RFID Based Learning Assessment System

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Abstract: - Learning Assessment or traditional testing is typically performed with the participation of a proctor, who must be physically present in the classroom at all times. Protecting the integrity of learning assessments, in any form, often involves complicated procedures and adjustments to the assessment process and environment. The Radio Frequency Identification (RFID) based Learning Assessment System (RLAS) is aimed at removing the need for a human proctor and reducing the complexity involved in the assessment. This is particularly important when assessment is more complex than a traditional pencil and paper variety. RLAS integrates RFID tags, Pocket PC (PDA's) and a server to create a complete learning assessment system. RFID tags are used to track students' movements and PDAs are used as communication devices. Students are then monitored by a virtual proctor on a server. In this paper the development of the RLAS system is described and its use as a tool to develop and execute individualized learning environments for students in K-12 is considered. The system integrates audio, video and common textual learning tools depending on the student's location and learning style needs. The system further assesses the effectiveness of the chosen tools in the student's learning process.

Key-Words: - Learning Assessment, Proctor, RFID, Sensors, Communication

1. Introduction

As we hurtle through the space and time of rapid change and integration in our educational environments, we occasionally become overwhelmed by all of the dramatic new possibilities for modifying the way we teach and learn. Today we speak of education as synchronous or asynchronous, we consider more closely learning styles and educational modes of delivery, and we have begun to see learning as an exchange of information and a kind of effective management of information with our educators as facilitators, instead of simply fountains of knowledge to be relayed to a passive audience [1]. These changes in perception are all attributable, in many ways, to the advent of the Internet and new applications of technology in our educational systems. As the Internet has proliferated over the last 10-15 years, we have become more and more comfortable with integrating all kinds of new consumer technology in creative and inventive ways to improve student experiences in education and to improve and safeguard our assessment processes as educators. Now we even have offshoots of online learning referred to as: m-learning (mobile learning) and e-learning. [2][3].

In fact, integration of the Internet and related technologies has created a new set of challenges for teachers, either online or in a classroom setting, and we are still learning to adjust to those challenges. One of the biggest challenges for education in general has been our ability to proctor and manage educational activities and assessment. In the classroom setting and online even a traditional pencil and paper objective test is a complicated procedure because of an increase in cheating activity [8]. Online, we have used everything from setting specific times for tests, to yielding to creating open book tests, and/or requiring students to go to a specific location at a specific time to take a test with a live proctor there to verify the student's identity and to verify the student is not cheating using resources that are not allowed to be used in the test environment. In the classroom setting we have been forced to deal with standardized tests because of large class sizes that make it difficult if not impossible to use complex assessment processes based on an individual's learning style [9].

In a classroom setting we still have difficulty managing the assessment process and many teachers remain concerned about how well traditional testing processes really reflect student learning. In fact, online or in the traditional classroom these standardized assessment and education techniques are proving to be both inefficient and ineffective when used as the sole means of student performance and knowledge evaluation. We need a new solution to this particular problem.

The Radio Frequency identification (RFID) based Learning Assessment System (RLAS) is aimed at removing the need for proctors and reducing the complexity involved in student performance assessment when we deviate from the standard pencil and paper objective assessment activities. RLAS involves a unique integration of RFID tags, Pocket PCs (PDA) and servers to create a remote assessment and proctoring environment. RFID tags are used to track students' movements in the remote assessment environment and the PDA is used as a primary content communication device. Student activity can then be monitored by a virtual proctor on a server. Using the RLAS system, educators will be able to create a more individualized learning plan for young students in K-12 and adjust the assessments of learning to their individual learning style despite larger classes. Because the system handles most of the proctoring duties, one person can handle more students and their work, and still effectively and efficiently administer individualized learning experiences.

This is new ground that we cover in this paper and there is probably no specific literature on the deployment of a technology system like the RLAS system in the classroom— either for assessment purposes and/or student enrichment. The technique being discussed in this paper is a new application of RFID and PDA technology to form what the writers here call the RLAS System (Radio Frequency Identification Learning Assessment System.) This system is capable of both proctoring traditional tests for online courses and is capable of being deployed in more complex ways to create an individualized learning environment—including assessment processes for students.

