USE OF MULTIMEDIA IN COST EFFECTIVE ROCKET TESTING (UMCET)

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ABSTRACT.

Internet technology allows companies and individuals to overcome many of the physical constraints that often prevent them interacting from a distant. In the past several years, communication using data, audio, and video applications has become increasingly popular to overcome this burden. These applications help people to control/view their remote systems and to share ideas between employees and colleagues as if being in the same environment. In this study, an environment composed of video streaming, audio/text conferencing, and the local to remote user data transfer is implemented. This java based environment is capable of handling the text messaging, data transmission, and audio session initiation (ASI) that launches Robust Audio Tool (RAT) for audio conferencing between selected users. In order to stream video, a video capture card with two cameras is used.

Keywords: Remote control, internet conferencing, remote collaboration.

1 INTRODUCTION

Although effective and dependable experiments provide good analysis, they are often costly, time consuming, and most of the time promote safety hazards. Therefore, more safe and dependable avenue, which would reveal the same or similar reliability, cost, and timeliness levels, must be explored with the potentials offered by the current technology, in multimedia and internet. Remote process control is an avenue that can be instrumental in providing cost and efficiency effective services. Therefore, remote monitoring/control (RMC) has a large potential and bright future, especially in companies with many branches where electronically controlled machines are deployed as a part of the workforce. A computer, connected to the automatic control devices (Data Acquisition Cards, Programmable Logic Controllers, etc.) can control data from a physical unit, and allowing user to process the data according to the rules and regulations, then issue responses to manage the system.

Taking above necessities into consideration an RMC system could be useful for the following areas [1]:

- Laboratories, test/experimental sites,
- Computer based education,
- Industrial control systems (mines, nuclear or chemical plants, etc.)
- Remote office works,
- Shopping, reservations.

The infrastructure of the hybrid rocket facility at the University of Arkansas at Little Rock (UALR) falls into first category since it is providing services to remotely located sites over the internet. The infrastructure of the testing site consists of a laboratory scale hybrid rocket motor, video monitor, data acquisition, and computer control system. The facility was originally built for plume diagnostic and combustion studies. Recently, emphasis has been added to focus on the physical parameters of rocket motors [2].

2 BACKGROUNDS

Rapidly growing interest in health related issues have forced some of the traditional approaches in research and development to be abandoned or, if not, to be replaced by safer cost effective approaches. More specifically reconsidering approaches from the cost, reliability, and timeliness perspective has formed the foundation of a collaboration between UALR, NASA- Stennis, and Hercules Aerospace to establish a test site where rocket plume related experiments can be conducted and monitored. The aim of the hybrid rocket test facility developed at UALR, therefore, is to help NASA sites to investigate and understand the combustion of hybrid rocket fuels related improvements in a cost effective, reliable, and safer manner [2].

A hybrid rocket uses a solid fuel, like rubber or plastic, and a liquid oxidizer, such as liquid oxygen or hydrogen peroxide. Hybrid rockets are much more reliable than liquid ones. Unlike solid rocket motors, hybrid rocket motors are not explosive by nature. Also unlike solids, hybrids can be shutdown and restarted, and they can be throttled, though not to the degree generally available with a liquid rocket motor [2,3].

Therefore a RMC system, called UMCET, is prototyped at UALR to allow NASA's scientists to monitor and control the experiments conducted in real-time at the hybrid rocket test facility over the Internet. The purpose of the UMCET environment is to allow researchers at different remote locations to monitor and control the no-delay test site where rapid, complex, and variable burning activities are taking place.

3 BRINGING MULTIMEDIA INTO CONTROL

A hybrid rocket testbed has experimental data such as pressure, temperature values, positions of valves, etc. to share with the experts or scientists at different sites. These data needs to be transmitted for further analysis and monitoring at different distant sites where perhaps process control is also required to start and stop the system, and control the scheduling and transmission activity. Therefore, the role of multimedia can be justified in terms of the cost involved in the testing process at different sites.

