WWW-based video camera remote control

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Abstract:

An automatic system for remote video camera control is presented. An electronic device which controls the camera is connected via a serial link to an IBM PC compatible host computer which acts as a local WWW server. Due to use of the WWW, the software control panel of the system is platform independent. The camera can be controlled from any computer with a Web browser and connected to the Internet from virtually any place in the world.

Key words:

multimedia, automatic measurements and control, virtual instruments

Introduction

The last few years have been the time of enormous expansion of the Internet. Initially, the network was being used mainly for e-mail exchange. The invention of the World Wide Web has now made it also a great source of information. Now people using the Internet enjoy real time voice conversation, but they are already looking forward to having full videoconference capabilities. And this does not seem to be far away if you consider the rapid development in the field of multimedia and data transfer technology[1]. So it is quite possible that within a year or two an intercontinental videoconference via Internet will be nothing unusual.

In the case of just a social video-conversation, a very simple model of camera can be used. But in the case of some commercial applications the equipment must be more sophisticated, so that one may even need to employ special technical staff to serve it. This is especially true in the case of a multipoint videoconference. Having a central studio from which all the cameras and other devices could be remotely controlled, would reduce the costs due to smaller staff. Of course, once the equipment is electronically controlled, some typical actions can be preprogrammed and then performed automatically. That makes operating the equipment much easier. This paper describes such an automatic system for remote video camera control − a perfect example of a practical implementation of concept of virtual instruments[2, 3].

Concept of the system

Considering that videoconferencing sites can be in distant locations and that at least some of the videoconnections may be realised by means of the Internet, a software control panel of the device was implemented in a WWW form. Due to the use of the WWW the software control panel is platform independent, hence the camera can be controlled from any computer connected to the Internet and equipped with a Web browser.

A block diagram of the system is presented as Fig. 1. The video camera is controlled by an electronic circuit which is connected via a serial link to a computer called "the remote computer" (as it is distant from an operator of the system). The operator controls the device using the Web-based software control panel located on another computer named "the control panel computer". As the remote control panel software is browsed on the control panel computer,

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any action on the remote computer must be performed by means of CGI scripts. CGI scripts can be run, however, only on server. It is possible, of course, to design a system in which the control panel computer would run a CGI script on a server from which the data would be retrieved by the remote computer, but it is much easier to make the remote computer acting as a local server.

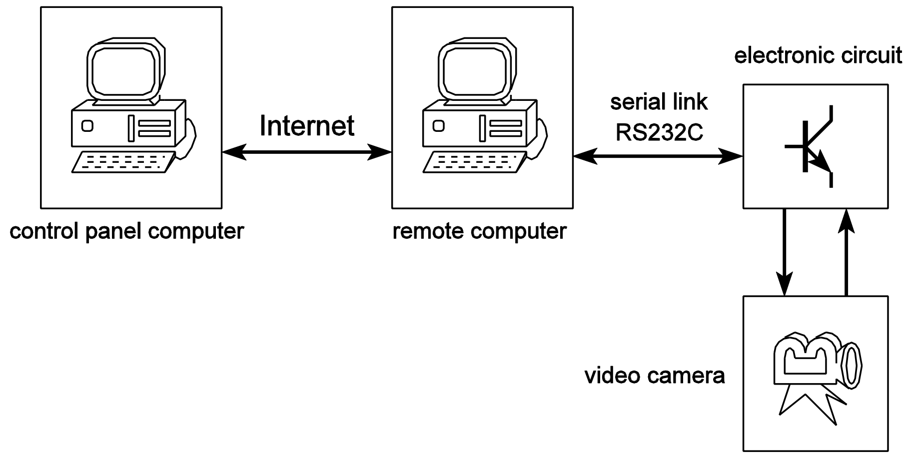

Fig. 1. A block diagram of the video camera remote control system.

The number of the video camera remote control devices controlled simultanuously by the same control panel computer is not limited, as the Web control panel software can be easily enhanced to support more than one device or the operator can run multiple copies of the Web browser application (this may not apply to all operating systems).

