Adaptive Ogmented

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ABSTRACT

Object Oriented Programming is one of the major skillsets any computer scientist should possess in order to be successful in the programming world. In this project, an attempt is made to train users on some of the basic concepts of Object Oriented Programming. The concepts of user adaptation and augmented reality are used as the base for developing this application. User adaptation is the technique in which the application adapts itself for each of the individual in order to provide better user experience. Augmented reality is the technique of superimposing computer generated objects on the user's view of the real world.

KEYWORDS

User adaptation, augmented reality, object oriented programming, Java, user profiling, explicit feedback, implicit feedback, object instantiation, inheritance, composition, polymorphism.

1 INTRODUCTION

The amount of information available over the web has drastically increased in the past decade. In spite of the abundance of available data, it has lost its value due to its sheer volume. A better way to handle the overloaded information is to create personalized approaches for information access. Research is performed to explore the use of a personalized approach and how the bulk information can be tailored to make it presentable to individual users. Making the applications work specific to any user is achieved by gathering extra information from users and this process is called User Profiling. [1]

Bulk data is filtered based on user's interests by removing irrelevant data and focusing on information relevant to the user. To make the user profiling effective, the filtering technique is enhanced to combine information from multiple users and show them as recommendations. This system is known as collaborative recommendation systems. The main drawback with this technique is gaining control over the privacy of other user's data.

Personalization has become vital and is used in several fields like rating systems for e-mail, e-newspaper, web documents, improving navigation effectiveness etc. Personalization is done mainly on user profiles which are constructed using the information gathered from explicit and implicit feedback from the user. User profiles can be sub-divided into two categories. They are dynamic profiles and static profiles. Dynamic profile content can be modified whereas static profile content remains the same over time. Short-term profiles have user's current interest and long-term profiles have user's interest that is not subject to change over time.

When a new user registers to the application or system for the first time, the system will not have any prior information about the user. This can affect the user's initial experience. In order to limit the drastically extreme user experience, explicit feedbacks are collected to adapt the system to a certain extent for the user[2]. But the explicit feedback should be kept to a minimum as it can adversely impact the user's interest.

When the user starts using the application, several metrics are collected without interrupting the user to enhance his/her experience. Collecting information this way is called implicit feedback [1]. Implicit feedback is preferred over explicit feedback as this doesn't hamper the user's experience.

Combining explicit and implicit feedback can help in creating a good user profile. Once a profile is created, it is very important to make it adaptive. The adaptation of content to user-specific needs involves deciding which content is most useful to the user based on his/her profile, also called content adaptation. Thus, an Adaptive Recommendation system can be built using the user profile and all the data collected implicitly as the user interacts with the system. This recommendation system can utilize Content-based [3] and/or Collaborative filtering methodologies [4] to cater to the needs to the end user.

Making students engage in social learning technologies has become a trend in the field of e-learning. Open social student modelling solves the issue of providing support in the context of social learning along with control of different user's data. The current project – Adaptive Ogmented, is a platform where OOPS concepts are taught to users visually in an interactive manner through the use of augmented reality. Content-based filtering along with group collaboration has been implemented to get a better adaptive experience for users while learning concepts.

1.1 Project Idea

The main idea of the project is to provide a platform that enables students with varying levels of expertise to learn OOPS concepts in Java intuitively by leveraging the capabilities of augmented reality. In this project, the users are taught the core principles of Object Oriented Programming such as Classes and Objects, Inheritance, Composition and Polymorphism. Based on the user's level of expertise in JAVA, they are redirected to the appropriate levels in the application. The various tasks implemented along with the respective concept covered are as follows:

1. Task 1 - Classes and Objects
2. Task 2 - Inheritance
3. Task 3 - Composition
4. Task 4 – Polymorphism

1.2 Project Description

The first stage of the project involves implementing the login and registration modules. A new user who wants to access the platform should register to the system by providing a username, password and his/her level of expertise in Java programming language.