Planning with colleagues is necessary for research and development. To provide such a medium (getting people together) for researchers who are far away from each other is time consuming and not easily affordable [4]. To overcome these constraints, RAT is used as an audio conferencing tool in UMCET environment. RAT is unicast and multicast audio conferencing tool and can be used for both point-to-point audio conferencing. It requires a direct link between two hosts or for multiparty conferencing with many participants via the Internet Mbone [5]. RAT is just an audio application, it does not perform call services like user location, and neither does it listen to session announcements to discover advertised multicast sessions. The UMCET environment initiates an audio communication session via RAT using the remote host IP address and port number.

The purpose of video streaming is to deliver a live captured experiment related to a rocket test to viewers at the remote site. Since rocket firing is very important for our research, two cameras are used to obtain a wide angle view of the testbed. Using the visual component of UMCET, researchers at the remote site have the ability to view initial settings, firing, and flame parameters for evaluation. It also helps to estimate some precaution before any misleading consequences [6]. The captured pictures are either streamed through the web server or stored in the server to get a playback opportunity. Once the picture is captured from the camera, it needs to be encoded into any compressed video format due to the bottleneck in communication bandwidth.

In addition to data transfer, audio conferencing, and video streaming, the UMCET environment also provides a comprehensive text message passing protocol and whiteboard utility for collaboration. It is possible to chat one–to–one or in a group session using text messaging or a whiteboard drawing environment.

Text messaging also has private chat room option that allows clients to create password protected rooms so that only invited users can join. The capability to create rooms helps researchers to discuss different topics in different rooms at the same time. Moreover, the users can use the whiteboard feature by drawing online and save as pictures to support their discussion on research or distance learning.

4 DESIGN AND IMPLEMENTATION

The prototyped UMCET environment is based on three fundamental design issues: modularity, scalability, and portability. The modularity property is to handle the maintenance more effectively. The scalability is to provide the topological flexibility. Finally, portability is to minimize the platform dependency constraints.

The motivation of the design comes from 1) the firing of a rocket is made possible by mixing nitrogen, oxygen, and propane gases in a chamber and igniting them in some period of time. 2) The amount of gases that is going to be burned can be controlled by valves. 3) Furthermore, the timing of ignition is one of the most important issues that affect the experiment and its results. That is why the ignition also needs to be controlled as an important issue in the proper manner. Therefore, to be able to control the rocket firing, the control of valves and ignition spark must be monitored. To handle the firing sequence and valve control issues, a well-equipped control card that can communicate with a PC in real time is chosen. The control card is capable of accommodating task specific programs developed to control the timing sequence of valves and the ignition process. Therefore, it is known to be a task dependent function and varies from one task to another.