Hardware

There are no special hardware requirements to the control panel computer and the remote computer. In a test setup an IBM PC compatible with 486DX2-66 processor and 12 MB RAM memory was used as the remote computer. However, neither processor speed nor memory size of the remote computer are critical. Simple test of reducing memory size to 4 MB did not show any noticeable increase in reaction time of the whole system. The main factors that limit overall reaction time of the system are the Internet data transfer rate and properties of the camera positioning device.

In the test setup a CCD-TR500 SONY video camera recorder with a HVR-500 rotary table were used. The main drawbacks of the positioning device were: very low speed (approx. 30 seconds needed to rotate the camera by 270°); no capabilities of position programming; and no feedback information of current camera position. The low speed of the positioning device was not a critical factor, as the device was to be used for test purposes only. However the lack of information of the camera position could not be neglected, because the need for being able to set the camera to the same position is an essential feature of such an automatic device. The solution of remotely adjusting the camera to the required position based on observation of the video signal being recorded by the camera had to be rejected because of the significant and unstable length of the Internet transmission time. In the case of using the Internet for controlling the camera motion, any camera reaction to user commands occurs after some delay the length of which depends on the actual Internet traffic, etc. And finally one of the key assumptions to the research was to design a device that could be used in full-automatic systems. Hence, the device had to be provided with some kind of a local feedback, that would stop the camera movement after reaching the desired position. This feedback was obtained by the optical detection of the camera position. Detection of the horizontal position of the camera was done by means of an aluminium plate with slots on the circumference, mounted on the camera rotary table. There was an air-gap optocoupler fixed at the edge of the aluminium plate, with an IR transmitter and receiver placed on the opposite sides of the plate (Fig. 2), so that any horizontal movement of the camera resulted in an electrical pulse at the output of the optocoupler while a slot of the aluminium plate was passing through the optocoupler. Another aluminium plate with slots and optocoupler was used for checking vertical position of the camera (Fig. 3). An additional optocoupler was used to detect end position of the camera.

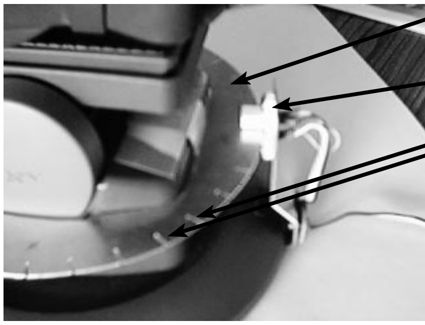

Fig. 2. The circuit used for the horizontal camera movement detection

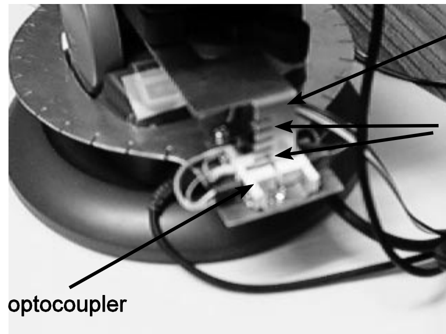

Fig. 3. The circuit used for the vertical camera movement detection

A local closed loop control was obtained by means of an electronic circuit that was used for direct control of the positioning device and testing the optocouplers' outputs. The circuit was a small microprocessor system based on a one-chip microcontroller and linked to the remote computer with an RS232C serial interface. An RS232C as the link was chosen, because this kind of interface is commonly used in all kinds of computers including Laptops / Notebooks. Hence it would be possible to have a Notebook working as the remote computer and to easily link it to the electronic circuit without the use of any additional hardware. To make the firmware development easier, a special prototype system board based on a 80C31 microcontroller and adapted for in-circuit debugging was used. However, in order to reduce the hardware size, in the particular target system another microcontroller instead of 80C31 should be used. In the case of a simple video camera remote controlling device with not many functions to control (that affects minimum number of the microcontroller's pins) and not requiring analog control, an AT89C1051 or AT89C2051 microcontroller and a MAX 233A (RS232C / TTL signal level converter) could be selected. If SMD components are used, the total size of the printing board of such a minimum system should not exceed 2 − 3 cm^2. All mentioned microcontrollers (80C31, 89C1051, 89C2051) are equipped in a hardware serial port, which reduces firmware size to a minimum and due to software compatibility of 89C1051 and 89C2051 with 80C31, the firmware developed on 80C31 may be used on the other microcontrollers unchanged.[4]