To begin the process of integration of RLAS we must first consider several important aspects of our education experience. We need to consider what we are doing well and where there are weaknesses. We've already indicated that one specific weakness the RLAS system is designed to address is the inability of teachers to create more individualized learning assessment processes that can be tailored to the student's best learning style. Because our system allows one person to work asynchronously and devote their time and energy to design and outcome assessment instead of managing the actual learning environment, we believe the RLAS system can effectively provide the solution.

For the educator implementing the RLAS system, the time has come to consider issues of learning style, cognition and understanding for students more intensely and worry less about monitoring the security or integrity of the environment in which they work. This is true also in online education or in the hybrid classroom. In fact, there is a large body of literature relating the history of the development of effective online education considering learning styles and student cognition [5]. That literature also provides us with an overview of the challenges that have arisen as online education developed over the years. For example, in its very early form online education was primarily textually based—something that worked for a visual learner perhaps, but not for kinesthic or for those with aural learning styles. Additionally, textual materials online often failed to hold even the visual learner's interest, was difficult to organize, and the environments lacked a sense of community involvement [5] It was essentially reliant on the learner's willingness to teach themselves, on some level, and was too much like older correspondence classes with less time elapsing between when students had contact with each other, teachers, and/or their assignments.

There is additionally a body of research developing around m- learning (mobile learning) that in many ways has some similarities in theory to our deployment of the RLAS system in either online or traditional classroom settings. [3][6] Over time the RLAS system should be compatible with m-learning and e-learning environments in fact.

There is also a large body of research related to content design for DE or technology facilitated instruction and much of that research is rooted in theories related to student learning styles. Those learning styles include visual learners, aural learners and kinesthic learners [7]. There is a great deal of evidence that indicates that the better adapted the presentation of materials and content are to the individual learner then more capable the learner is of understanding and retaining that material. It makes sense then that once we've adapted content to the student's learning style we should also adapt assessment strategies to that same thing. However, in the past, adapting learning assessment to individual learning styles has been too cumbersome for most faculty to consider. The RLAS system will allow a more efficient way to do so while providing additional security to avoid student cheating and misuse.

The following methods are typically used to conduct learning assessment by educators:

1. Paper and Pencil Tests (PPT) and
2. Computer Based Tests (CBT).

CBT's have many advantages over PPT's, which may include faster scoring services, saving time of proctor in evaluating and personnel resources and development of new methods of assessment [4]. In fact, the Internet has revolutionized the way that traditional assessment is done. Online assessment enables the design of questionnaires, generation of assessment forms and the evaluation and analysis of the assessment results. The assessment process is completely performed online.

2. Learning Assessment

Assessments are the core of our jobs as educators. Assessments help us identify our student's progress and to verify that each student has reached a particular level of skill and command of material so that they may move on to the next educational building block. However, assessment is truly a complex process and we must consider all kinds of assessment tools in order to know our student's achievements as well as their stumbling blocks as we proceed through the educational materials and concepts. Assessment at its most fundamental core takes the form of some kind of objective test—a set of questions, whatever the type—that must be answered by a student, with or without the aid of books, papers, and outside sources. These kinds of test assessments described above are designed to show us what the student does know and can adequately share with us in a given time span. However, there are many additional ways to assess student learning and progress that involve interacting with models and content, listening to audio or watching video content and interacting with it or responding to questions, just to name a few options. The RLAS system allows teachers to consider either in an online environment or in a traditional classroom environment these assessment alternatives as options to gauge student progress.

Many educators today may teach face-to-face classes, hybrid classes, which are a mixture of the two or entirely online classes. All of these options can lead to confusion and ineffective educational planning and assessment. Often at the root of the problem is our inability to be sure our students are doing their own work and in the conditions and circumstances we have proscribed for the assessment. When we can't be sure students are doing what we ask, when we ask, the way we ask, we find ourselves as educators redesigning and contorting our educational plans and assessments to meet that need and the result is often unwieldy at best or ineffective and unworkable at worst.