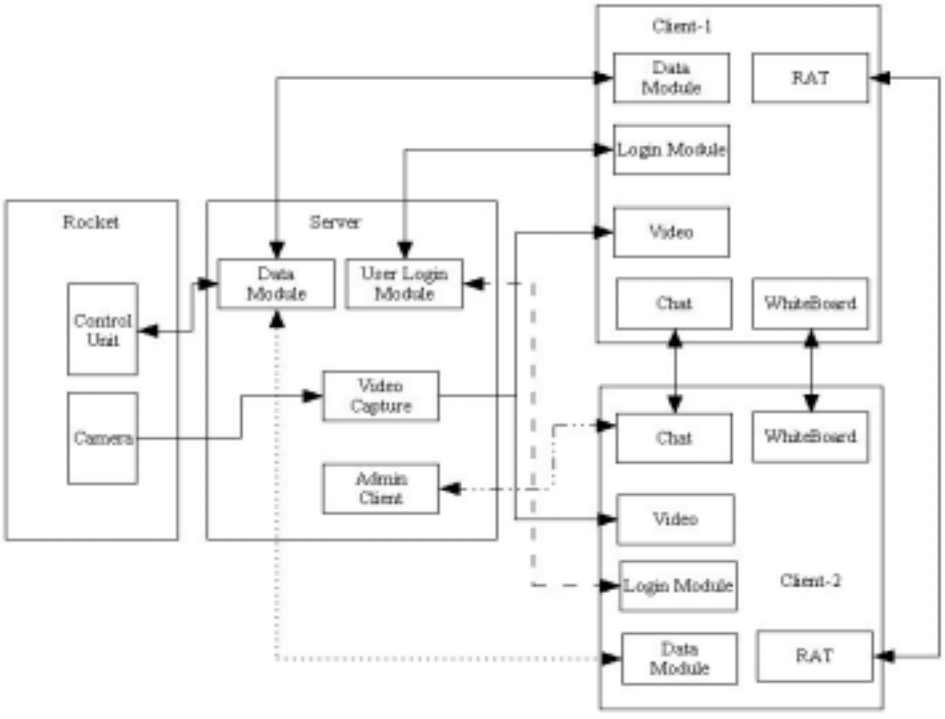

Figure 1. Component based model of system

With the help of the control card, measurements like pressure, temperature, and oxygen flow rates can be observed and recorded. Once these values are captured by card, according to the program that is running on its processor, the values are sent to a server computer. The control card not only sends the measured values, but also waits for start/stop commands coming through the server PC. Moreover, the control card's memory is loaded with new programs to carry out new experiments in different firing scenarios.

As shown in Figure 1, the UMCET environment can be technically decomposed into three parts: 1) Video Streaming, 2) Server Program, and 3) Client Program. Although the video streaming system works on the server computer, it is independent from the server program. Server and client programs communicate with each other using sockets and individual protocol.

4.1 Video Streaming

Besides the data, the UMCET environment has the potential to provide video streaming through the use of a GeoVision GV 600 video capture card and 2 GKB ¼" Color Camera. The idea of live capturing the testbed and stream gives remote viewing possibility to the client. By encoding, the testbed live video can be viewed from clients without being interrupted. Current encoding technologies gives the opportunity to reduce the size by 1%; that is still not adequate for dial up connections, but it is reasonable enough for high speed connections like LAN, DSL, etc.

UMCET's video streaming provides two types of compression; JPEG and MPEG4. The GeoVision video capture card and its associated software handle both encoding types, and the user can select either one of them. JPEG encoded images can be viewed from an applet that provides a connection to the video streaming server. Furthermore, a user can zoom on live images and save a frame using JPEG applet. For the purpose of developing an easy to use system, an interface between client application and client operating system is developed to identify the operating system type and run the default browser with the video streaming server URL accordingly.

4.2 Server Environment

The server environment, which runs on the server computer, is an interface between clients and testbed. Its purpose is to retrieve data from the rocket environment, send these data to granted clients, and start the RAT tool. Since, there is no delay tolerance in pressure and temperature for rocket data, as soon as data is present on the port of computer, the program gets the data and transmits to the online users immediately. In addition to sending the data, the client-side start/stop commands need to be transmitted to the control card without any delay. Meanwhile, the server program loads the required code to the control card for controlling the timing of different experiments and sequences.

An administrator manages the server program in terms of adding new users, remove existing users, disconnecting the online user(s), and joining the chat and whiteboard rooms as admin client. Furthermore, the server program also has the capability to deny or grant the user the login, or to distribute chat text and whiteboard drawings. The logical flow of the server can be summarized as follows:

```
INITIALIZE (port)
        if (userid='valid') then session='open'
        else Login ='reject'
READDATAFROM('rocket')
SENDDATATO('client')
READDATAFROM('client')
SENDDATATO('rocket')
RECEIVE('message text','whiteboard')
DISTRIBUTE('message text', 'whiteboard')
OPENCLIENT_UI('admin client')
DISCONNECT()
```

Some of the client-side communication commands include;

- PING sent by the server to the client for making sure the connection is still valid.
- CONNECT sent by server to a previously connected user to notify a new user connection,
- ROOMLIST sent by server to give available user list to client,
- DISCONNECT sent by the server to a client when the server wants to disconnect the client.

4.3 Client Environment

The design and implementation of the client environment is based on the logic given in below. The client environment is implemented as an interface that not only connects the authorized person to the server via internet/intranet but also allows a user to control/view online the rocket test-bed remotely through the server, with respect to the given permission. When client environment runs, the login panel appears and requests username, password, and the address of the remote system that is to be connected (server). Upon the verification of the login, the client program starts to maintain the remote monitoring process, as shown in Figure 2.

