Smart Notice Boards using IoT and Single Board Microcomputers

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Abstract

Most of the academic libraries in India have budget constraints due to which they lack IT infrastructure, and ultimately it becomes a hurdle in giving effective user services.The combination of limited funding and below-average technical knowledge of staff can be a devastating combination for any institution, but for someone who is not ready to compromise with limitations and happy in experimenting and exploring new possibilities, thereis no big worry. With right information at right time, everything can be achieved. Technology is such a savior for humanity and keeps on changing-. Raspberry Pi is one such constructive innovation which has transformed the landscape for programmers to gadget lovers. Because it is so powerful, flexible and adaptable, it became very popular worldwide.Librarians around the globe have also greeted this new tech tool enthusiastically, and are experimenting in different projects. With the emergence of ICT, libraries in future will be more content rich, more user-friendly, more interactive and digital in all aspects, but only having number of servers or collection of E-Books servers doesn't make digitally future pro of unless a fully paperless and eco-friendly workspace is developed. This articleis aimed at library professionals who are new to Raspberry Pi and it attempts to elaborate the use of this miniature marvel in institutional and public libraries using a case study at IIAS Library.

Keywords: Raspberry Pi, Internet of Things(IoT), Linux, Digital Signage, Kiosk, Library OPAC, Microcomputer, Open Source

1. Introduction

Internet which is a giant leap in changing our world, from communication, media to medical and data banks. The next big thing was robotics and artificial intelligence which ultimately turn out to be the origin of 'Internet of Things' ('IoT'). The emergence of IoT home and workplace automation became much easier and cost effective. During the 1970's Theodore G. Paraskevakos theorized and patented the idea of a device which combined both telephony and computing capabilities. A smart device, which has its own processing unit and can compute complex instructions, is assigned a unique IP address just like the computer and this makes it easily identifiable over the internet with a unique ID. Many of devices (e.g. health monitoring, weather monitoring etc, sensors for various operations) do not require full computing power, hence low-cost computing platforms which consume less power can be used to perform a specific function. The IoT is expected to offer a platform to automate and connect every smart device with exceptional connectivity. This research is experimented at IIAS Library, Shimla and tested thoroughly.

1.1   About IIAS Library

Indian Institute of Advanced Study, Shimla formally known as Rashtrapati Niwas and prior to that as Viceregal Lodge, is one of the prominent research organization in India. Institutes library has an amusing collection of resources and other documents, where the prime collection is of Humanities and Social Sciences. The collection of 2 lakh documents comprises of books, manuscripts, Audio/Visual CDs, DVDs, Microfilms and other resources in the area of History, Religion, Philosophy, Socio-linguistics, Psycho-linguistics, Social and Cultural Anthropology etc. The library is completely computerized and makes full use of its ICT infrastructure to all extent.

2.   The inception of the Idea

IIAS, which is also a major tourist attraction in Shimla, tourists and nature lovers from all over the globe visit the premises to help educating the tourists briefly about the building, it was decided to install a display screen showing the dynamic contents of information about the building, its history,and interiors. After exploring all the available options for this task, Raspberry Pi was found as the most suitable and cost-effective solution. At the preliminary stage, the Pi board was configured to run on Raspbian OS with Chromium browser on full-screen mode, a static HTML page was programmed to run on start-up, which shows the photo gallery with captions, information about ticket prices and tour timings. A news ticker is also there which flashes the news about the institute's events. All of these functionalitiesare configured and stored on the Raspberry Pi and works as a standalone system over the network, however it can be customized as per requirement.

Later on, when the library decided to revamp the circulation area to make it more attractive and informative, it was decided to remove the old notice board and replace with similar kind of digital display screen system with more dynamic contents. Unlike the digital display at the ticket counter, this was planned to have direct access to the Library database server, to cast latest arrivals and upcoming news and circulars about the library. It's worth mentioning here that Scientists from Software R and D division of INFLIBNET Centre were consistent source of support during the entire assignment and wrote an ASPX code exclusively for the SOUL WebOPAC at IIAS library to display newly arrived books in a scrolling manner.

2.1   What is Raspberry Pi?

The UK based non-profit Raspberry Pi Foundation which was formed in 2008, the organization intended to tech computer coding and basic programming to relatively young students through tiny and low-cost microcomputers. From the day it was launched, it won million hearts, from hobbyists, engineers to astronauts.