Upon finishing the explicit feedback task, the user is then redirected to a task appropriate to their level of expertise. Four tasks have been implemented each showcasing four different concepts. Every task begins with a short description explaining the concept being covered. This builds a foundation for what lies ahead and gives the user a heads up on what to expect in the upcoming task. Next, at the top of the screen, hints are suggested to the users to help them to accomplish the goal set for them. On the top right corner, the details of the user are available. On the top left corner, we provide details on the user's performance. Here, one version of an open user model has been implemented showcasing the performance metrics of the user in comparison to the rest of the world. In particular, the number of wall collisions that have occurred during the course of the task is shown. Next, we keep track of the time taken by the user to accomplish the task. Below that, we have a performance indicator showing how the user is performing in comparison to the rest of the users who have previously attempted that particular task. The performance metrics can take one of the following three values and is based on the time taken by the user to finish the task:

1. Bad
2. Average
3. Good

Upon successfully finishing the task, we display the end of task statistics. These statistics have two levels of granularity:

1. Global level:
    a. Average time taken to finish the task (global-level)
2. User level:
    a. Average time taken to finish the task (user-level)
    b. Time taken in previous attempt
    c. Time taken in previous successful attempt
    d. Time taken in current attempt

Next, options are provided to the user to either continue to the next task or replay the current task. In case the user fails to meet the set expectation, the end of task statistics are displayed with an option to repeat the task.

Task 1:
Objective: To instantiate an object of the class cube and set its color to green
Walkthrough:
Initially, the user has the ability to maneuver a sphere that represents the parent "Object" present in Java. Next, upon picking up the yellow object, three classes of objects are visible on the screen: cube, capsule and cylinder. Here, the expectation is for the user to navigate the sphere to the cube object. Upon successfully doing so, the user will now have the ability to navigate the cube. Next, another yellow object appears. Upon picking up this object, three colors are displayed on the maze: yellow, red and green. Upon, picking the "Green" object, the user successfully finishes the set task.

Task 2:
Objective: To demonstrate human evolution
Walkthrough:
Initially, the user has the ability to maneuver a sphere that represents the parent "Object" present in Java. Next, upon picking up the yellow object, three classes of base classes are visible on the screen: ape, pig and rabbit. Here, the expectation is for the user to navigate the sphere to the base class that leads to human evolution i.e. ape. Upon successfully doing so, the user can now have the ability to navigate the ape. Next, another yellow object appears. Upon picking up this object, three derived class objects are displayed on the maze: human, penguin and bear. Upon, picking the "Human" derived class, the user successfully finishes the set task.

Task 3:
Objective: To demonstrate composition (HAS-A Inheritance)
Walkthrough:
Initially, the user has the ability to maneuver a house object. The objective of the task involves picking up objects that a house is composed of. Next, upon picking up the yellow object, three objects are visible on the screen: door, tree and car. Here, the expectation is for the user to navigate the house to an object that is present within the house i.e. door. Next, another yellow object appears. Upon picking up this object, three more objects are displayed on the maze: chair, ape and bear. Upon, picking the "chair" object, the user successfully finishes the set task.

Task 4:
Objective: To demonstrate polymorphism
Walkthrough:
Initially, the user has the ability to maneuver a sphere. The sphere, in this case, represents a behavior. In particular, this behavior is the area functionality. Next, upon picking up the yellow object, three objects are visible on the screen: cube, cylinder and capsule. On colliding the sphere with any of the objects, we show their respective area. Here, we are trying to convey the idea that, the area behavior is polymorphic based on the class of object it is being attached to. The same area functionality, when added to different classes of objects, have different behavior. The task ends with the user selecting all the objects.

1.2 What is Adaptive Ogmented

Augmented reality system complements the real world with virtual objects which seem to exist in the same space as the real world. To create a positive impact on user experience, we try to adjust the application to the context of use. To foster the functional ability, adaptive augmented reality is used which makes the system easy for use.

2 MOTIVATION

OOPs is a fundamental programming paradigm. The main motivation behind this application is to provide a platform for users, with varying levels of expertise, to strengthen their knowledge in OOPs concepts.

2.1 Need for Adaptation

Adaptive learning environments are essential today due to the information overload that is presented to the learning community, upon searching for a specific topic of interest. It is particularly difficult to identify and decide upon a source that is complete as well as easy to comprehend and navigate through.