While the RLAS system might be adapted to also monitor traditional objective test taking experiences, our paper involves integrating it into a two-step process for educators—we have created the RLAS system to allow educators to create an individualized learning assessment system for students that will grow and change with the student over time and that can be based on how the student learns each kind of material best. Our goal is to allow educators to offer options for student learning and assessment that can improve learning.

So, if our goal is to design learning and assessments for individuals based on learning styles we must take two steps. The first is to identify the student's primary learning style and the second is to find an appropriately personalized delivery style best suited to that student's individual needs. Once this first step of the process is executed then designing the assessment process becomes also more individualized and should adapt to fit the learning style of the student as well.

For example, we may evaluate a small group of students [3] and determine that one learns best by seeing video and with immersive technology, one learns best with audio delivery and the last student prefers to learn visually through textual material. So, first we must set up a system that allows us to test students individually in online environments to determine their most effective learning style, and second we must now create materials that can be delivered in any of these modes to each individual as they enter our online environment. Once we have this process established we shouldn't then simply revert to assessments that don't take into account these learning styles. Specifically, we can't then ask these students with different learning styles to now abandon those styles and take a textually based test as their primary assessment method. This is completely leaving out the learning styles of two major types of learners and handicaps those students in proving their true mastery of the material

Our second step is to sync up our assessment process with our learning styles. The question though for the educator is where to find the time to manage creation of these individualized assessments while handling one or more classes of 25-40 students. This paper will introduce the reader to the RLAS system and explain how it might be deployed to create a unique individualized learning system for each student based on their unique learning attributes.

3. RFID Based Learning Assessment System

The RLAS system is one that is a real-time learning assessment method for interactive teaching and is conducted by means of portable electronic devices like PDA's. This project involves also, the use of several other devices—RFID tags and RFID sensors. This process involves using an assessment system to carry out real-time assessment of the result of learning conducted by means of these portable electronic devices. The assessment system compiles the statistics of the student's performance on tests taken with portable electronic devices, for creating records of assessment methods conducted by means of portable electronic devices [9].

The Radio Frequency Identification (RFID) system used in this project consists of a reader and large number of small, low cost tags with unique ID's. The RFID tags are attached to objects to track their location and monitor security. There are two types of RFID tags, active and passive [10]. Many ubiquitous computing scenarios require an intelligent environment to infer what a person is doing or attempting to do [11]. Human-activity tracking techniques have focused on direct observation of people and their behavior with cameras, worn accelerometers, or contact switches. A recent promising avenue is to supplement direct observation with an indirect approach, inferring people's actions from their effect on the environment, especially on the objects with which they interact. There are three main techniques to human-activity detection: computer vision, sensors, and active RFID tags.

Vision involves well-known robustness and scalability challenges. Sensors provide accurate object identification but require batteries, making them impractical for long-term dense deployment. With the emergence of increasingly affordable RF tags and RFID readers, RFID technologies have now made their way into many end-user applications [11]. These applications include education, medical, military, industries and museums.

A network of RFID sensors are installed and connected into a building's existing network. The sensors use Ultra Wideband (UWB) radio technology to detect and react to the position of RFID Tags. The sensors send the tag location information to the sensor software platform, which creates a detailed, real-time view of the environment [12]. This model can be used by an unlimited number of simultaneous programs that are able to respond immediately to changes in the space that is created.

Sensor software can be integrated into other corporate systems such as communications or scheduling systems to create a real-time operating system for location and context aware computing. The main goal of this project is to integrate learning assessment system with RFID based tracking system.

