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Design of Qt Embedded Linux System for Video Capture

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Abstract: With the rapid development of the computer, network, image processing and transmission technology, the application of embedded technology in video surveillance is wider and wider. This proposed design is based on ARM9 hardware platform and Linux operating system [1], it uses USB web camera for video collection, LM35 and LDR sensors senses temperature and light, combined with video interface technology and MJPG video coding and decoding and video transmission technology, aiming at design a low-cost high-performance programme. Video capture system using friendly ARM9 board support package is presented. This application system captures video, shares among networked systems. This system works in a real time environment and is supported by embedded RT Linux. This system provides low cost and high effective intelligent monitoring system like in elevators, home security systems, Patient monitoring in hospitals, Polling booths etc with low power consumption.

Keywords: Linux, ARM9 Processor, MJPG Streamer, Qtopia, LM35 Sensor And LDR Sensor.

I. INTRODUCTION

Video capture systems play very important role in many fields of our society such as in banking, personal security, finance etc. Starting from small houses to big industries, now video surveillance is necessary and plays very important role to fulfill our security aspects in many ways. The preceding and existing video surveillance system which entails high end cameras, video servers, network switch and monitoring PC all these resources leads to complexity, expensive, high power consumption and also requires more area to establish. Traditional video surveillance can generally achieve close distance monitoring, by using the PC as a monitor host, monitor host connected monitor camera with coaxial cable and uses MPEG video compression. MPEG's basic principle is to compare compressed images to be transmitted over the network, using the first compressed image as a reference frame, sending it and only the parts of following images that differ from the reference image. MPEG is in fact far more complex than indicated MJPG, and parameters such as prediction of motion in a scene and identifying objects are additional techniques or tools used within MPEG. Due to this differential data compression quality often decreases when footage contains lots of movements and requires more time latency therefore not suitable for live streaming.

In proposed system LDR and LM35 sensors[5], a USB camera, ARM9 board, and a PC is used for the real time live video monitoring and MJPG streamer algorithm is used as real time operation is needed. By means of MJPG streamer algorithm, live streaming from camera is converted into different frames and then each one is transmitted through Ethernet built in ARM9 board to the web server. Here we used LINUX operating system, so interface between USB camera and ARM9 board is in CGI (Common Gateway Interface) script. Here BOA web server [4] is used to display real time video from USB camera to the client side. Here video surveillance from the remote place to the web server is done only within the time delay of few microseconds. Entire video monitoring of the system is under the control of S3C2440. Meanwhile, it possess some advantages, for example, hardware and software can be cut, compact construct, portable, low power consumption, more suitable for long-distance transmission. The main intention of this project is to collect the sensors data and displayed on to the LCD[2] screen of the ARM board then web camera capture the video and transmit it on to the monitor of pc as soon as possible with minimum time delay. To achieve it, we used camera which is interfaced to a micro controller. This process continuously repeats with time delay of one millisecond.

II. PROPOSED SYSTEM

Capturing and playback immediately are two crucial issues to realize video surveillance system. In the existing system cameras are used to capture video, but it has not able to play immediately that is live streaming due to challenging problems such as time latency. In order to overcome the hitch in the preceding and existing system, we present a proficient where it uses few hardware resources for the implementation of the video capture system along with sensors. In the proposed system video data is captured from a USB camera, compressed into MJPG format, transferred to PC under the control of the ARM9 chip; then, the monitor client will receive the compressed data frame to restructure, and recompose video images. Wireless video monitor system provide a practical solution for remote

wireless monitoring with low cost. Motion JPEG (MJPG) is a video codec where each video field (frame) is separately compressed into a JPEG image as shown in Fig.1. The resulting quality of video compression is independent from the motion in the image [5]. Characteristics of M-JPEG are at low bandwidth availability, priority is given to image resolution (i.e. transmitted images would maintain their quality; however some images would be dropped), Minimum latency in image processing and Images have a consistent file size. Similar to a digital still picture camera, a network camera captures individual images, compresses them into a JPEG format and then makes them available as a continuous flow of images over a network to a viewing station. As each individual image is a complete JPEG compressed image, they will all have the same guaranteed quality, determined by the compression level as defined for the network camera or network video server.