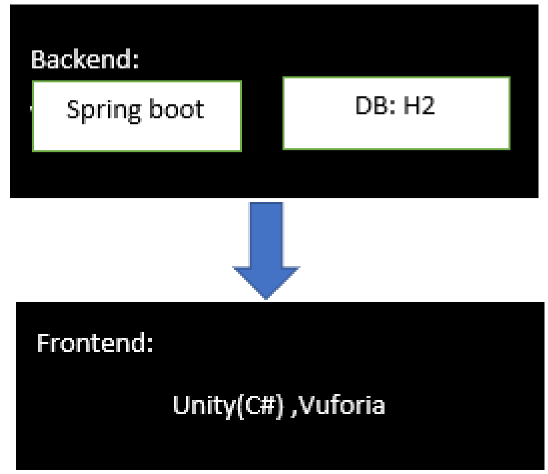
The goal of this project is to build an adaptive learning system that attempts to teach OOPS concepts. The learning environment is made adaptive by considering implicit and explicit feedback from the platform and users respectively. Group collaboration functionality is implemented in tandem with open user model to allow the users to gauge their performance in comparison to the rest of the users.

The learning environment will be a comprehensive base for users to test themselves on OOPS concepts. Furthermore, the learning environment is made open to the user [5], so he/she has access to the history, progress and analysis on his/her activity. The system works on the user profiles that have been built by interacting with the system. I-Han Hsiao et al. [5] discussed an open-social version of the same that attempts to make content about other users or peers available to each user. This promotes healthy competition amongst the user base as they compare their progress with that of their peers and work towards being on par or getting ahead of their peers. The project tries to incorporate this feature through visualizations that compare scores and performance in each level.

The work by Bull & Britland [7] also prompted the use of group collaboration. Aside from being an enhanced feature in an adaptive learning system, it is also particularly useful to encourage users by showing his/her performance when compared to others. Another important aspect that motivates research in this area of adaptive learning and the implementation of this project is the ability to provide users with hints which are generated and recommended using content-based filtering. Users only see content relevant to his/her expertise level and the system adapts to the user's progress by continuously updating the saved user profile. The system also adapts to user speed continuously based on wall hit counts and the time taken to finish each task.

3 SYSTEM DESIGN AND IMPLEMENTATION

3.1 System Architecture



The system can be broadly categorized into:

1. Backend components:
   a. Database: Embedded H2
   b. REST Service: Spring Boot
   c. Hosting Service: AWS EC2.
2. Frontend components:
   d. UI: Unity with C#
   e. Augmented Reality: Vuforia

The final application was packaged as an android (.apk) application.

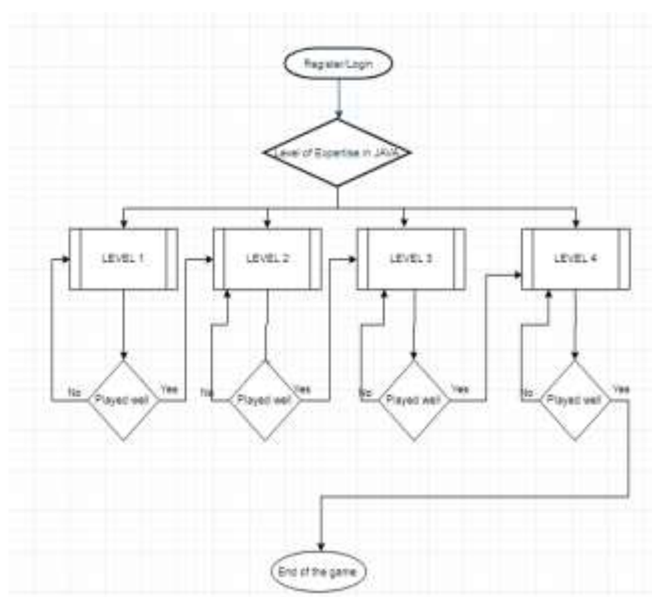


Fig 3.1: Workflow diagram of the application

3.2 Content Model (Database design model)

Relational Database Management System named **H2** has been used in this Adaptive Ogmented application.

