MOVING OBSTACLE DETECTION AND REMOTE VIDEO MONITORING SYSTEM USING CORTEX-A8

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Abstract—In this paper the Detection of Moving obstacle and remote video monitoring and extracting the key frames from the captured video system based on high performance SAMSUNG S5PV210 CORTEX-A8 processor core is build and expanding peripheral devices using embedded Linux as the operating system. Today monitoring systems are either webcam based or simple motion detection based. Here we have interfaced both webcam and PIR sensor to the embedded system so that the user can get an immediate alert message and can take necessary steps. This system is based on the kernel of Cortex board with the GSM module being triggered by a Pyroelectric Infrared Sensor (PIR), which senses changes in the external temperature, especially in this case when an invader enters in to remote location and send SMS to the user. At the same time, by using a smart device or a PC, the user can link to the video streaming server constructed on the embedded board via the internet and browse the webpage to monitor the surveillance area, here the UVC driver and V4L programming is used to interface USB camera to the board to capture video information and then board will do two parallel works first one is transmits the processed captured video information using wireless network, which will be collected and monitored at client side using wireless network connection through the wireless device, second one is extracts the key frames from captured video using OpenCV and served on a server, the both provides an advantage to surveillance monitoring system.

Keywords— Samsung S5PV210 Cortex-A8, Video Capture, Video compression, video streaming, server, Key Frame Extraction, OpenCV

I. INTRODUCTION

Lately, the Internet has very popular, and many kinds of consumer electronics products posses communication ability. Therefore, connecting a surveillance system to the so-called “smart devices” can be an important application. Both the platform and the communication technology of the modern surveillance system have been improved to the point of achieving a high level of video streaming and real time image processing. Many engineers design a smart Camera on the embedded system and use image processing methods to analyze and judge surrounding things in home surveillance or traffic surveillance [1-4]. Although image processing methods achieve the function of surveillance, they have to be implemented by choosing a pc with high speed and real time processing, and for this reason a design using a PC cannot develop the advantages of low power consumption and low cost. Besides, a surveillance system design based on IP technology cannot be realized by means of a low-end microcomputer. We therefore use an embedded system to handle the image data packets and compress the packets for the wireless access point server so that by utilizing “smart devices” the user can access the immediate video via the Internet [5-6].

To sense human body temperature we use a pyroelectronic infrared sensor to sense variations in temperature. The sense signal of the PIR is amplified by a high-gain amplifier and generates an interrupt signal to send SMS to the user. This design has high efficiency resource utilization [7-8].

In view of existing designs and previous research projects, we focus on selecting an adequate embedded board which provides video streaming server support and a webpage browsing function. And extracting the key Frames from captured video and served on server.

II. HARDWARE AND SOFTWARE DESIGN OF THE VIDEO MONITORING SYSTEM

A. Hardware Architecture

Fig. 1 shows the Hardware Architecture of the monitoring system. The hardware system includes processor, video-capture devices, and router to receive video information through Wi-Fi. In this paper SAMSUNG S5PV210 [9] Cortex-A8 processor is chosen to complete the core control; Logitech CMOS camera is used as a video-capture device; and the user’s phone or PC connected to the wireless Internet to receive video information to achieve real-time video monitoring.

1. Samsung S5PV210 Processor

The mini210 development board is a powerful Cortex-A8 board offering a comprehensive solution integrating both hardware and software. It is designed, developed and distributed by friendly ARM. It uses Samsung’s S5PV210 microprocessor whose maximum frequency is up to 1GHz. The S5PV210 integrates the powerVR SGX540 graphic engine, supports 3D and can drive video playing on screens up to 1080P. The Mini210 inherits all the
features and benefits of our popular Mini2440 and Mini6410 excelling in quality and easy to use with low cost. It is equipped with a 5” LCD, 512M DDR2, 1G SLC NAND flash, SD Wi-Fi, D type WM8960 audio which supports 8Ω 1W speakers. In addition it has a miniHDMI output, USB2.0 camera and 8x8 matrix key boards. It also supports power idle mode. These features make it easily and widely used in MID development, Android notepads, auto electronic devices, industrial applications, GPS systems and multimedia systems. It is very easy and convenient for users to refresh the system with various OS via a TF card with our specially developed super boot.

GSM. The PIR sensor receives the variations of the temperature made by someone emitting infrared energy to the surroundings; it produces the variations of electric charges by means of a Pyroelectric effect. Because the electric charges are very few and not easily sensed, we adopt the high impedance FET to pick up the signal. In addition there is a disadvantage in the output response of the sensor. Since the output voltage we measure, about the level of mV, is too small, we have to amplify the out signal from the sensor with two-stage high-gain amplifiers. Nevertheless, if the gain is very high, tiny noises are amplified simultaneously and interfere seriously with the output signal.