Once the system is put in place students can be placed in the learning environment at a given time, with given restrictions on their movement and activity in that environment, to take a traditional test or to complete other more tailored learning assessments. Because student movement and activity is traced and recorded the instructor is able to review the information or check in during the test taking time frames to determine whether any of the parameters have been breached by a student taking the test. In this way the Instructor is able to remotely monitor the students' assessment environment without the need to introduce a live person there to do so. This allows more flexibility in times and dates for assessment as well, while still protecting the integrity of the assessment process. Because there is a video component Instructors can match the visual picture of the student to say a picture provided by a student at the beginning of the semester of him or herself. If there is a discrepancy than the problem can be addressed immediately. Additionally, there is a permanent record of the test taking experience that can be relied on as an objective indication if deception or cheating takes place

4. RALS Architecture

RFID based Learning Assessment (RLAS) is a client server system developed in Microsoft .Net framework/.net Compact framework, C# [13] as the development language with visual studio 2003 IDE with Ubisense COM library [14].

The task of monitoring a group of participants is performed at the RLAS server. A story is sent to the participants depending on the room they are in. The story is sent to the participant in the following ways: audio, video, and text.

The RFID tags are attached to each participant and their ID are recorded on the Object Admin of the Ubisense system. We use PDA's to establish communication with the RLAS, by using C# objects over the TCP/IP connections. PDA uses access the RLAS server through the wireless internet. The sensors detect the position of the tag and send the position to RLAS server through the router. The RLAS has the following components: (1) RLAS Client, (2) RFID Tags, and (3) RFID Sensors.

The architecture of RLAS is shown in the Fig.1.

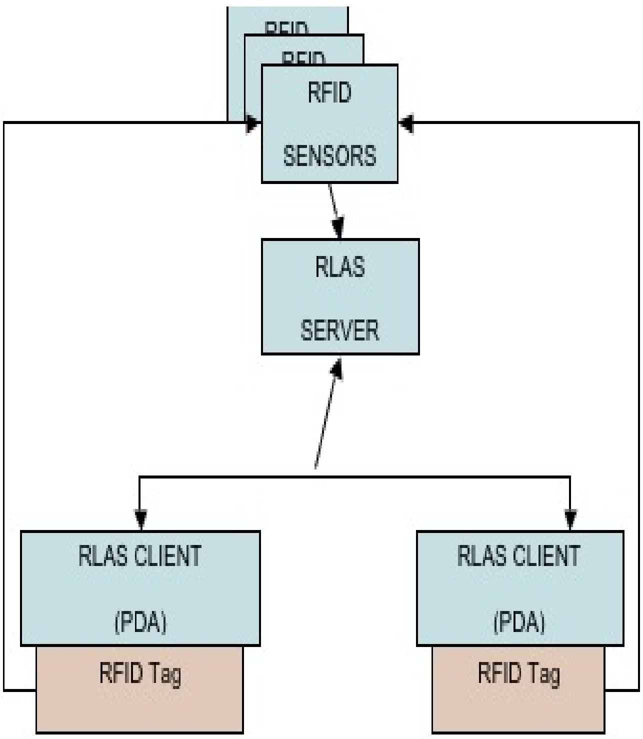

Fig.1: Architecture of RLAS

4.1 RLAS Client

The first step of the client is to login to the RLAS server by using PDAs and entering username and server's IP address. After user enters the login name the RLAS server adds the new user's IP address to the list of users already logged into server. The server GUI is updated with the new list of connected users. The RLAS client allows the users to read the story, listen to story or watch the story in the form of video in the respective virtual rooms. The users are then required to complete a short questionnaire

4.2 RLAS Server

RLAS server is a windows application. The GUI of the server consist of a window with few button by which the proctor can view the list of connected users, start/stops the user connections and stop them. The RLAS server is installed on the desktop PC and it performs the following functions like

- Listening to the client requests and accepting the client connections. The RLAS server when started will listen to the client requests for connections on a designated port.
- Updating the GUI with the list of connected users, when the server gets the requests from the clients for connection it accepts them and adds them to the list of users to the list of list box on the RLAS server window.
- When a participant enters a room the RLAS server sends the story to the RLAS client depending on the room they are in.
- The virtual map of the actual room shows the location of the participant in the area where the sensors are installed. It also tracks the participant's movement in the room.
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4.3 RFID Sensors

A network of sensors is installed and connected into a building's existing network. The sensors use Ultra Wideband (UWB) radio technology to detect and react to the position of RFID Tags [12][14].

