Building the National Virtual Collaboratory for Earthquake Engineering Research

NEESgrid

Technical Report NEESgrid-2003-02
www.neesgrid.org

(Whitepaper Version: 1.0
Last modified: January 12, 2003)

Video Support in NEESGrid: Telepresence and Data-Quality Video

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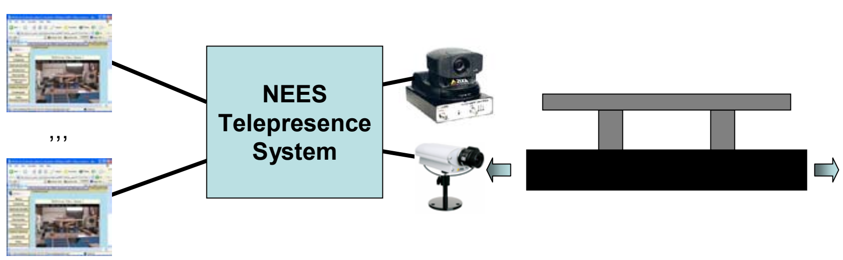
Acknowledgment: This work was supported primarily by the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Program of the National Science Foundation under Award Number CMS-0117853.

Introduction

This white paper will discuss the issues and video synchronization as they apply to telepresence and data as data. Is very important for us to keep these two seemingly similar concepts separate. Telepresence is typically used provide a remote user a sense of being somewhere. For example, a NEESGrid telepresence camera allows a remote viewer a sense of what's going on during an experiment. In shake to experiment they can see the nature of the experiments and have a better understanding perhaps for some data that they're watching on the screen and which is being captured by sensors. To perform data analysis on video, it must be high quality and precisely synchronized with the data gathered by the other sensors.

Telepresence

All the work to date on this project has had to do with telepresence. The telepresence environment provides a remote user with a sense of what's going on. It is impressive to use telepresense watch an experiment as it takes place. Telepresense gives users the sense of belonging to the experiment by giving them a visual image to make the data more meaningful. It is not something that can be ultimately analyzed as data except for a very gross sense. A human can analyze telepresense video by watching it and drawing gross conclusions but is not practical to be used by image processing programs to analyze.



Telepresence is viewed by the NEESGrid project as one of those capabilities which will be useful across a wide range of sites and directly impact the ability to do experiments with remote collaborators. Given the nature of telepresense, it is built into the base NEESGrid software distribution. The NEESGrid system integration team has come up with a solution based on commodity equipment using AXIS (www.axis.com) cameras which have a number of significant advantages for telepresense. Their primary advantage is that the AXIS cameras have built in capabilities so that they can be remotely manipulated across the Internet. This allows users with proper authorization to remotely pan, tilt and zoom the cameras so they can better see experiment in progress

Using commodity hardware and network transport protocols for telepresense keeps the price low allowing for easily deploy telepresense. In addition, low-cost commercial streaming products allow the number of viewers to scale to hundreds of viewers at the expense of latency and video quality. However, the inherent limitations of the commodity hardware and network protocols do *not* allow one to maintain precise synchronization with other data elements.

Even if telepresense video is recorded using commodity recording mechanisms such as QuickTime, AVI, Windows Media, or RealMedia and stored in the data repository, its primary purpose is to give the user a sense of the experiment rather than provide data for programmatic analysis. This recorded material will be treated as a "blob" with respect to the ultimate metadata stored with an experiment:

```
<experiment site="nees-unr" date="2003_05_20" serialno="SH-000123">
 <tpvideo format="MPEG-1" data="exp_00123.mpg" length="1:43"/>
 <samples>
  <sample time="00:00:00.01" value="1.0" />
  <sample time="00:00:00.02" value="1.1" />
   ….
  <sample time="00:01:43.35" value="0.3" />
 </samples>
</experiment>
```

There should be sufficient metadata recorded for the experiment to allow the telepresence video to be replayed along with the data with reasonable synchronization (1-2 second latency) for viewers who are replaying the experiment at a later date.

Data Quality Video

Is a more challenging problem to produce video information which can be used for rigorous data analysis? Instead of thinking of the video as a stream of video for viewing or a single file of "recorded" video, the data video should be thought of as a series of frames, with each frame having a precise time indication for the frame using the same time scale as the other data elements for the experiment.