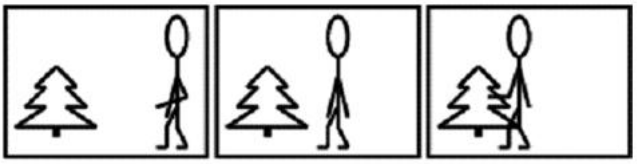

Fig.1. Sequence of Motion –JPEG images(MJPG).

A. Block Diagram

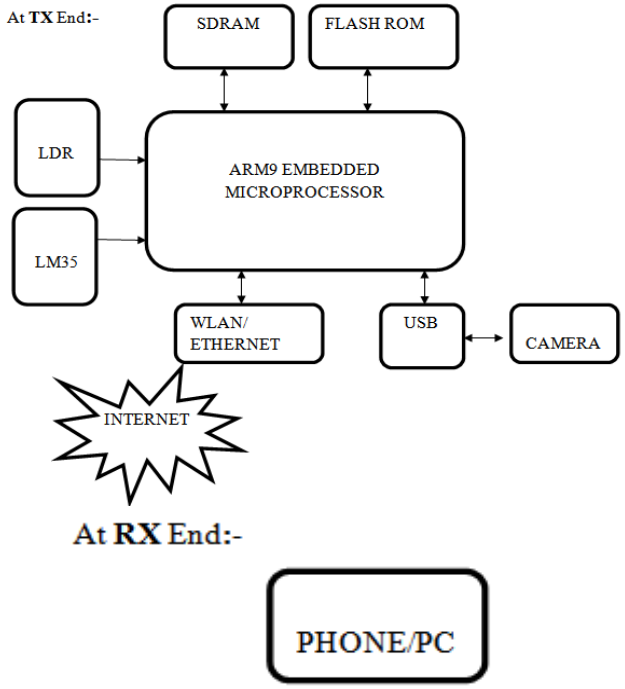

Fig.2. Block diagram of proposed system.

In the project at transmitter end, there is a temperature sensor and LDR sensor which are connected to microprocessor using ADC. They are used to sense temperature and light intensity of the local area respectively and displayed on the LCD screen of the processor, processor provides a camera interface to support camera as shown in Fig.2. A web camera connected to the processor continuously captures the video and send to the Friendly ARM board. Processor sends this video on web server through DM-9000 Ethernet controller built in ARM9 board. At the receiver end on pc browser user input on the corresponding IP-address http://192.168.1.230/stream.html and then the webpage is opened and the output video is streaming.

1.ARM9 Processor: S3C2440 is a microcontroller developed with ARM920T corefamily. This microcontroller works for a voltage of +3.3V DC and at an operating frequency of 400 MHz. Individually we cannot get S3C2440 chip, it will get in the form of FRIENDLY ARM board and also we can call it as MINI 2440 board. It provides a camera interface (camif) to support camera [9].

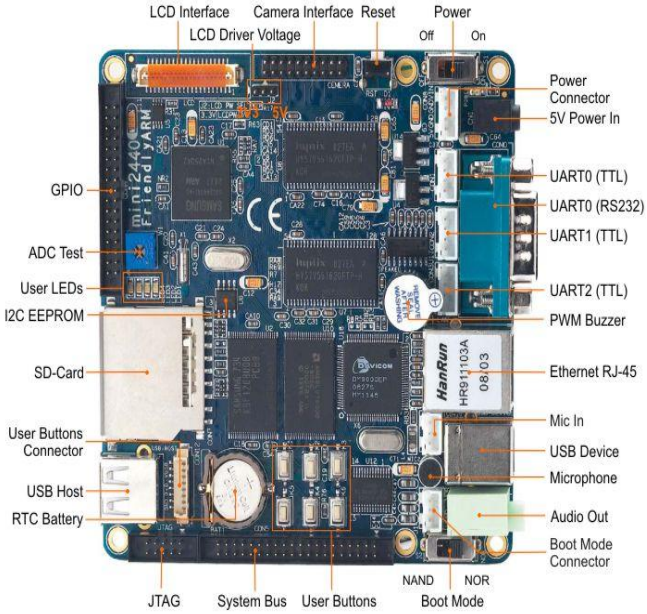

Fig.3. Friendly ARM board.

