System Design of Raspberry Pi for Radio Frequency Identification and GPS

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Abstract - A real time handheld system design: Raspberry Pi, is a credit card sized single board computer, which was introduced with the intention of promoting the teaching of basic computer science in schools. It is built using ARM11 processor. This project deals with Radio Frequency Identification card for an attendance recorder system for the purpose of maintaining attendance details of the employee and Global Positioning System for setting up a clock for raspberry pi without an internet connection. It incorporates protocol named Network protocol, which is a networking protocol for clock synchronization during the availability of internet. Raspberry pi uses Raspbian operating system with supporting tools python or PHP. Using an application included in Raspbian, users can browse through several categories and download what is necessary.

Key terms – ARM11 processor, Raspbian, Radio frequency Identification, GPS.

I. INTRODUCTION

Raspberry Pi is a credit card sized single board computer, designed with the intention of promoting the teaching of basic computer science in schools. It is built using ARM11 processor. This device does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage. It uses Linux operating system with supporting tools python or PHP. Using an application included in Raspbian, users can browse through several categories and download what they want. The Raspberry Pi has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor (The firmware includes a number of "Turbo" modes so that the user can attempt over clocking, up to 1 GHz, without affecting the warranty), Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and long-term storage. The Foundation's goal was to offer two versions, priced at US$25 and US$35. They started accepting orders for the higher priced model B and the lower cost model A.

The rest of the paper is organized as follows. Basic stratergies are explained in section II. Proposed concepts are explained in section III. Concluding remarks and future enhancement are given in section IV.

II. BASIC STRATERGIES

A. Components-
Figure 1 shows the components of raspberry pi

- SD card:
  Minimum size 4 GB; class 4, the class indicates how fast the card is. Branded SD cards are more reliable.
- HDMI to HDMI / DVI lead:
  HDMI to HDMI lead for HD TVs and monitors with HDMI input. HDMI to DVI lead for monitors with DVI input.
- RCA video lead:
  If the HDMI output is not used a standard RCA composite video lead to connect to analogue display.
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- Keyboard and mouse:
Any standard USB keyboard and mouse works with raspberry pi. Keyboards or mice that take a lot of power from
  the USB ports however may need a powered USB hub. This may include some wireless devices.

- Ethernet cable [optional]:
    Networking is optional, although it makes updating and getting new software for Raspberry Pi much easier.
- Power adapter:
    A good quality, micro USB power supply that can provide at least 700mA at 5V is essential. Many mobile phone chargers are suitable. If the supply provides less than 5V then Raspberry Pi may not work at all, or it may behave erratically. It does not matter if the supply is rated at more than 700mA.
- Audio lead [optional]:
    If HDMI is used then a digital audio is used. If analogue RCA connection is used then stereo audio is available from the 3.5mm jack next to the RCA connector.
- GPIO header:
    The Raspberry Pi serial port consists of two signals a transmit signal, TxD and a receive signal RxD, made available on the GPIO header.
- DSI Display connector:
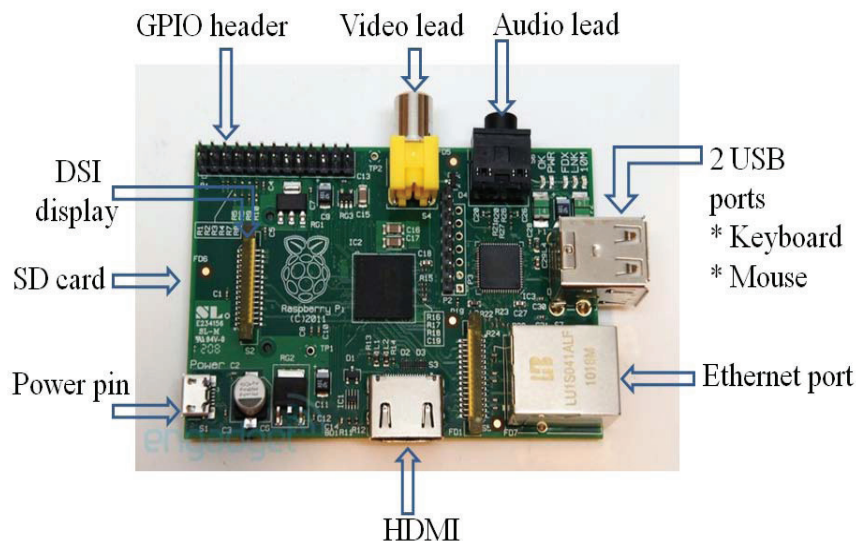   This is used to connect to TFT display, in case if the device is not connected to HDMI.

