

## Design of Smart Sensor Using Linux-2.6.29 Kernel

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### Abstract

Smart Sensor Interface Standard, puts forward the idea of the combination of smart sensor and video monitoring, designs the architecture based on Industrial Ethernet smart sensor. Samsung S3C2440A Microprocessor as the core of this sensor, Embedded Linux System and web server are transplanted, accomplish the on-site collection of temperature by the temperature sensor LM35 and camera, on-site real-time temperature can be displayed on a browser by a remote end. The aim of this project is to design and implement a Smart Sensor Perform for Transforming Temperature reading and Capturing Images by using ARM9. This system is based on the kernel of an ARM board. The Microcontroller is connected to temperature sensor, which gives analog voltage signals. These signals are measured and translated into the responding values by Analog to Digital Converter (ADC). To maintain the controlled environment these sensors are provided with the set points. By these set points the environmental parameters are maintained in the required range. Software modules are implemented in the Linux C language. The web server is implemented on the ARM9 controller; the user can link to the web server constructed and can browse the webpage and receive the sensors data to monitor the weather station by smart phone or PC via the internet or a Local Area Network (LAN). Embedded Linux operating system is ported to ARM9 embedded board.

**Keywords:** LM35, Analog to Digital Converter, Local Area Network, IP technology.

### INTRODUCTION

Smart sensor technology is a developing modern sensor technology involved various subjects. It is an advanced technology in rapid development in today's world. Some people think smart sensor is a kind of sensor with microprocessor and has the functions of information

detection, information processing, information memory, logical thinking and judgment. From its function, smart sensor has one or more sensitive functions as follows: it can complete the auto-zero, self-calibration, auto correction and auto compensation; complete automatic data acquisition and proceed the pre-treatment, Automatic test, automatic range selecting and automatic trouble locating to the data, complete the data storage and memory and the information processing, complete two-way communication, standardized digital or symbol output complete judgment and decision processing. A transmitter, must has the ability not only to express the sensing quantity or controlled quantity, but also to integrate the sensor/actuator with the network environment application. 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. So this project contains an embedded system to handle 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 images via the internet.

### OBJECTIVE

The objective of this project is to implement a home surveillance system which provides the functions of security monitoring and home surveillance using ARM9 processor with embedded Linux as operating system.

### Proposed method description:

Smart sensor technology is a developing modern sensor technology involved various subjects, it is an advanced technology in rapid development in today's world. The

concept of smart sensor is this definition of the sensor version. The core is smart sensor can increase the amount of information data, and be able to support the distributed processing and decision. The image is the main carrier of information, and 70% of the information people acquired are obtained by image. Therefore, the design of smart sensor with video motoring, especially in remote monitoring field, is extremely important.

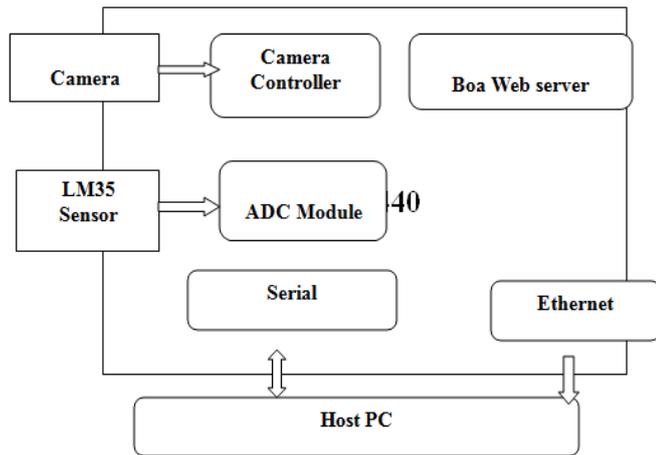
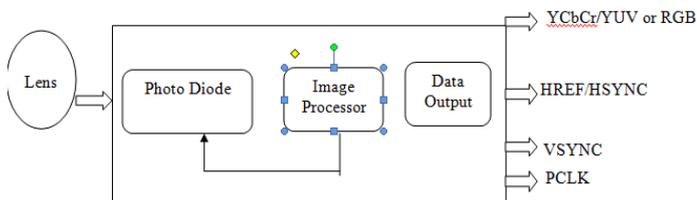


Figure Smart Sensor basic block Diagram.

Omni Vision (OV9650) camera is used for monitoring and the captured images are transferred from ARM9 based system to client using Personal Home Page (PHP) programming. Hypertext Mark up Language (HTML) is used for creation of web pages and these web pages provide Graphical User Interface (GUI) for home monitoring and collecting the Images and Sensor readings.

### Theory of Operation:

A temperature sensor operates on the measurement principle that a material's electrical resistance changes with temperature.