Friendly ARM Board: The Friendly ARM or Mini2440 is a single board computer based on a Samsung S3C2440 ARM9 microprocessor. The board measures 10 cm x 10 cm, ideal for learning about ARM systems or integrating into numerous products as shown in fig.3. By providing a comprehensive set of common system peripherals, the S3C2440 minimizes the overall system costs and eliminates the need to configure additional components [11]. The Samsung S3C2440 features an ARM920T core, a 16/32-bit RISC microprocessor, to provide hand-held devices and general applications with cost-effective, low-power, and high performance micro-controller solution in a small form-factor. The S3C2440 is developed using 0.13 um CMOS standard cell and a memory compiler. In addition, it adopts a new bus architecture called Advanced Microcontroller Bus Architecture (AMBA).S3C2440 is a derivative product of Samsung's S3C24XXX family of microprocessors for mobile communication market. The S3C2440 / S3C2440A / S3C2440A-40's main enhancement over the baseline product, S3C2410X, is the addition of camera interface for multimedia messaging services.

2. LM35 Temperature Sensor: LM35 is a precision IC temperature sensor with its output proportional to the temperature (in^{o}C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. The operating temperature range is from -55°C to 150°C. Its scale factor is 0.01V/ ^{o}C. We use LM35 temperature sensor to sense the temperature of room or a location and take controlling action if needed as shown in Fig.4.

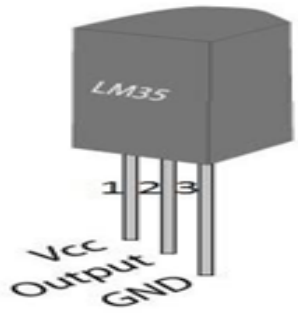

Fig.4. Pin diagram of LM35.

3. Light Dependent Resistor (LDR): A photo resistor or light-dependent resistor (LDR) or photocell is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. In this LDR senses the Light intensity of room or a location with the help of ADC of processor as shown in Fig.5.

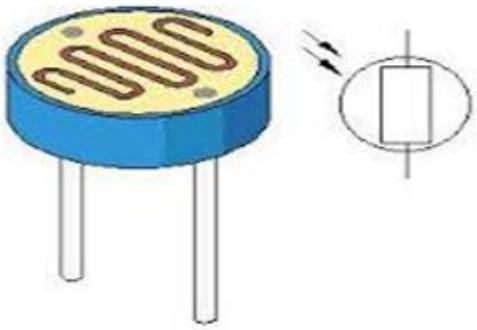

Fig.5. LDR component and circuit symbol.

4. Camera Module: The USB Webcam is connected to processor. There is a 20pin plug with 2mm pitch in ARM used as extension to connect the camera. Webcam capture the video and send to the Friendly ARM board. Friendly ARM sends this video on server to see the live video. There is a 20pin plug with 2mm pitch in ARM used as extension to connect the camera. These web cameras continuously monitor the room and send the video.

III. SOFTWARE DESIGN

A. Transplantation of Operating System Into S3C2440 Board

Firstly, the Linux kernel is ported into ARM9 board[6]. Supervivi Boot loader, kernel and root file system are ported. The main functionality of boot loader is to initialize all the devices that are present on the mother board of MINI 2440 and at the same time to find out whether any problem or any other fault is there in the devices that are present on that mother board of MINI 2440. Kernel is the core part of an operating system. Operating system will perform its functionalities like File management, Process management, Memory management, Network management and Interrupt Management with the help of the kernel only.

B. Porting MJPG Streamer

MJPG-streamer is a software solution that takes raw frame data from the webcam and outputs a stream in the MJPG format, a series of JPEG images. The MJPG streamer is cross-compiled and loaded in to the S3C2440 board to act as a web streaming server. The server periodically obtain videos from camera through the private network, such videos are transmitted from camera to the server. In order to use Friendly ARM as a video capture system based on MJPG transmission technology, we will need to install a MJPG streamer. The following instructions will guide through porting MJPG streamer.