The sensors send the tag location information to the server, which creates a detailed, real-time view of the environment. This model can be used by an unlimited number of simultaneous programs that are able to respond immediately to changes in the space that is created. The Sensors are connected to a router using Ethernet cables and then from router to the PC. The sensors are two types, master and slave. Each slave sensors is connected to the master sensor with Ethernet cable. See Fig. 2.

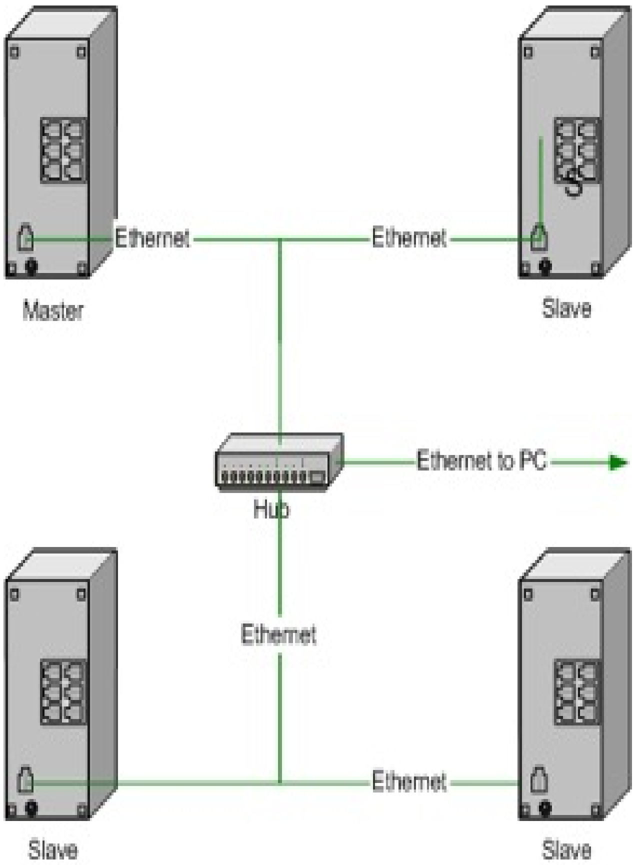

Fig.2: RFID Sensors

The sensor's receives Ultra Wideband (UWB) pulses from RFID tags which are then used to determine exact location based on time difference of arrival and angle of arrival. Sensors have an array of four UWB receivers enabling angle to be calculated with a high degree of accuracy. Sensors also support two way standard RF communications permitting dynamic changes to tag update rates and making interactive applications possible. The location of the participants can be viewed on the RLAS server. It shows the relation between the participants and the room

4.4 RFID Tags

A RFID tag is a small tag worn by a person or attached to an asset allowing it to be accurately located within an indoor environment. Tags also have two programmable buttons, which can be used for applications, two LED's for communications and a programmable buzzer.

5. Implementation of RLAS

The RLAS system uses asynchronous socket communication. Socket communication is nothing but opening a path to communicate with other machines .NET supports socket communication through System.Net.Sockets namespace. It contains the implementation of the windows socket interface. It supports both asynchronous and synchronous communication modes. The asynchronous mode doesn't depend on the other connections with the server machine. Every client is handled independently and doesn't affect the communication of the other clients with the server. While in synchronous mode of communication all the clients are dependent on each other. The call functions that perform the network operations wait until the operation is completed and the calling program gets back the control. These calls are returned back immediately in asynchronous communication mode.

RLAS is implemented in the following ways

- Creating virtual rooms
- Installing the sensors in rooms
- Object administration
- Asynchronous communication
    - RLAS Server
    - RLAS Client
- Storing the results of the questionnaire in RLAS Database

5.1 Creating Virtual Rooms

This is the first step in the implementation of the RLAS system. A real world model of the area where the participants are to be monitored is created with rooms and furniture. This helps to view the replication of the area on the RLAS server. We have used Ubisense software [14] to

- Import walls and fixed furniture to create building model
- Create new walls or edit existing imported structure
- Define rooms for analysis, reporting and locating
- Test route planning algorithms used in the Simulator
- View model in both 2D and 3D.