4. Global System for Mobile Communication (GSM)
Fargo Maestro 100/Fargo Maestro 20 are a ready-to-use GSM modem for voice, data, fax and SMS services. It also supports GPRS Class 10(Fargo Maestro 100) or Class 2(Fargo Maestro 20) for hi-speed data can be easily controlled by using AT command for all kinds of operations. With standard 9-pin RS232 port and telephone-like audio plug (via optional cable) the Maestro 100/Fargo Maestro 20 can be set up with minimal effort. By using this GSM modem user will altering message.

5. Router
Router is a device that forwards the data packets between computer networks. Router is connected to Corex-A8 board through Ethernet cable. Using Wi-Fi we can stream the video through mobile or laptop, the processed data is uploaded into the embedded server using TCP/IP protocol and is streamed at the client side using HTTP protocol.

B. Software Architecture
Fig.2 shows the development procedure of the embedded software design. In cooperation with the operating system of the embedded system, we develop the application program and the debugging program at the PC host. By using a cross compiler we compile the embedded application and bundle them into the specific OS that is suitable for the hardware platform.

Figure 1: Hardware Architecture of the monitoring system.

2. Web Camera
Logic tech camera with 1.3 million pixels is selected in the built system. Particularly in poor light, the speed of CMOS camera is slower, but its price very low, and CMOS has power consumption only when the circuit is connected, it is generally used low-end cameras, digital cameras and toys. There is a 20P plug with 2mm pitch in ARM used as extension to connect the camera. These web cameras continuously monitor the room and send the video.

3. Pyroelectric Infrared (PIR) Sensor
In this paper the PIR sensor is used to sense whether someone is passing through the surveillance area or not. If an intruder enters the surveillance area, the sensor is triggered and sends SMS to user using
Fig. 3 shows the software architecture of the video monitoring system in which we adopt Embedded Linux as the system OS. Embedded Linux is for embedded boards which can be used in mobile devices, home appliances, embedded devices and single purpose systems. This OS not only excels at network communication, but also conforms to GPL and features of free software.

Physically the architecture of embedded Linux and Linux are very similar. However, Embedded Linux is a kernel specified on a specific platform and for specific sets of libraries and utilities. Thus, the format of Embedded Linux is a combination of a kernel image and a root-file system image. It can be built on different kinds of embedded platforms, and this OS can be tailored to offer specific functions to specific users.

We use the Linux c language for programming. Linux includes a series of compiler tools and debugging tools as well as a function toolbox. Moreover, it not only features high-level language, but also low-level language for easy control of the hardware. Linux C is therefore an adequate language for us to develop a program in an embedded system. OpenCV libraries are used to extract the key frames from captured video.

Our software program consists of 4 parts as shown in Fig. 3:

(a) Streaming program: Captures dynamic video
(b) Key Frame Extraction program: captures dynamic images
(c) Sensor scan: Scans trigger from GPIO
(d) Web server: Builds a webpage on embedded system

Fig.3 shows the kernel module which includes a GPIO scan driver and a camera module driver. When we recompile the Linux kernel, we have to combine them as a module. The camera can be used on an Embedded Linux OS. On the Linux platform the drivers are the subsets in the kernel module, and they are compiled with the kernel by the gcc compiler, but the drivers cannot be combined with the kernel as an image file. Only when we launch the camera will the drivers be downloaded (insmod) to the kernel. This method reduces the memory consumption and prevents the OS from not being able to be booted normally when the drivers fail.

Steps:
I). A color histogram is a representation of the distribution of colors in image.
II). Representing histogram by taking BIN value.
III). The value stored in each bin is the number of pixels in the image that shows the range.
IV). These ranges represent different levels of intensity of each RGB component.
V). The conversion of RGB to HSV is done.
VI). Start with the first frame to image distance between the current and the next frame
\[ D(H_t, H_{t+1}) = \sqrt{\sum_{k=1}^{Nt} (H_{t,k} - H_{t+1,k})^2} \]
Where \( H_t \) Denotes image histogram for the \( t \)th frame \( H_{t,k} \) denotes the values on the \( k \)th colour \( H \).
VII). Then find the histogram difference between HH and SS of two successive frames.
VIII). Find the sum to list difference for H and S.
IX). The calculated sum is compared with empirically found threshold.
X). If the sum greater than threshold then we obtain the key frames and then served on web server.
2. Building and Cross Compiling Of Opencv

OpenCV [11] is a collection of software algorithms put together in a library that to be used by industry and academics for computer vision applications and research, Using this libraries we design applications. To build OpenCV we need to install some libraries, Using below command we can install those libraries

```
sudo apt-get install libjpeg-dev libjasper-dev libtiff4-dev libpng12-dev libpango1.0-dev libcairo2-dev libgdk-pixbuf2.0-dev libgtk2.0-dev cmake cmake-gui
```

After installing those libraries Download OpenCV source and configure the OPENCV using below commands:

```
cmake-gui
cmake-gui
cmpack
```

Cross-Compile OpenCV and its libraries, to run on boards.