- Download binary package: http://mjpg-streamermini2440.googlecode.com/files/mjpg-streamer-mini2440-bin-r6.tar.gz or source code and compile.
- Copy to mini2440 using NFS, FTP or SD card.
- Create a directory, for example: mkdir /mjpg-streamer.
- Untar: cd /mjpg-streamer; tar zxf mjpg-streamer-mini2440-bin.tar.gz.
- To try using CAM130 – run: start_s3c2440.sh.
- To try using USB UVC based camera - connect camera to usb socket and run: start_uvc.sh.

B. Developing Application in Qtopia

Qt_Embedded is a C++ toolkit for GUI and application development for embedded devices. It runs on a variety of processors, usually with Embedded Linux. Qt_Embedded based applications write to the Linux frame buffer directly and includes several tools to speed and ease development in testing and debugging of applications. Applications targeted for Embedded Linux can be developed using standard Qt tools, including Qt Designer for visual form design, and with tools specifically tailored to the embedded environment [8]. Here are the steps of creating a GUI application for Friendly arm board. We should have development tools ARM-Linux GCC 4.4.3 and ARM-Qtopia 4.6.3 already installed. The following are the steps

- Open Qt designer which is available with "ARM-Qtopia 4.6.3". With Qt Designer create the main form.
- Create a script file "build" for building the application. And create a script file "formuic" for compiling the .ui form file.
- Run the script and generate the .pro (project) file using the qmake tool.
- A project file serial.pro has been created and Open it with the text editor and Build the application.

Various widgets namely LDR, LM35, acquiring parameters and capture video are created in Qtopia which appear on the Touch Screens of the board. In order to transfer the data between ARM9 boards and PC/Smartphone TCP/IP protocol is used. The various files created in this application are Main.cpp: This is used to run the main application by initializing the Qt Application. videocapture.cpp: this contains actual application of project. videocapture.h: header files of video capture system as shown in Fig.6.

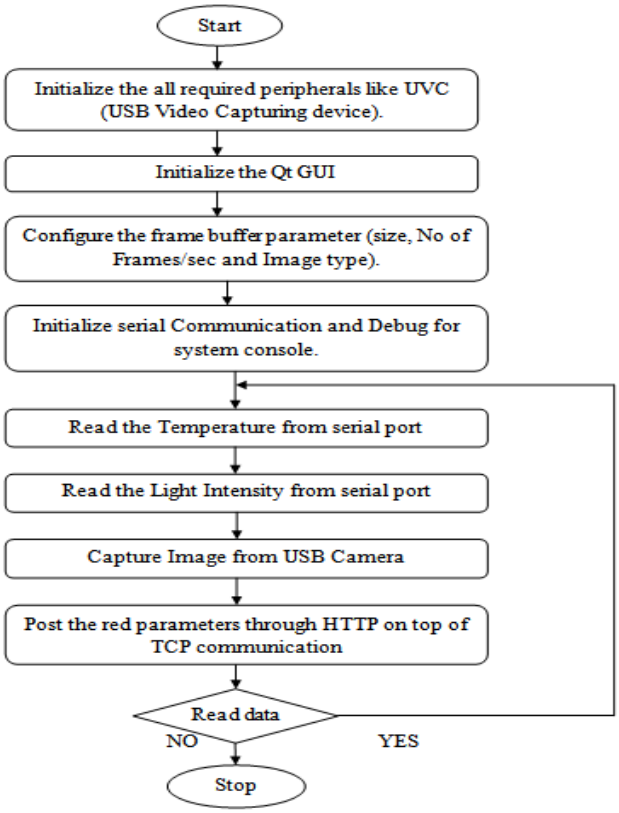

Fig.6. Project Flow Chart.

First of all note the software and hardware components required to complete the project. Be acquainted with the new OS (Linux), new software (Qt, GCC, MJPG) and new language (C++). Also keep in handy the various hardware components like Friendly ARM board, LM35 sensor, LDR sensor, Camera and other peripherals. Then dump the Linux OS into ARM board. And burn the Qt GUI application into the board and install MJPG streamer. Now connect all the peripherals like UART cable, Ethernet cable and web camera to the processor board. Then burn the program which is developed in Qt into microcontroller. Now switch on the power of complete system. After initialization make system to read the sensor values and capture the video and play it on pc through TCP communication.