Figure 1 Parts of Raspberry pi

B. ARM11 Processor-
    Using a RISC-based approach to computer design, ARM processors require significantly fewer transistors than processors that would typically be found in a traditional computer. The benefits of this approach traits which are desirable for light, portable, battery-powered devices such as smart phones and tablet computers. The ARM architectures are reduced instruction set computer (RISC) in 2010 alone, instruction set architectures (ISA). According to ARM Holdings, producers of chips based on ARM architectures reported shipments of 6.1 billion ARM-based processors, representing 95% of smart phones, 35% of digital televisions and set-top boxes and 10% of mobile computers. The name was originally an acronym for Acorn RISC Machine and subsequently, after the name Acorn was dropped, Advanced RISC Machine. Micro architecture improvements in ARM11 core includes:

- SIMD instructions which can double MPEG-4 and audio digital signal processing algorithm speed
- Cache is physically addressed, solving many cache aliasing problems and reducing context switch overhead
- Unaligned and mixed-endian data access is supported
- Reduced heat production and lower overheating risk
- Redesigned pipeline, supporting faster clock speeds (target up to 1 GHz)
    - Longer: 8 (vs 5) stages
    - Out-of-order completion for some operations (e.g. stores)
    - Dynamic branch prediction/folding (like XScale)

- o Cache misses don't block execution of non-dependent instructions
  - o Load/store parallelism
  - o ALU parallelism
- 64-bit data paths

C. SD card set up-

The Raspberry Pi will not start without a properly formatted SD Card, containing the boot loader and a suitable operating system. Many problems with booting the Pi are a result of an improperly formatted or corrupted card. Make sure that the card is inserted before powering on the Pi and shutdown the Pi before unplugging the card. A distribution is to be chosen. The RPi boot loader is used to launch the distribution. Several SD Cards with a separate distribution on each can be used, then power off, swap cards and restart the Pi to use that card. Some Raspberry Pi kits will come with a ready-to-go card with the distribution pre-installed, or these can be bought separately. There is more on this below. If a pre-installed card is not available then a new card is to be prepared.

D. Installing operating system-

Steps to install rasbian operating system if as follows:

Step 1: Download the Raspberry Pi operating system

The recommended OS for raspberry pi is called Raspbian. The OS can be downloaded in the website of raspberry pi organization. It will be a zip file.

Step 2: Unzip the file that you just downloaded

Extract the files in zip file. Following the instruction, finally an .img file will be obtained. This .img file can only be written to the SD card by special disk imaging software.

Step 3: Download the Win32DiskImager software

Unzip it in the same way as the Raspbian .zip file. A new folder called win32diskimager-binary will be obtained. Now write the Raspbian image to your SD card.

Step 4: Writing Raspbian to the SD card

Plug the SD card into PC. In the folder obtained in step 3, run the file Win32DiskImager.exe (in Windows Vista, 7 and 8 - recommended that right-click that file and give run as administrator option. If the SD card (Device) isn't found automatically then click on the drop down box and select it. In the Image File box, choose the Raspbian .img file that has been downloaded. Click Write. After few minute the SD card is to be used in Raspberry Pi is ready.

Step 5: Booting your Raspberry Pi for the first time:

For the first boot the change settings of the device according to the need. Then Raspberry Pi will reboot and Raspberry pi login and password is to be typed.

        Login name   : pi

        Password   : raspberry

Then the prompt: pi@raspberry ~ $ will appear here type startx to start the desktop environment.

