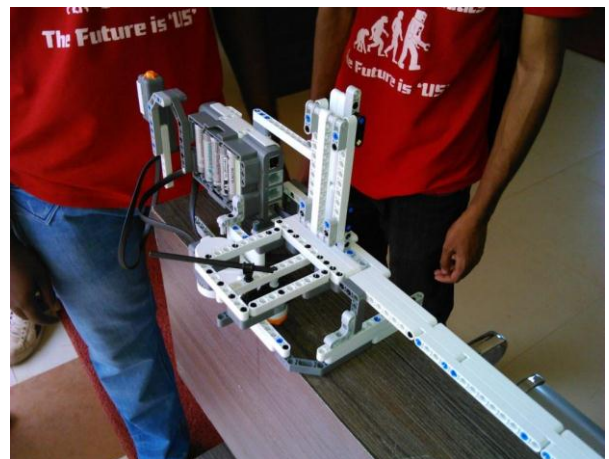

Fig. 4.2 Humanoid Robot

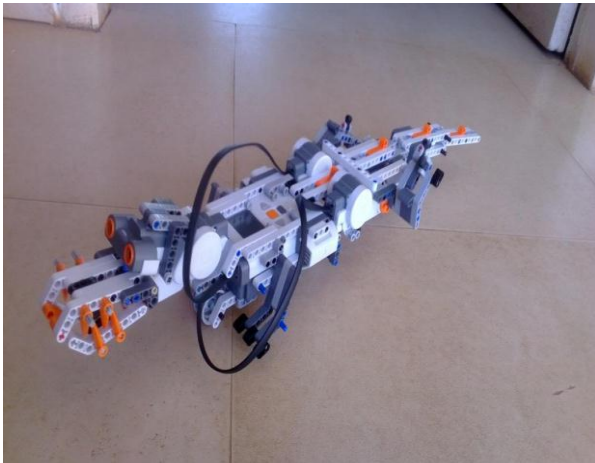Team 3:

Fig. 4.3 Machine gun

Team 4:

Fig. 4.4 Robogator

5. DATA ANALYSIS OF FEEDBACK

A very good feedback has been received from students for this new teaching method. As per the students feedback received, the data and graph show that the new teaching method has motivated students to learn Java programming.

Table 5.1 Students feedback

Attributes	Very good	Good	Satisfactory	Not Satisfactory
1. How do you rate the content of the course?	30	10	2	
2. How do you rate the way the course is delivered?	32	7	3	
3. How do you rate the associated Lab practice?	27	10	4	1
4. How do you rate the course project work?	33	7	2	

Fig. 5.1 Analysis of students' feedback

6. CONCLUSION AND FUTURE ENHANCEMENT

6.1 Conclusion

The "using hardware based course projects to reinforce Java programming" teaching method is a new teaching method based on constructivism theory. It is a more effective teaching method for learning the Java programming with hardware integration and it breaks through the traditional teaching method. Students have a sense of achievement and the spirit of exploration during the process of learning. Through Java programming with hardware integration, students not only learn much in project development process, in order to master the knowledge, but also improve the ability to solve practical problems. Meanwhile, it plays a positive role in promoting students' teamwork, innovation and practical ability.

6.2 Future Enhancement

Existing project uses microcontroller which is in built in NXT brick and it supports Lego mindstorms kit parts, instead we can use Arduino board and develop project using parts available in market. Instead of using Lego minstorms kit, two improvements can be added for this teaching method.

1. Arduino interfacing with Java using RXTX Java library. The Arduino IDE itself is written in Java, and it can communicate to the serial port via the RXTX Java library. That library is very similar to the Java Communications API extension. Internally the IDE remembers which port and baud rate you used last time. Unfortunately that internal implementation can not be considered public API we can reliably use. So we will have to keep our own settings to remember which COM port our Arduino board is using.

2. Arduino interfacing with Java using JArduino firmware and JArduino library files. JArduino enables us to write Java applications that can easily communicate with arduino board with some settings on the Arduino board.

ACKNOWLEDGMENT

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