The main advantage of choosing H2 over others is that –

- It provides multi version concurrency.
- Very fast database engine.
- It offers in-memory databases.

The following are the tables used in the application:

1. USER_TBL

This table houses the details of all the users that are registered to the platform. It includes information such as user id, password, user's level of expertise and the user-specific object speed.

2. USER_LOGS

This table contains the logs of all the tasks for all the users. This includes information such as time taken to finish the task, indicator of whether the task was successfully accomplished, the number of wall collisions, task number etc.

Figure 3.2 shows the details of each of the fields present in the aforementioned tables.

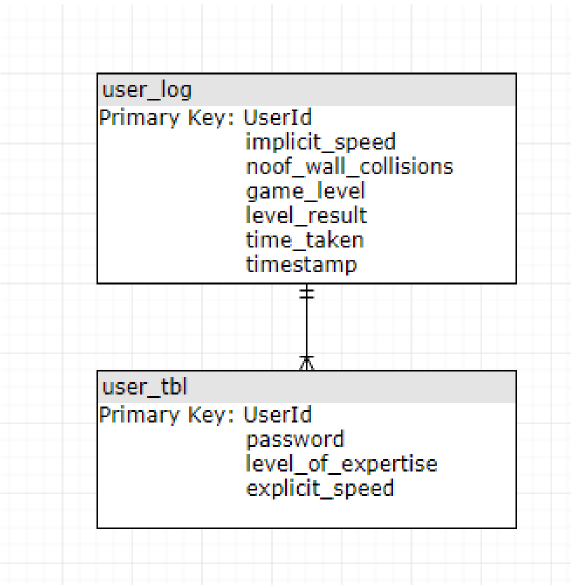


Fig: 3.2 UML Diagram of the Database Sytem

3.3 Components

3.3.1 Registration

The registration module facilitates the user to register to the platform. The following three inputs are taken:

1. User ID
2. Password
3. User's level of expertise in Java

Fig 3.3.1(a): New user or existing user screen

Fig 3.3.1(b): Registration screen

3.3.2 Login

The logic module facilitates the user to login to the platform. The following three inputs are taken:

1. UserID
2. Password

Upon successful login, the user is redirected to an appropriate task.

Fig 3.3.2: Login screen

3.3.3 Game

This is the main module that incorporates the maze within which the user accomplishes the assigned task. Some of the key functionalities included are:

1. Performance Indicator
2. Task hints
3. Task description
4. User details

Fig 3.3.3 (a): Speed Adjustment initial screen

Fig 3.3.3 (b): Initializing object speed that is adaptive to user hand movement

Fig 3.3.3 (c): Level1 concept explanation with stats values initialized to zeros.

Fig 3.3.3 (d): Level 1 with "Good" user performance and time taken so far

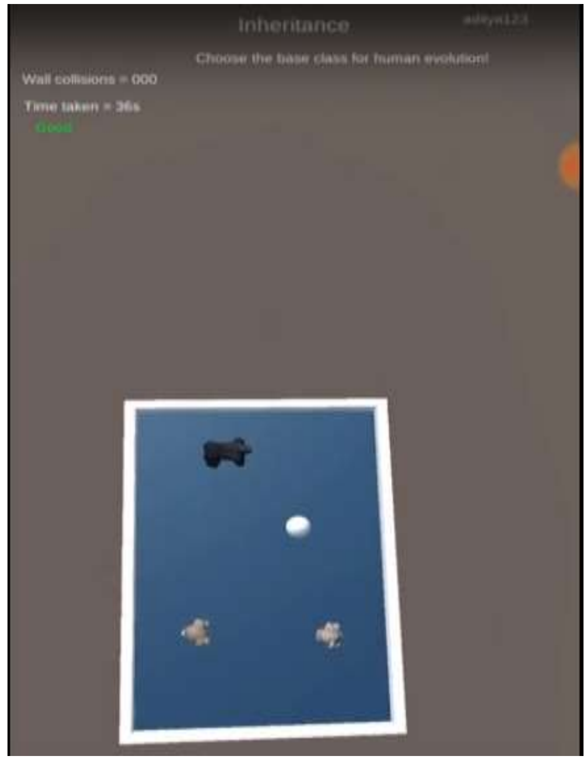


Fig 3.3.3(f): Level 2: Inheritance (choosing base class)