OpenCV cross compiling steps:
1. Set up the compiler tool chain.
2. Build v4l-utils
3. Configure OpenCV
4. Build and install OpenCV

3. Flow Chart of the Project

Flow chart of the Project shown in figure 5:
The flow chart shows that,

Step 1: when a person passes near to PIR sensor then it triggered and send alert message to user. After seeing that message the user can link to the video streaming server 1 or server 2 constructed on the embedded board via the internet and browse the webpage to monitor the surveillance area.

Step 2: The camera continually monitor the room and captured the video, this captured video is compressed using MPEG-2 compression technique and display in the server 1. Compression of video must be done, because some mobile devices allow only restricted amount of packet size between the server and themselves.

Step 3: From the captured video the key frames are extracted and compressed using JPEG which is done OpenCV tool and saved JPEG image in SD card and also served on server 2.

III. EXPERIMENTAL RESULT

Web camera captures the video and allows the user to monitor by synchronous video streaming. We implement the software modules in the Linux C language for the video display and for the triggered signal while sensing the temperature. We also build a streaming server and a Web server on the embedded board to allow the user to browse the surveillance system. In streaming server some Linux web-
streaming packages to be installed and configured on board, this implements the embedded server using TCP/IP protocol and is streamed at the client side using HTTP protocol.

The Mplayer embeds an encoder called mencoder and transforms the different media specification to the standard format for video streaming (ex. transforming MPEG 2 to avi). We turn on the browser and input the IP address on the embedded board. We link to the embedded video streaming server and build the operation interface by using a streaming server. Fig 6 shows the implementation of displaying the real time video streaming on the web server.

![Figure 6: Implementation of displaying the real time video streaming on the web server.](attachment:image)

Figure 6: Implementation of displaying the real time video streaming on the web server.

Figure 7: shows that output of the PIR sensor and sending SMS to the user using GSM modem. PIR sensor is used to sense whether someone is passing through the surveillance area or not. If an intruder enters the surveillance area, the sensor is triggered and sends SMS to user using GSM commands.

**A. Experimental Set Up For Web Camera**

At first the parameters related to the video sequences are considered as listed in table 1 then based on that for an amount of time interval the obtained key frames from above mentioned steps are noted based on the appropriate threshold as listed in table 2.

Here the key frames are changing according to threshold value, the higher the threshold the lesser the key frames and lower the threshold higher the key frames so based on application we can make a relevant threshold so that we can save the transmission bandwidth accordingly.

![Figure 7: Output of the PIR sensor and sending SMS to the user using GSM modem.](attachment:image)

**B. Key frame Results**

The below shown figure 8 represents the key frames which are extracted from live video using CORTEX-A8 board and served on web server and Figure 9 shows the final output key frames.

![Figure 8: Output of Key Frames](attachment:image)

**Table 1: experimental setup**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Parameters</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Video length (assumption)</td>
<td>60 sec</td>
</tr>
<tr>
<td>2.</td>
<td>Frame rate</td>
<td>25Fps</td>
</tr>
<tr>
<td>3.</td>
<td>Resolution</td>
<td>352x288=101376</td>
</tr>
<tr>
<td>4.</td>
<td>Number of Frames</td>
<td>60x25=1500</td>
</tr>
<tr>
<td>5.</td>
<td>Bit rate (compressed)</td>
<td>60x512kbps=30720 kbps=30.720Mbps</td>
</tr>
</tbody>
</table>

![Figure 9: Final output key frames](attachment:image)

**Table 2: Result Analysis**

<table>
<thead>
<tr>
<th>S. N o</th>
<th>Threshold (k)</th>
<th>Actual Key Frames</th>
<th>Detected Key Frames</th>
<th>Transmission bandwidth (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>K=1</td>
<td>10</td>
<td>19</td>
<td>19x512kbps=9.7</td>
</tr>
<tr>
<td>2.</td>
<td>K=5</td>
<td>10</td>
<td>15</td>
<td>15x512kbps=7.6</td>
</tr>
<tr>
<td>3.</td>
<td>K=10</td>
<td>10</td>
<td>10</td>
<td>10x512kbps=5.1</td>
</tr>
<tr>
<td>4.</td>
<td>K=15</td>
<td>10</td>
<td>7</td>
<td>7x512kbps=3.58</td>
</tr>
</tbody>
</table>
CONCLUSION

In this paper we have designed and implemented the moving obstacle detection and remote video monitoring system using Cortex-A8 board. Based on an integrated design, we have combined PIR sensor circuit to detect the temperature change of the surveillance area as a trigger to send SMS to the user, Logic tech CMOS Camera module to capture the video and video streaming server on the embedded board for surveillance to view the captured video also we have implemented the extraction of the key frame from the captured video on the Cortex-A8 board using this we save the transmission bandwidth and memory. We have adopted Embedded Linux as the operating system on the embedded board because Linux supports well on the network, and many free required modules can be selected.

REFERENCES