Sample metadata for this may look as follows:

```
<experiment site="nees-unr" date="2003_05_20" serialno="SH-000123">
 <samples>
  <sample time="00:00:00.01" value="1.0" image="IM-000123-000001.tif" />
  <sample time="00:00:00.02" value="1.1" image="IM-000123-000002.tif" />
   ….
  <sample time="00:01:43.35" value="0.3" image="IM-000123-010335.tif" />
 </samples>
</experiment>
```

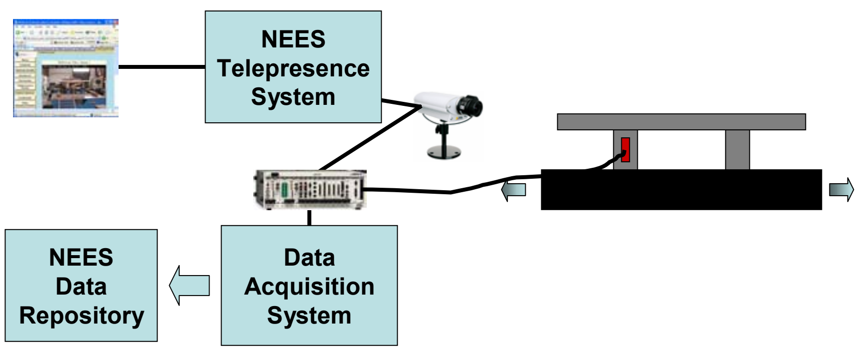
It is important to note that the metadata could support both stored telepresence data as well as data quality video for the same experiment. Different experiment viewers may make use of each of these video sources in different ways.

In order to provide this type of highly synchronized video, the video sources need to be directly connected to data acquisition hardware.

Data quality video and telepresence video may differ greatly in the areas of quality and frame rate. Commodity video operates at 30 frames per second and has a nominal maximum resolution of 640x780 and usually involves some compression. Data quality video frame rate will range from one image per day, to several thousand frames per second. Date quality video will often require no compression, lossless compression, or a compression scheme with mathematically-bounded compression algorithms.

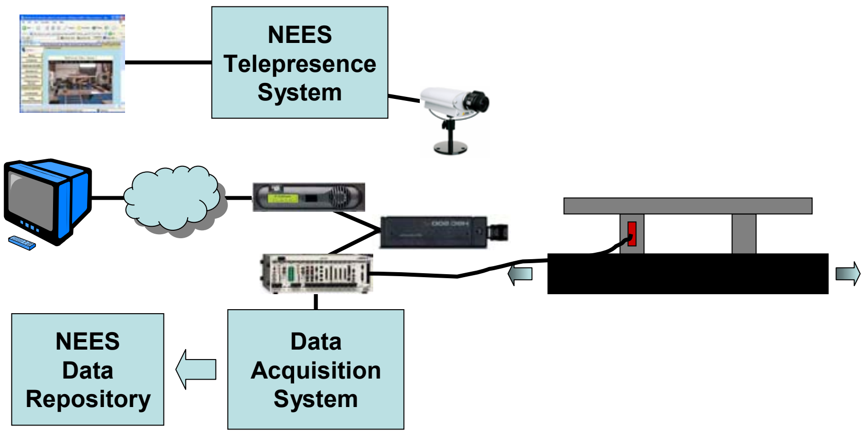
Deployment

It may be possible in some experiments to use the same video cameras for both data quality video and telepresence video by splitting the video signal between the NEES telepresence system and the data acquisition system.



This dual-use of the video signal will be possible where the date frame rate requirements and frame quality and resolution are low enough to be satisfied by a commodity video signal at 640x480 and 30 frames per second.

For deployments with higher resolutions and/or frame rates, specialized cameras may be needed. In addition, there may be situations which require a remote collaborator to view video information with precisely bounded frame rates and quality. Each of these additional requirements may require specialized hardware and/or connectivity capabilities to be deployed for that particular site. For example, some sites may require high-end remote video with specialized hardware compression equipment and highly tuned Internet2 network connections.



It is important to note that because of the highly specialized nature and close integration with the data acquisition system, these more specific cases are not supported by the "out-of-the-box" NEESGrid system. Sites will have the capability to extend the NEESGrid capabilities to help solve these more complex problems.

Conclusion

The NEESGrid system provides integrated support for telepresence capabilities as part of its base distribution. The ability for remotely viewing video of an ongoing experiment to gain a sense of "presence" is expected to be something that nearly all the NEES sites will find the need to deploy. This has significant value for both remote collaborators and as part of educational outreach activities for the site. By using commodity equipment and video viewers, these capabilities are inexpensive to deploy and available to a wide range of viewers ranging from collaborating scientists to sixth-grade students.

However the use of commodity equipment precludes the use of this video data as part of data analysis. Data analysis has very different requirements for bandwidth, latency, synchronization, and image quality. These requirements may vary dramatically from experiment to experiment where some experiments last for seconds while other experiments last for days or even months.

Because the requirements for the capture of data quality video differ so dramatically across different categories of experiments, the NEESGrid base software does not provide and off-the-shelf solution for the capture of data quality video.

Some sites may be able to use the same video signals for both telepresence data capture. Also, sites may use the NEESGrid telepresence capabilities as a starting point for their data quality video capture and transmission.

It is important to note that the NEESGrid data repository is capable of supporting both telepresence and data quality video as part of the data recorded for the experiment.