### Photo Diode:

Photo Diode is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed (to detect vacuum UV or X-rays) or packaged with a window or optical

fiber connection to allow light to reach the sensitive part of the device. Many diodes designed for use specifically as a photodiode use a PIN junction rather than a p-n junction, to increase the speed of response. A photodiode is designed to operate in reverse bias.

### Data Output:

It is receive the data from image processor and transmit output.

### Schematic layout:

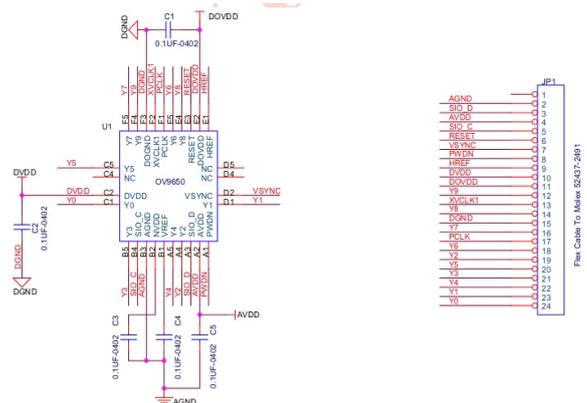


Figure: camera pin diagram

### Steps for Configuration and Compilation of Linux-2.6.29 kernel:

```
# cd /opt/FriendlyARM/mini2440(in working directory)
```

Place the kernel version Linux-2.6.29-Mini2440-20090708.tgz in working directory

Extract the Linux-2.6.29-Mini2440-20090708.tgz

```
#tar -xvf Linux-2.6.29.tgz
```

And creates a Linux-2.6.29 directory

```
#cd /Linux-2.6.29
```

Copy the default configuration file config\_mini2440\_n45 to a file .Config as follows

```
# cp config_mini2440_n45 .Configuration.
```

Then do "make menuconfig" to configure the kernel modules.

The kernel configure interface appears as shown in Figure In this configuration interface select the modules which are required for implementing the driver.

```
# make menuconfig
```

Start the kernel compilation by using command make

```
# make zImage
```

After compilation, the interface appears to indicate zImage is ready or not. The built Linux kernel image file (zImage) can be route to arch / arm / boot directory and then download the zImage to the development board using dnu utility under windows.

## EMBEDDED WEB SERVER BOA

In this explains about working of embedded web server and generation of dynamic web pages through php with java scripts.

### Server:

A computer or computer program that manages access to a centralized service in a network.

### Web server:

Web server can refer to either the hardware or the software that helps to deliver content that can be accessed through the Internet.

### Embedded web server:

The web server which is specifically designed for embedded devices and which requires relatively small storage space and less memory to run, which makes it quite suitable for embedded applications. The typical embedded Web server has three kinds, namely tthttpd, Boa and thttpd. As the simplest Web server, tthttpd has the weakest functions among the three. It does not support authentication and CGI technology while Boa and thttpd support these functions. If Web server only provides some static web pages such as simple online help and system introduction, then a static server can be adopted; if you need to improve system security or interact with users such as real-time status query and landing, then you have to use dynamic Web technologies. In such situation, either Boa or thttpd can achieve these goals. In the present research, the Web server Boa suitable for embedded system, because thttpd has less function and needs far more resources to run.

### The principle of Embedded Web server Boa:

Boa is a single task Web server. The difference between Boa and traditional Web server is that when a connection request arrives, Boa does not create a separate process for each connection, nor handle multiple connections by copying itself. Instead, Boa handles multiple connections by establishing a list of HTTP requests, but it only forks new process for CGI program. In this way, the system resources are saved to the largest extent. Like a common Web sever, an embedded web server can accomplish tasks such as receiving requests from the client, analyzing requests, responding to those requests, and finally returning results to the client.

### Working process:

- Complete the initialization of the Web server, such as creating an environment variable, creating socket, binding a port, listening to a port, entering the loop, and waiting for connection requests form a client.
- When there is a connection request from a client, Web server is responsible for receiving the request and saving related information.
- After receiving the connection request, Boa analyzes the request, calls analysis module, and works out solutions, URL target, and information of the list. At the same time, it processes the request accordingly.

After the corresponding treatment is finished, the Web server sends responses to the client browser and then closes the TCP connection with the client. For different request methods, the embedded Web server Boa makes different responses. If the request method is HEAD, the response header will be sent to the browser; If the request method is GET, in addition to sending the response header, it will also read out from the server the URL target file of the client request and send it to the client browser; If the request method is POST, the information of the list will be sent to corresponding CGI program, and then take the information as a CGI parameter to execute CGI program. Finally, the results will be sent to client browser. Boa's flowchart is shown in Figure.