5.2 Installing the Sensors in the Rooms

Sensors are to be installed in the rooms so that the RFID tags location can be tracked using these sensors. The sensors are generally installed on the 4 corners of the area so that each sensor can see the other 3 sensors. The calibration of the sensors is a critical path to get the accurate location of the RFID tag. See Fig. 3.

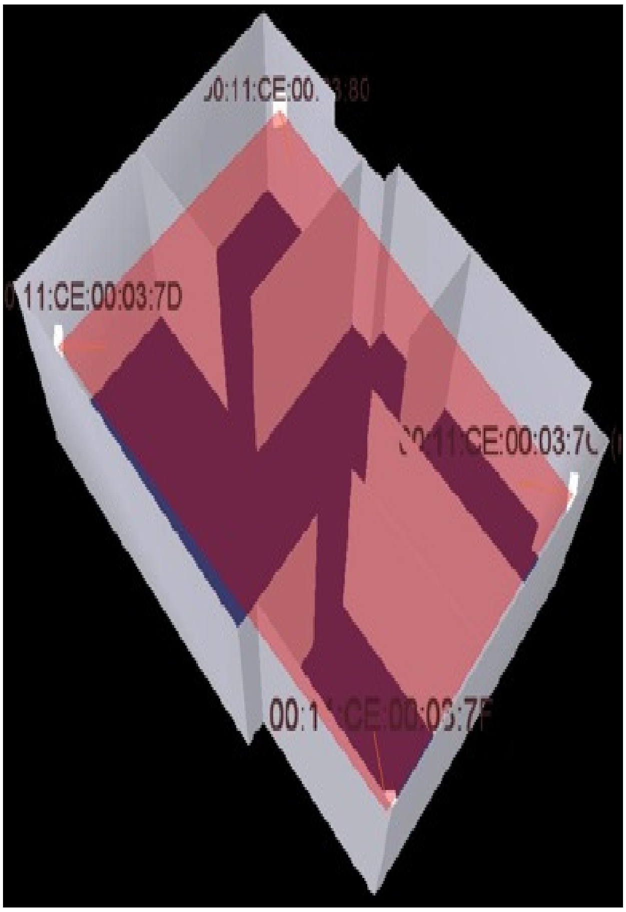

Fig. 3 Sensor Installation

5.3 Object Orientation

Object Administration allows to manage the objects, assets, people, etc that will be tracked. Profiles can be set for the update rates of the tags, types can be created like people, asset, etc, assign representations, and many other features. In the object administration the name of the person is entered and the RFID tag is assigned to each person. This helps the server to know the location of the RFID tag with the respective person name in the area.

5.4 Asynchronous Communications

5.4.1 RLAS Server

The RLAS server starts and listens to the clients for the incoming connection requests on a port number. When a client requests a connection, the connection request event handler is fired and the server asynchronously handles the other client requests. Fig. 4 shows the sequence of events that happen between the RLAS server and RLAS client.