The raspberry pi window looks like in the figure 2. The right bottom indicates the pi usage reading, time acquired from NTP server. Left corner arrow symbol is the start button. The desktop contains certain icons like Debian references, Wi-Fi configuration, etc. The terminal here is called the LXTerminal since this operating system is much similar to Linux operating system.
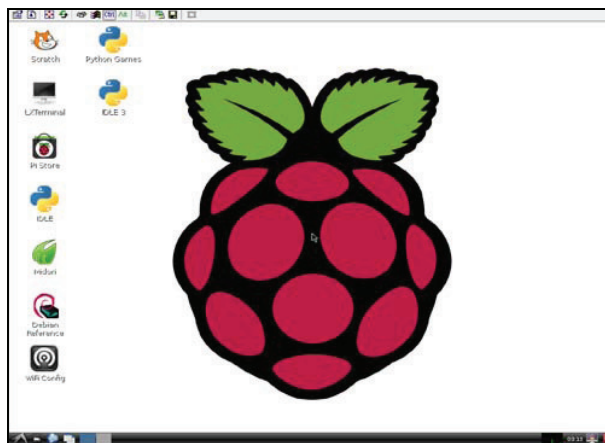

Figure 2 Raspberry pi desktop

E. Minicom-

Minicom is a text-based modem control and terminal emulation program for Unix-like operating systems, originally written by Miquel van Smoorenburg, and modelled after the popular MS-DOS program Telix. Minicom includes a dialling directory, ANSI and VT100 emulation, an (external) scripting language, and other features. Minicom is a menu-driven communications program. It also has an auto zmodem download. A common use for minicom is when setting up a remote serial console, perhaps as a last resort to access a computer if the LAN is down. This program is to run a linux terminal through which you can send and receive text and commands via the serial port.

In LXTerminal, type:

sudo apt-get install minicom

Once installed, know the port name of PC's serial port. On the Raspberry Pi this will be:

ls -l /dev/ttyAMA0

Run minicom with the following parameters: minicom -b 9600 -o -D /dev/ttyAMA0

In this case the port name is /dev/ttyAMA0. You can exit minicom with Control-A x , when you are finished.

F. Setting device port-

By default in Raspberry pi the USB port serial port will only be connected for the external USB connection. Minicom is a serial communication program to access a network or security device through its console port. This tool is similar to Hyper Terminal, which is by default available on a Microsoft Windows system.

We can now start Minicom:

minicom –s

```
        +-----[configuration]------+
        | Filenames and paths      |
        | File transfer protocols  |
        | Serial port setup        |
        | Modem and dialing        |
        | Screen and keyboard      |
        | Save setup as dfl        |
        | Save setup as..          |
        | Exit                     |
        | Exit from Minicom        |
        +--------------------------+
```

Figure 3 Minicom configuration

To leave Minicom: Ctlr A -> Z -> X.

The default config will be saved as /etc/minicom/minirc.dfl

The next time you want to use Minicom you just have to enter the following command:

To start Minicom with settings configured on a specific file:

minicom -b 9600 -o -D /dev/ttyUSB0

The serial port configuration window will appear

```
+-----------------------------------------------------+
| A -    Serial Device      : /dev/ttyUSB0            |
| B - Lockfile Location     : /var/lock               |
| C -   Callin Program      :                         |
| D -  Callout Program      :                         |
| E -    Bps/Par/Bits       : 115200 8N1              |
| F - Hardware Flow Control : Yes                     |
| G - Software Flow Control : No                      |
|                                                     |
|    Change which setting? █                          |
+-----------------------------------------------------+
        | Screen and keyboard      |
        | Save setup as dfl        |
        | Save setup as..          |
        | Exit                     |
        | Exit from Minicom        |
        +--------------------------+
```

Figure 4 Serial port setup

III. PROPOSED CONCEPTS

A. Radio Frequency Identification-

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. The tags contain electronically stored information. Some tags are powered by and read at short ranges (a few meters) via magnetic fields (electromagnetic induction).Others use a local power source such as a battery, or else have no

battery but collect energy from the interrogating EM field, and then act as a passive transponder to emit microwaves or UHF radio waves (i.e., electromagnetic radiation at high frequencies). Battery powered tags may operate at hundreds of meters. Unlike a bar code, the tag does not necessarily need to be within line of sight of the reader, and may be embedded in the tracked object.

