CHAPTER 3

SYSTEM ARCHITECTURE

The integrated e-learning system contains the following components namely registration/login module, learning style identification sub system, pair programming learning using peer learning agents sub system, pedagogical learning using conversational agents. The decision manager sub system includes learner evaluation module and group evaluation module in addition to the target learners. Each of the components is an individual sub system and they function independently but coordinate with the other sub systems to achieve the integrated e-learning system. In addition, for the purpose of evaluations questionnaires testing module and descriptive answers testing modules are used which uses questionnaires database and questions - descriptive answers database. The input to the proposed system is the individual learners with different profile information and learning styles and the output is appropriate recommendations on the methodology of the learning to the learners provided by the decision manager. The proposed integrated e-learning system in this research work for e-Learning is shown below in Figure 3.1.
Figure 3.1 Proposed Integrated E-Learning System Architecture
3.1 REGISTRATION / LOGIN MODULE

The individual learners register themselves through the registration/login module with their original profile information. The profile information includes name, age, gender, educational background, career choice and domain of interest.

3.2 PRE-TEST

Before the learners could learn E-contents through self-learning and peer-learning, direct peer-learning, pedagogical learning and peer-learning agents, they take a preliminary test called as pre-test using the questionnaires available in a database. These pre-test marks help them in knowing their level of knowledge in a particular subject so that they can make effective decisions in choosing the learning methodology. The pre-test is a simple test having multiple choice questionnaires which consists of 50 questions. These questions are useful for testing the ‘C’ programming language constructs namely datatypes, operators, functions and looping statements. However, this pre-test is done before incorporating any type of learning methodology in order to analyze if the three groups of learners were homogeneous in terms of level of achievement. Based on the pre-test marks, the learners are directed to the appropriate learning methodologies.

3.3 LEARNING STYLE IDENTIFICATION SUB SYSTEM

Learning style identification sub system identifies the learners into four categories namely active, medium active, medium reflective and reflective so that they can be provided with a suitable learning content. For this purpose, the target learners after the test are directed to any one of the learning methodologies namely self-learning followed by pair programming learning using peer-learning agents (self learned group), pair programming
learning using peer-learning agents (peer learned group) and pedagogical learning through conversational agents followed by pair programming learning using peer-learning agents (conversation agent learned group). Meanwhile, for the self learning methodology of learning, appropriate e-contents are recommended to the learners based on identifying their learning styles in order to increase the self-efficacy of the learners learning through web environments. Felder-Silverman learning style model is chosen in this work for learning style identification in web learning environments. Moreover, fuzzy rules derived from Gaussian membership functions (Basterretxia et al 2006) are used in this work to handle the uncertainty in learning styles identification based on the learners’ membership degree for active/reflective type of dimensions in Felder–Silverman dimensions of learning style model. To facilitate this, the learners’ web usage activities are recorded and some important parameters in such activities of the learners are considered for learning styles identification. Based on monitoring the web usage activity information of the learners and fuzzy Gaussian membership function the learners are classified into four categories namely active, medium active, medium reflective and reflective. Such efficient learning style identification is performed through learning style identification sub system.

3.4 PAIR PROGRAMMING SUB SYSTEM USING PEER-LEARNING AGENTS

Learning through pair programming strategy makes use of the peer-learning agents for learning the target course. The learner and the agents alternate roles of a tutor and tutee to learn an e-course. The specified roles are alternated in three situations which include, when the target program had been successfully compiled and finished execution, when the learner or the agent had scripted syntactically incorrect programs or when there is no user activity for a specified interval of time. In the initial experimental setup, the agent
database consisted of 10 programs which include C programming constructs namely datatypes, operators, functions and looping statements and the database is prone to addition of new programs on subsequent learning when tutee roles are assumed. Therefore, this sub system provides a collaborative learning environment and this kind of collaboration is found beneficial to the learners especially when learning a programming course.

3.5 PEDAGOGICAL LEARNING THROUGH CONVERSATIONAL AGENTS

This is another type of agent learning methodology where the agent assumes only the instructor role and the agent database will not be updated. The agent tutors the learners learning through web environments and the learners interact with the agent tutors in case of any problems encountered during the learning process. However, the learner interacts once in a while with the tutor for any clarifications. The agent database consists of 10 programs which include ‘C’ programming constructs namely datatypes, operators, functions and looping statements.

3.6 DECISION MANAGER SUB SYSTEM

The role of the decision manager is facilitated by two modules namely learner evaluation module and group evaluation module. The learner evaluation module is facilitated by ontology construction and alignment. Two separate ontologies are constructed from the learner and a domain expert respectively. These ontologies are constructed from the descriptive answers which are answered by the learner during the descriptive answers testing module. The domain expert ontology is constructed using the questions and answers present in the questions and descriptive answers database. In case of group evaluation, the learners are tested using multiple choice questions. The
learners as a group are evaluated using the pre-test and post-test marks obtained from the questionnaires testing module.

3.6.1 Learner Evaluation Module

In the learner evaluation module, the learners are evaluated using both simple multiple choice questionnaires and short descriptive answers patterns. The evaluation test pattern at this stage is called as post-test. The simple multiple choice questionnaires of the post-test consists of 20 questions which includes the ‘C’ programming language constructs as described earlier. The second type of evaluation uses descriptive answers patterns and to validate the descriptive answer patterns ontology based knowledge representation technique is used in the proposed system.

Initially, the descriptive answers text written by the learner is converted to an ontological structure. The constructed ontological structure is based on propositional logic and pronominal anaphora resolution which considers the concept of axioms and correlation between multiple sentences respectively. The constructed ontology for the learners’ document is validated using an ontology constructed from the answer pattern document provided by the domain expert. For the purpose of such validation, ontology alignment technique is used in the proposed system. The ontology alignment is performed using deontic logic since it has the ability to consider both dominant and non-dominant words present in the answer patterns text provided by the learner and the domain expert. The proposed ontology alignment framework considers not only the predicate logic features namely equals and partial-equals, but also the newly added consistency checking deontic predicate ‘conflicts’ and hence it covers all the aspects of logic including unification, resolution, subsumption and conflict identification. The ontology alignment validation in the proposed system is performed for six
short descriptive answer patterns for ‘C’ programming language construct namely datatypes, operators, functions and looping statements.

3.6.2 Group Evaluation Module

This module enables the decision manager in analyzing the performance of the learners as a group. The module is responsible for analyzing the performance of the groups of learners’ namely self-learning group, peer-learning group and conversation agent learning group. This is achieved by the recorded pre-test and post-test marks of the simple multiple choice questionnaires and the differences in the different methodologies of learning described above is found using t-test and ANOVA test evaluations. At a single instant of time the first two groups namely self-learning group and peer-learning group are analyzed for performance using the t-test evaluation technique. This t-test is responsible for finding the differences in the mean values of the pre-test and post-test. When all the three groups mentioned earlier is considered for analysis, ANOVA test evaluation technique is used to analyze the performance of all these groups.

Finally based on the t-test, ANOVA test evaluations, ontology alignment similarity measure computed from the learners and domain expert ontology structure and the learners profile information the decision manager provides suitable recommendations on the methodology of learning to the learners. The metrics used by the decision manager are t-test results, ANOVA test results, ontology alignment similarity computation measure, learner profile information namely age, professional career, domain of interests and learning styles.