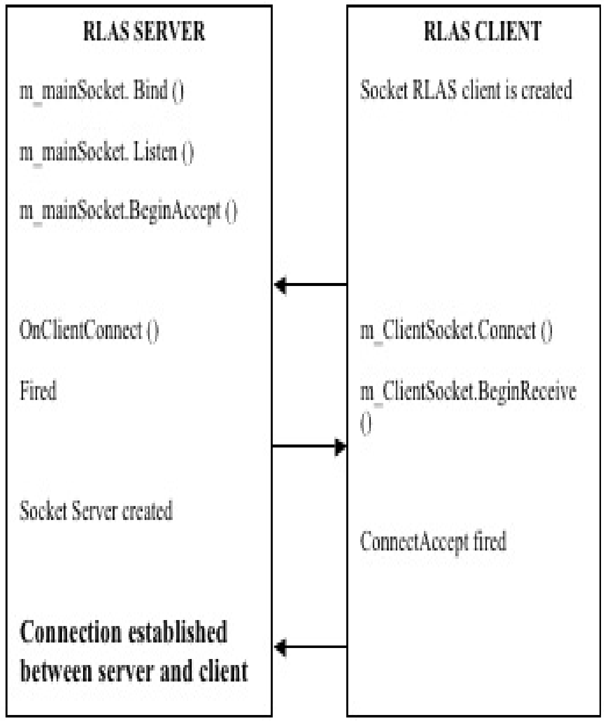

Fig. 4 RLAS Server Client Implementation

There are various methods used in the server client implementation.

StartListen ()
This method starts by finding the IP address of the RLAS server and binds the IP end point with the socket, which listens for client connections. m_mainSocket.Bind () method is used to bind the local IP address. This method causes the connection oriented Socket to listen for any incoming connection requests. The number in the bracket of the Listen method represents the number of the incoming requests that can be queued. The m_mainSocket.BeginAccept () is a method which is used to process the incoming connection requests asynchronously. By accepting the incoming requests the RLAS server gets the ability to send and/or receive data to/from RLAS clients. In this project we only send data from RLAS client to RLAS server only once when establishing connection with the server.

OnClientConnect ()
It is a method which implements the AsyncCallback delegate is passed to the Begin Accept method along with the socket object as parameters. When the server gets the request from the client server uses a different method to execute this callback method. This method uses m_mainSocket.EndAccept() method to asynchronously accept incoming connection attempt and creates a new Socket to

handle remote host communication. The method calls the m_workerSocketList () method, which adds the list of new clients to an array list. Fig. 4 shows how it works

WaitForData ()
This function is used to wait for data from client to the server. AsyncCallback functions is specified which is invoked when there is any send activity from the connected client.
OnDataReceived ()

This call back functions is invoked when the socket detects any client writing of data from the stream. When the client sends the messages the OnDataReceived () method is invoked on the server. The method decodes the message sent by the clients. The server identifies the various message types by the first three bytes of the message. The login message contains the IP address and the name of the participant added to the client IP list.

OnEntry ()
OnEntry is an inbuilt event function [14]. Events are the mechanism by which COM objects can notify applications when some asynchronous event has occurred. The application creates a handler for the events it wants to receive. A handler is simply a method with a signature that matches that of the event. This function can be achieved by using the following in Visual C# [13].

public event Ubisense._ISpatialClientEvents_OnEntryEventHandler OnEntry(*string* *container*, *string* *container_role*, *string* *contained*, *string* *contained_role*)
Where Container is the area where the RFID tag location is like a particular room, and the role of the container is to fire an event to the RLAS server on entry of any RFID tag in that area. The Contained is used to send the name o the participant who is using the RFID tag and the role of the participant is Person in this project. OnEntry is raised by the client when a relationship between two objects becomes true. The relationship must match any filtering parameters.

The Fig. 5 shows how the color of the room changes to red, which indicates that the person has entered in that room.

WorkerSocket.Send ()
This function called when the above OnEntry function is invoked. This function sends data to the RLAS client based on the area which they entered. The RLAS client is sent data and a questionnaire.