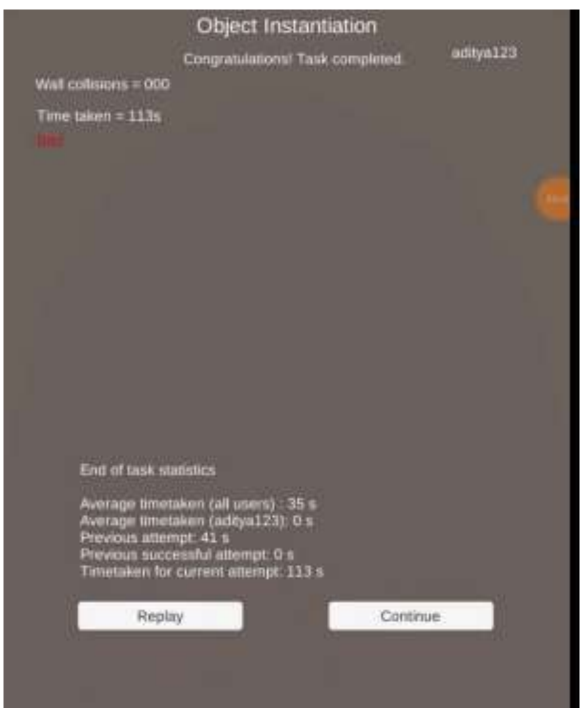


Fig 3.3.3 (e): User statistics at the end of the level

Fig 3.3.3(j): Level4: Polymorphism (displaying area of different objects)

4 METHODOLOGY

The ability to impart knowledge effectively has always been a challenging task. We are presenting a platform that can be leveraged by students to strengthen their OOPS concepts in an intuitive way. The open social student model provides an approach to technology-based learning, which makes student models available to learners for exploration. This encourages the users to perform better than their peers thereby introducing healthy competition. The use of augmented reality to explore the concepts provides an easy to understand means for the users to grasp the knowledge.

5 EVALUATION PLANS

The current project, Adaptive Ogmented, focuses on introducing basic concepts of Object Oriented Programming to users in a very intuitive and interactive way. It also uses Augmented Reality to better explain the users. There are multiple ways in which the application was evaluated.

One of the ways in which the application was evaluated was by verifying the adjustment of speed of the movement of the objects for each user based on his behavior. Based on the initial external feedback collected, the speed of the movement of objects are varied for individual users.

The performance of the user was continuously monitored by using statistics like time taken to complete the task (Successful / Unsuccessful) and the number of collisions happened during that time. An indicator has been displayed on the UI indicating the user his performance with respect to other users of the system. Based on these indicators and end of task statistics, the user can decide to repeat the same task or continue to the next one.

These are some of the ways in which the application was evaluated. The expectation is that once the user completes all the levels in the application, he/she should have basic understanding of the object oriented programming concepts.

6 CONCLUSIONS

6.1 Summary

The application successfully meets the expectation of training the users on basic concepts of OOPs. As the user continues using the application, the system adapts well to his / her behavior providing him / her with a better user experience, thus achieving behavior modelling. The end of game statistics help the user to evaluate himself and try to improve. The user can compete against himself beating his previous record or can compare himself against the global users. Explicit feedback in the application is only collected once while registering in order to avoid any chance of user becoming disinterested to provide feedback. Implicit feedbacks are collected regularly to enhance the experience for the user.

6.2 Discussions and Future work

In future, we plan to implement the below set of features to make the app more user friendly and give better recommendations.

1. Add more levels in each concept by increasing the complexity of questions.
2. Consider more implicit feedback and improve the system based on the information collected.
3. Give suggestions if the player is going out of way.

7 ACKNOWLEDGMENTS

We would like to extend our sincerest thanks to Dr. Sharon Hsiao for her guidance and support throughout the project. We appreciate all the time and effort she has spent in imparting knowledge about the subject, making it interesting and aligning our project closely with the theory taught in class. We now have a deeper understanding of adaptive systems and recommendation systems and what goes into making such systems more effective.

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