Software

The whole system-dependent software used to control the designed device can be divided into: HTML software browsed on the control panel computer (by means of a system-independent Web browser software), operating system, WWW local server software and CGI scripts run on the remote computer and 80C31 firmware. Most of the HTML software are HTML forms which create a software front panel of the remote control "transmitter". The most important of these HTML forms are those used to predefine device parameters and a few preset camera positions (Fig. 4) or to control the camera movement (Fig. 5). Pressing a button on the software front panel sends all the form data to the remote computer which then activates a CGI script. If the pressed button should cause the camera movement, the CGI script sends appropriate commands (one or two bytes) via the serial link to the electronic circuit. In order to increase reliability of the system, every byte sent to the electronic circuit from the remote computer is acknowledged by a control byte. After sending the command to the electronic circuit, the remote computer waits until receiving an additional control byte indicating end of the camera movement. Then the CGI script sends to the control panel computer some additional HTML data. Such a handshake (keeping transmission between the server and the control panel computer active until reaching the appropriate position by the camera) prevents the user from pressing another button (sending another movement command) until the previously activated command action is finished.

As already mentioned, in the test setup an IBM PC compatible computer running under Windows 3.1 was used as the remote computer. The software that made it act as a local WWW server was Windows HTTPD v. 1.4c[5]. The CGI software was written in Pascal for Windows with the use of TPWCGI v. 1.1 library[6]. The 80C31 firmware was

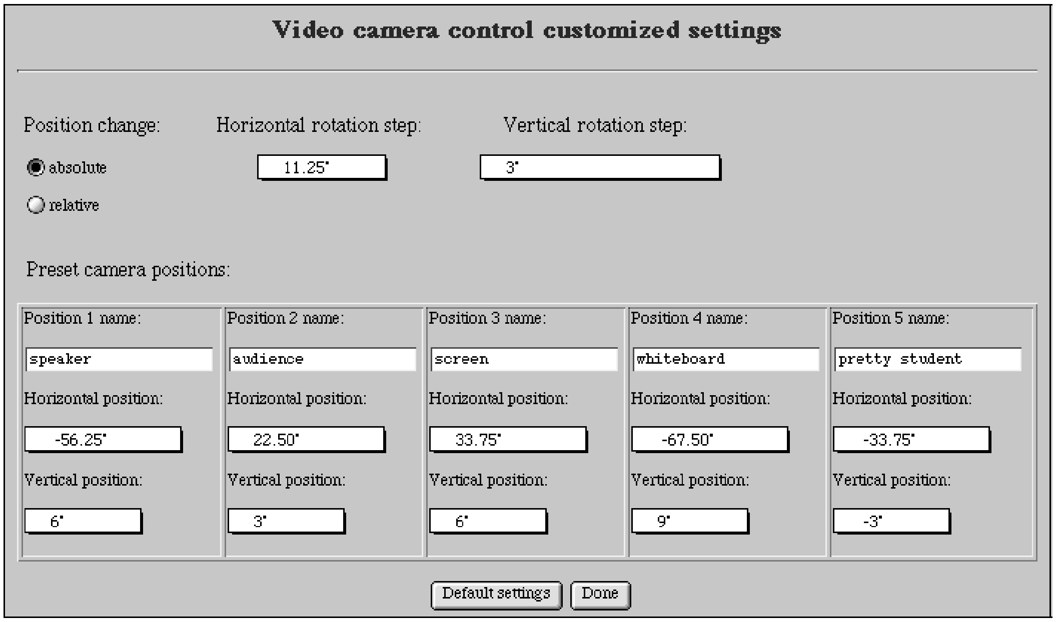

Fig. 4. An example of the video camera customized settings Web page.

written in assembler and contained only some basic procedures controlling the camera movement for example, resetting the camera position, moving the camera to a programmed position, etc.