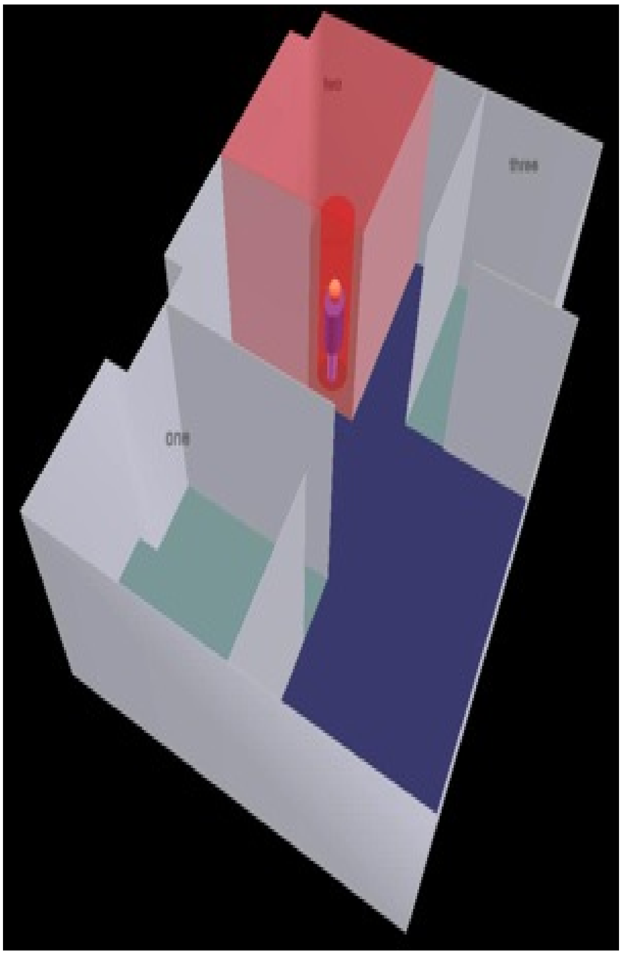

Fig. 5 OnEntry event

5.4.2 RLAS Client

m_ClientSocket.Send ()
This function is used initially when the RLAS client sends a request to the RLAS server. This function sends the Name and the IP address of the RLAS client to the server.

OnDataReceived ()
This function is invoked when the participant enter a room with the RFID tag. Upon entry the RLAS server sends the data and a questionnaire depending on the room they enter. The data sent is different for different rooms.
Once the data is received at the RLAS client it decodes the data and enables the participant to access it. After the participant is done with reading or listening or watching the video he/she will see a button the RLAS client GUI on the PDA, which pops a questionnaire,

After the participants are done with answering questionnaire they will submit their answers. Once the submit button is clicked the data is sent to the database and stored under their name.

This will used be used by the proctor to evaluate by just sitting at the RLAS server. The log is created for each participant for each room they enter.

6. Experiment

Proctor can monitor and view the performance of each participant on the RLAS server. The Fig. 6 shows the GUI of the experiment. The proctor can view the results of selected individuals or all the participants. The GUI shows the name of the person, the percentage of correct, the room in which participant took the test, submission time.

RESULTS

Person	# of Correct Answers	Room#	Submission Time	Percentage
vamshi	1	one	12/15/2007 5:26:38 PM	20
vamshi	0	two	12/15/2007 9:01:35 PM	0
vamshi	2	three	12/15/2007 9:02:17 PM	40
sriram	3	one	12/15/2007 9:03:55 PM	60
vamshi	2	one	12/16/2007 12:15:56 AM	40
vamshi	5	three	12/16/2007 12:20:11 AM	100
vamshi	1	two	12/16/2007 12:20:41 AM	20
vamshi	4	two	NA	80
vamshi	4	two	NA	80

Fig.6 Results of RLAS system

7. Conclusions

Present traditional learning assessments (PPT or CBTs) are performed currently with participation of the proctor focusing on monitoring the environment for the test itself. The **RLAS** system attempts to improve the effectiveness of the learning assessments by creating an environment which is remotely monitored by a proxy thereby reducing the educator's time commitment to monitoring the physical work environment. This allows the proctor then to create individualized learning and assessment environments for each student because the RLAS system can deploy different kinds of learning experiences and assessments simultaneously and report back to the educator the outcomes as they happen.

The next step in this process is for the authors of this article to deploy the RLAS system on a broader based platform in different kinds of classes to assess whether or not student learning is indeed improved over time with the deployment of individualized learning plans and assessment systems. This will be done first in K-12 classes as we can track that community of learners over time. It will also be executed in traditional classroom settings that may have some hybrid components although over time this system may be adapted and deployed in online environments as well. It is our expectation that the **RLAS** system, when used in this fashion will create an environment where there is less human involvement as a proctor and improve student learning outcomes over time.

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