### Creating Dynamic Web Pages:

To create web pages with dynamic data, need a convenient and powerful server side scripting environment. Using the legacy CGI protocol is slow and difficult to create great looking web pages because you cannot see the result until it is rendered. In contrast, environments such as Embedded Server Pages.

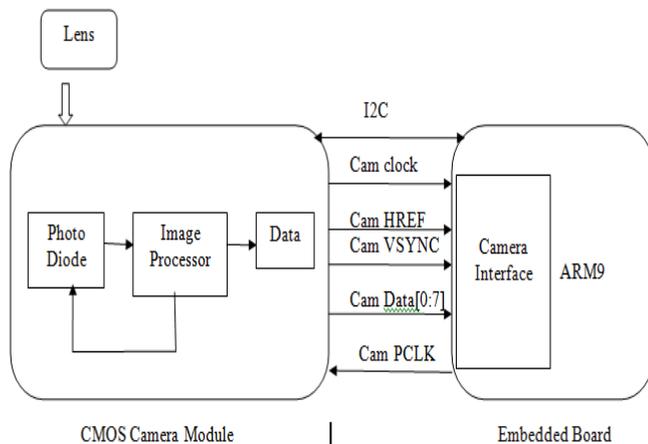
## IMPLEMENTATION

This chapter focuses on the implementation of embedded surveillance system. This system is based on the kernel of an ARM board, a CMOS camera and a LM35 sensor. In this design, Analog to Digital Converter (ADC) interface is used to provide the communication for the LM35 sensor with the I/O interface on the embedded board. Since we do not need to exchange data between the sensor circuit(transmitter) and the embedded board(receiver), the design simply needs to transmit the temperature readings to the server. If the LM35 sensor senses the tempetaure values passing to the Processor through the ADC pin. When the trigger signal is received by embedded board, the board captures the relevant images at that moment and records them either in the memory or on the disk. An application program is developed to capture and process the images of the camera module and then play the images on an LCD and to save the images. Software modules

are implemented in the Linux C language for the image capturing and for the transmitting values while sensing the temperature. We also built a web server Boa on the embedded board to allow the user to browse the surveillance system. In the web sever the image packets are transmitted via TCP/IP Protocol.

### CMOS camera interface:

The camera module communicates with the embedded board by using an Inter-Integrated circuit interface which is a camera interface for implementing the embedded surveillance system. Figure shows the communication interface between the camera module and the embedded board.



**Figure** Communication interface of camera module and ARM9 board

### Creation of an embedded web server in the linux system

The creation of a web server boa has the following steps

- 1) Download the source code of Boa. The source code can be download from <http://www.boa.org>.
- 2) Transplant the procedure of Boa. Decompress the downloaded source code and lead it to enter "src" subdirectory of the source directory

```
#tar xzvf boa.tar.gz
#cd boa/src
```

- 3) Create "Makefile" file:

```
#/configure
```

- 4) Modify "Makefile" file. Mainly modify the crosscompiler, find CC=gcc, change it into CC=armv41-unknown-linux-gcc, save these changes and quit "Makefile" file.

Specify the root directory path of Web server:enter"boa/src/" directory, and specify the absolute path of root directory of the Web server by modifying the statements which are in "defines.h" file.

```
#define SERVER
```

ROOT"/mnt/yaffs/share/www/boa/http"Then run "make" to compile, it will creat a file named "boa" in the directory of "boa/src". This file shall be the executable file of Web server Boa.

- 5) Configure Boa so that it can support the implementation of CGI programs.

- 6) Boa requires to establish a boa directory in the root file system"/mnt/yaffs/share/www" . A configuration file "boa.conf" will be loaded when the boa boots. This file must be edited before the boa program is running. There is already a sample boa.conf in the Boa source directory. It can also be modified on its basis.

The following configurations need to be changed:

Port 80 //set the port of Web

Oroup 0 //opening up the restrictions on the user group

ErrorLog/mntlyaffs/share/www/boa/log/boa/error\_log//set the actual path of the error log

DocumentRoot/mnt/yaffs/share/www/html //set the home directory of the HTML file

Script Alias/cgi-bini /mntlyaffs/share/www/cgi-bin/ /specify the actual path of the virtual path of the ColScript

ScriptAlias/index.html/mnt/yaffs/share/www/html/index.htm 1 //specify the actual path of the virtual path of the server's default page

- 7) Test whether Boa can work normally, and whether the static HTML pages can be visited normally.

- 8) According to the configuration of boa.conf, copy the tested home page index.html into"/mnt/yaffs/share/www" directory. The IP address of the board is set to be 192.168.1.230. Enter"/mntlyaffs/share/www/boa/src" through minicom, and then run "./boa", and visit the following website :<http://192.168.1.230> on PC browser. Then we could see the pages of "/mnt/yaffs/share/www/index.html".