RFID tags are used in many industries. An RFID tag attached to an automobile during production can be used to track its progress through the assembly line. Pharmaceuticals can be tracked through warehouses. Livestock and pets may have tags injected, allowing positive identification of the animal. On off-shore oil and gas platforms, RFID tags are worn by personnel as a safety measure, allowing them to be located 24 hours a day and to be quickly found in emergencies. Since RFID tags can be attached to clothing, possessions, or even implanted within people, the possibility of reading personally-linked information without consent has raised privacy concerns.

B. GPS to work on Raspberry Pi-

A task of Raspberry PI is to take over the duties of an existing ITX based Linux box running the weather stations. Raspberry PI has no onboard Real time clock – which means it needs to use an NTP server to get the time when it starts. Usually you would use the default settings and allow the PI to connect to the net for it is time. Now this is fine if you have a working net connection but what if you are not connected to the net? You might be in the field running the PI on batteries.

The solution here is to use GPS as a time source. GPS works by having a constellation of satellites in orbit and each one carries a highly accurate atomic clock & broadcast both their current position and the time. A GPS receiver then receives these signals and, as long as it has enough satellites and workout where you are by comparing the times from those clocks. So this paper also shows how to use a GPS receiver with the Raspberry PI

Figure 5 GPS receiver connected to USB

C. The GPS hardware-

A GPS receiver is a device that receives Global Positioning System (GPS) signals to determine the device's location on Earth. GPS devices provide latitude and longitude information, and some may also calculate altitude, although this is not considered sufficiently accurate or continuously available enough (due to the possibility of signal blockage and other factors) to rely on exclusively to pilot aircraft. GPS devices are used by the military, by aircraft pilots, by sailors, and for recreational purposes by the public.

Work done to use GPS device-

• First, the device was connected to the lower USB port, and then checked what was seen on the USB ports.

• The next steps are to install the gpsd (GPS driver) software, and start the gpsd service pointing to the device name just discovered. Gpsd starts automatically at boot time, and to tell the configuration tool what device to use.

• And now it is time to receive the signals to determine the device's location in the earth.

D. Viewing GPS under X-Windows-

GPS's work can be viewed from an SSH connection and also a graphical display can be used using the xgps client which must be installed. If a monitor is connected to the pi simply open a terminal and run xgps.

This will show a user friendly view of the satellites informations,this will be very usefull for users. The xgps shows the longitude, latitude, attitude, speed, climb, track, status, time.
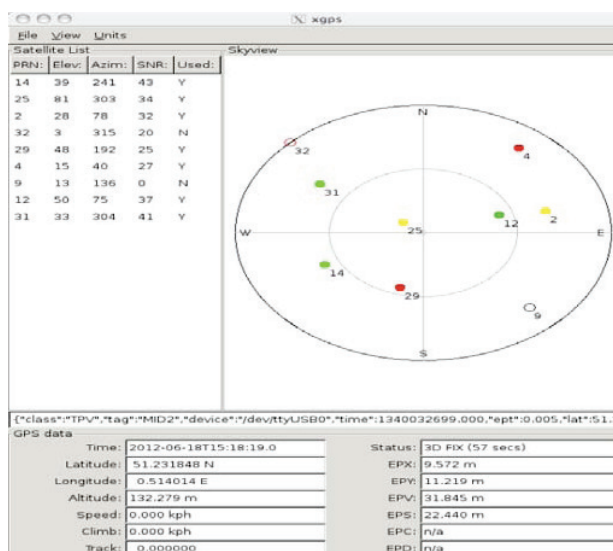
Figure 6 GPS output

IV. CONCLUSION

Raspberry Pi was introduced with the intention of promoting the teaching of basic computer science in schools. It is built using ARM11 processor with the application profile, real time profile and the multiprocessor profile. This project deals with Radio Frequency Identification card for an attendance recorder system for the purpose of maintaining attendance details of the employee like displaying the RFID card information on the web page after retrieving it from the database where it is stored. Global Positioning System for setting up a clock for raspberry pi without an internet connection. It incorporates protocol named Network protocol, which is a networking protocol for clock synchronization during the availability of internet. Installation of the Raspberry pi OS that is the Rasbian operating system with supporting tools python or PHP. The related information like the minicom, setting up the serial port for the RFID module reader, etc. were done.

Future Enhancement:

In future the work can be extended for the attendance recorder system by using biometric identification like fingerprints and face detection instead of using the radio frequency identification card.

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