IV. SIMULATION RESULTS

The following figures show the kit arrangement of the project. In this project we connect the two sensors to the controller with the help of ADC and web camera is connected through USB port. In Fig.7 window shows the actual GUI widget created using Qt. It shows LDR and LM35 icons for displaying sensor values, Capture video button and Acquiring parameters icon. Capture video button can be pressed using a tip of our finger to start the video capture.

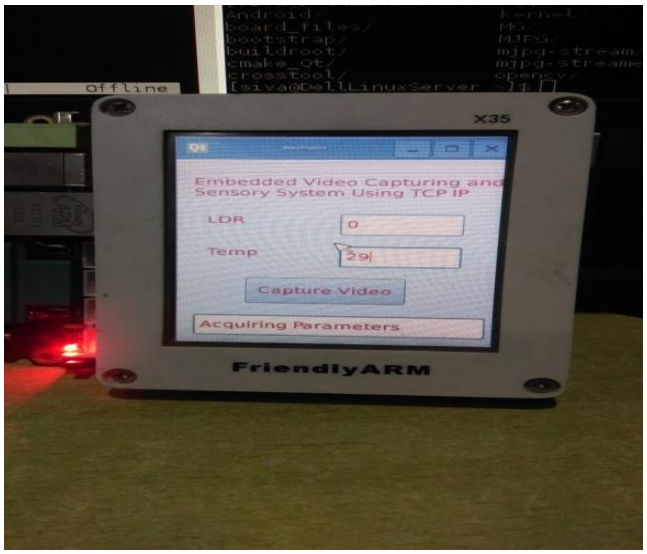

Fig.7. Screen shot of sensor outputs.

Transmitter module also has an Ethernet connection and a serial port to transfer the received video data serially to the computer for live streaming as shown in Fig.9. At receiver side, video data will be retrieved after clicking the "capture video" icon on LCD as shown in Fig.8.

Fig.8. Transmitter module.

In this project computer acts as receiver module as shown in Fig.10.The processed stream video data packets are uploaded into server using TCP/IP protocol and transmitted through wireless device so that user input the corresponding IP-address http://192.168.1.230/stream.html in address space of webpage after opening browser. Then the output video is streaming on web page as shown in Fig.9.

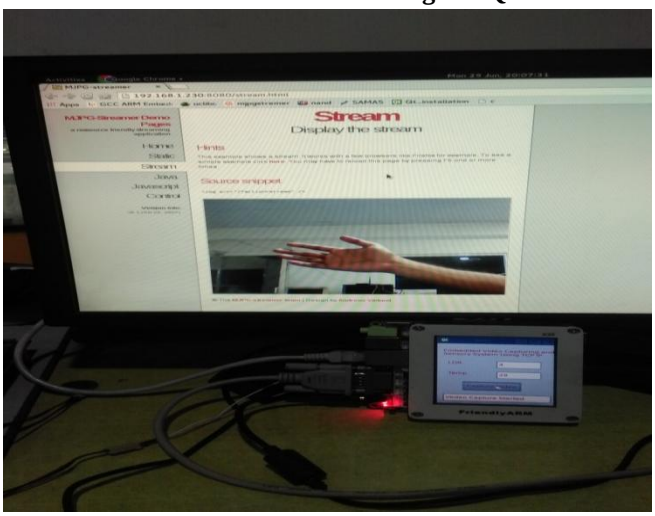

Fig.9. Screen shot of video output.

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

The project has been implemented to get a fully functional embedded product developed from scratch. Based on an integrated design combined LM35 and LDR sensors, camera, MJPG streamer and web server for live video capture. It has been developed by integrating features of all the hardware components and software used. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ARM9 board and with the help of growing technology the project has been successfully implemented. For this project 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.

B. Future Scope

The system can be further enhanced by developing necessary Wi-Fi technology on S3C2440 using Linux so that we realize remote surveillance by embedded system and wireless transmission. In future we can provide more security to data by using encryption, decryption techniques.

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