### Implementation of Dynamic Web Pages:

There are many kinds of technologies such as CGI, ASP, PHP JSP and so on, which are used to achieve dynamic Web pages. If the dynamic pages are to be realized under Linux operating system, CGI is preferred. CGI(Common Oateway Interface) is a common interface standard which is applied to interact between the application of external expansion application and Web Server. CGI provides the Web server with a channel to implement external program. This service technology makes browser and server interactive. CGI is the program consistent with these common interface standards and running on the Web server. CGI programs can be produced in any programming language, for example, Shell scripting language, Peril, Fortran, Pascal and C language. The C language is

chosen to write CGI programs. The client interacts with the on-site I/O module through CGI program. After the daemon of Web server receives client requests, a child process will be created. Then this child process will set relevant data requested by CGI as environment variables and meanwhile build two data channels between external CGI program and the server (standard input/output). Then the CGI program assigned by URL is started and keeps pace with the child process in order to monitor the implementation state of CGI program. The result of disposition is passed to the daemon of Web server through the standard output stream by the child process. Then the processing results are reported back to the client by daemon as a response message. A CGI program is usually divided into two parts. (1) Receive data from submission form according to POST method or GET method. (2) Generate the HTML source code by means of printf() function and then correctly return the decoded data to the browser.

## RESULTS:

This chapter will show the result of Project. Connect the input devices Camera and Temperature sensor. Open terminal execute commands. First connect the hardware and setup the software environment on system then run the command.

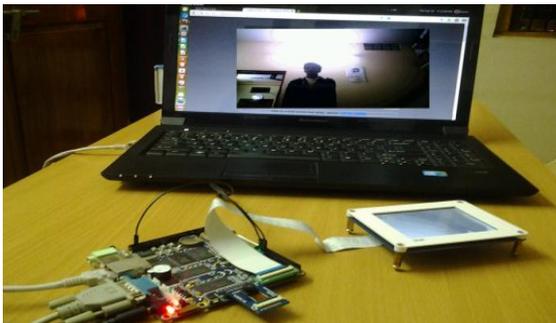


Figure shows implementation

Type <http://192.168.1.230/home/plg> it will display temperature values on web page figure 7.1 show the result.



Figure shows image on web page.

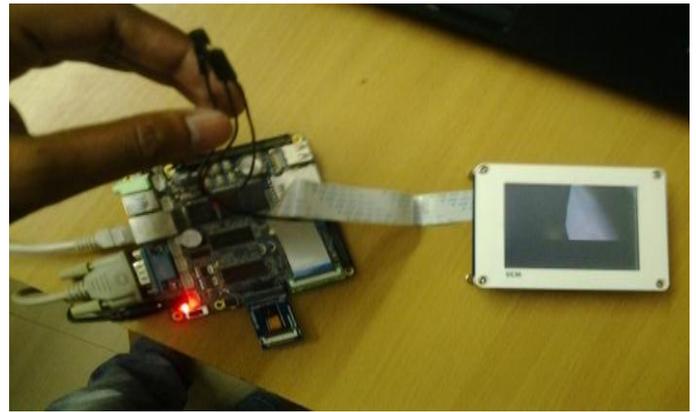


Figure shows Hardware connection

This is the way to execute the application. Type web site in internet will get result.

## CONCLUSION AND FUTURE SCOPE

### Conclusion

The embedded Web server designed for home video monitoring is based on the ARM-Linux operating system. The web server boa has been chosen for the proposed work. When compared to the traditional PC server it has small storage low-cost, portability, easy to maintain and upgrade. The Web server Boa selected in the present research consumes low power while functioning. It also has more functions and supports CGI Communication between external expansion applications and Web server. It can be achieved through CGI technology. This method not only improves system security, but also makes it possible to interact with users and create dynamic Web pages.

### Future Scope:

This embedded Web server is a separate module which can provide a standard interface. With slight modifications it can be applied easily to embedded fields such as on-site AC servo system, industrial control, and intelligent appliances. Remote monitoring is applicable in a wide range of industries like the oil and gas industry pharmaceutical, rail networks, electricity transmission and distribution of food and beverages. Remote monitoring in rail industry is a concept which is used for monitoring the wayside asset condition and signaling systems. The rail system has main objectives in which the remote monitoring helps in Safety of the passengers, nearby humans and animals; efficiency and timely operation of the trains and Management. The benefits of using remote monitoring are Adherence to regulatory, requirements in Operations, Improved safety in gas pipelines, and plant area handling hydrocarbon (explosive fluids), cost benefits in centralized remote operations, availability of real time data for better decisions and minimize the risk of emergency shutdowns due to failures and extend or eliminate scheduled service intervals.

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