A client can start either a protected or public chat room. In a protected room, the tool allows a client to create a password protected room that can only be accessible by invitation or by entering the password. The owner of the room can invite users into the room, or disconnect the current user(s). In public rooms, the text typed by the user is sent by pressing the return key to all on-line users (if send to all selected) or to the user who is highlighted. In addition, when a client draws a line on to the whiteboard area, the tool captures background information (color, thickness), start and stop position of the line by mouse click. Then these captured values and recipients ID's are sent to the server by LINE command. Once the drawing information is received by the target client, identical drawings are pictured by the recipient tool.

In addition to chatting tools, client environment gets the rocket data from the server and displays it as shown in Figure 2. Besides the display, it also grants the user ability to send start/ stop commands to the server.

```
INITIALIZE (port)
        if (connecton_request ='granted')
                Session='open'
READDATAFROM ('server')
DISPLAY ('data', 'incommingtext', 'whiteboard')
SEND ('message text','whiteboard')
AUDIOCONF ('RAT ip/port')
SEND ('start/stop')
CHATROOM ('name','password')
DISCONNECT()
```

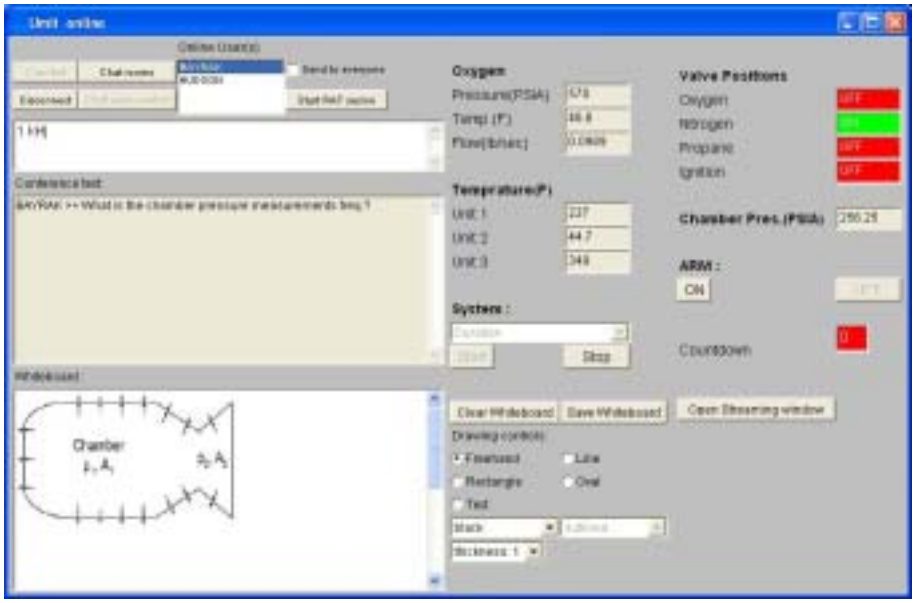

Figure 2. Client program GUI.

Example messages that are sent by the client are given below:

- ROOMLIST is a message sent by the client to the server to request a list of available chat rooms.
- INVITE is sent by the client to invite other client(s). The server forwards the message to the invited client.
- CHATTEXT is sent by the client with chat text entered by the user. Server forwards to the clients, #client parameter defines the number of clients which will receive the message. The message body is as follows:

  client_id, color, data, #client, [client_id...]

- LINE is a message that is formed and sent by the client when the user draws a line or freehand on the whiteboard, and it is also forwarded by the server to recipient clients.

  client_id, color, x0, y0, x1, y1, thick, #client, [client_id...]

5 CONCLUSION AND FUTURE WORK

UMCET is an environment that helps researchers in different geographical locations to view and control the test plant and share their knowledge. The aim of the study is to illustrate that any system can be managed remotely with ease using multimedia tools, such as audio conferencing and video streaming. By using such a system, researchers avoid the time and cost of travel. That gain cost effective infrastructure.

We believe that the proposed work is an economic and practical solution for companies, research facilities, and educational institutions, which have to work together. Applications are common for institutions having health critical or dangerous jobs.

As a future work audio conferencing Robust Audio Tool (RAT) and video streaming windows can be embedded to UMCET. Also, live data captured from server and previous data stored in the server can be displayed as graphical representations.

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