The main difficulties that arose during the software development were due to the poor quality of the Windows system functions associated with the COM ports driver. In the end, these functions were substituted with appropriate procedures written in Pascal and run by the CGI script instead of the original Windows system functions. A minor problem was the slow reaction of the mechanical camera hardware to commands sent by the electronic circuit. This was solved by a software correction of the camera position, implemented as an assembler procedure which became a part of the 80C31 firmware.

Conclusions

The device presented in this paper has been succesfully used in some basic videoconferencing experiments. The device can be used in semi-automatic and full-automatic control systems. The set of programmable functions can be easily enhanced and is limited mainly by the camera capabilities.

Similar devices could be used not only for videoconferencing purposes but also in a wide range of other applications when there is a need for a long distance video camera remote control eg. for industrial process monitoring, security purposes or even for watching children left at home. The main advantage of the device is that

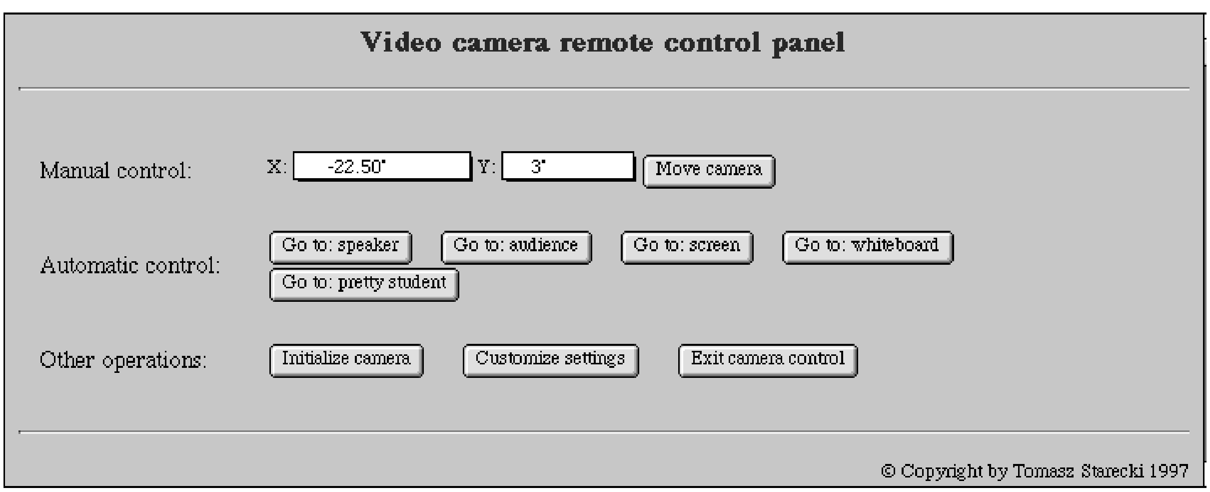

Fig. 5. An example of the video camera remote control panel Web page.

it can be controlled from virtually any place − the only requirement is to have an access to a computer connected to the Internet and equipped with a Web browser. Taking into consideration that it is possible to have a wireless connection to the Internet or to use a wireless RS232C compatible serial link (some such devices are already available on the market), the device can also be used in the field. Some potential applications of this kind are remote video recording and monitoring of hazardous objects, places and phenomena − eg. close range monitoring of volcano eruption. Of course in order to use the device in some professional applications, some of its technical parameters (eg. positioning speed) would need to be improved by replacing the existing mechanical and / or electronic circuit with a new one − designed for the particular application.

The most important feature of the described idea of Web-based remote control is that similar devices can be used in a variety of applications ranging from daily life (like switching on air-conditioning and the microwave oven with your favourite pizza inside when leaving the office) to very sophisticated distributed automatic systems used for measurements and control (eg. a real-time whole-country pollution database centre). The detailed concept of such systems will be likely presented in a separate paper.

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