Raspberry Pi is atiny Microcomputer about the size of a credit card, it's a single board device with its prime USP of being ultra-portable, super small, extremely extensible, and highly power efficient.It consists of a CPU, a GPU, a RAM, 4 USB and 1 Ethernet port, onboard Bluetooth and WLAN chips with HDMI Display port and 40 General Purpose Input Output pins for further extensibility and all of this on a compact 3 1/2 inches wide, 2 1/4 inches long PCB board, which weighs only 50 Grams. Its power consumption is so low that it runs only on 2A & 5 Volts DC power supply which is the same as smartphone charger. Back in the old days, Computer

Companies were named after fruits, like Apple, Acron, Apricot Computers, and most of them still retain this tradition. Mr. Ebon Upton, the brain behind this innovation thought of naming it as "Raspberry" paying homage to these IT legends, and "Pi" comes from "Python", the programming language on which this tiny computer intended to work in its early stage. At first glance, it doesn't look pretty impressive but it has become the favorite thing for students, programmers and DIY educators because of its low cost, simplicity, efficiency, functionality, and extensibility. Raspberry Pi 3 Model B+ which is the latest model of the device has a configuration,which can do pretty much everything that a normal desktop or laptop computer. However, like any other computer it does require a display screen, input devices like Keyboard/Mouse and other peripheral device intended to connect to it.

2.2 How to get it working?

The Raspberry Pi has no On/Off switch, so its ready to go once all the peripherals(SD Card, Display, USB Keyboard and Mouse) are plugged in and powered up with the 5V USB power supply. A complete Raspberry Pi starter kit comes with a micro SD card pre-installed with an operating system NOOBS, which they also call "New Out of Box Software"but an operating system can also be installed from the scratch onto any Raspberry Pi. In its literal sense, NOOBS also mean 'a person who is new or inexperienced in the sphere of Computes and IT'.It is more of an easy network installer, when boots up, gives a number of options of popular and Pi-compatible operating systems including Arch Linux, OpenElec,and Raspbian which can be install with just one click. It requires to have an internet access to download desired operating system to SD card from repository. A general recommendation for

MicroSD card is to prefer using a Class 10 card (preferably 16 GB), as these cards give maximum data read/write speed. A keyboard and/or mouse, SD card reader, as well as an HDMI display, will be required to install and configure the OS.

Rudimentary way to install Raspbian OS is to download the official image of Raspbian OS from https://raspberrypi.org/downloads/ and write this .iso image on to the memory card with help of image writer software e.g., Win32 Disk Imager for Windows and Etcher for Linux and Mac. NOOB Sis best for beginners, which gives a guided walkthrough of not only Raspbian but other compatible operating systems as well. This method of extracting files the Raspbian Jessie directly onto the MicroSD card, is for more advanced users. This tool also comes handy with pre-installed Raspbian OS on the card and can create a backup copy of it, just to tackle data loss and other future events of software or hardware failures. In the first boot after flashing the SD card the Raspberry Pi shows a rainbow of colors briefly on the screen followed by boot sequence.Desktop environment of Raspbian is similar to most of Linux flavor available.

It comes with many pre-installed essential and educational tools pre-installed, but since it is a Debian based operating system any desired software package can be installed from its aptitude software repository. By default, the username and password of the Raspberry Pi are set to:

Login as: pi
password: raspberry

Physical or direct access to the Pi board is available. It can be operated by attaching keyboard, mouse and monitor, and changes to its configuration can be through CLI. In case physical access to Pi is not

possible, an SSH connection can be made by using a third-party software "Putty" on any computer. In this scenario, both raspberry pi and the remote computer must be on the same network, and Raspberry Pi must be reachable through IPv4.

2.3 Initial Configuration

No operating system or hardware will fit everybody's need out of the box, and same is true for Raspbian, since it is installed by flashing the image to the SD card, it doesn't let us chose all the configuration parameters at the time of installation. Hence, before going for anything else, it is advised to tweak its initial configuration, there is a simple and user-friendly tool built into the system which is "raspi-config" it actually is a command which when issued will show an instruction set. It has all the essential settings and options to be configured after the first boot, which are self-explanatory, and all of these can be found in one place, but there is a Geeky way to do everything, there are commands and sytexst exclusively for each task. This configuration UI can be accessed by issuing the following command in a terminal window.

$ sudoraspi-config

Since Raspberry Pi has WLAN and Ethernet capabilities, any of it can be used to provide network access. Since the Raspberry Pi will work standalone without any input activity, as per its default settings it may tend to go to sleep mode to reduce power consumption, but because in case of a kiosk or smart screen notice board,it needs to talk to the server and display the data all the time, it is required to disable its power saver mode by entering the following command into the terminal window.

$ sudoiw wlan0 set power_save off

Now with a graphic interface, it is easy to connect to the Wi-Fi network or assign static IP's but in the same can be done using a command line interface as well by editing appropriate configuration file.

The IP address assigned to the Pi board can be found using a $ifconfig command in the terminal, and later can be used to make SSH connection for its remote control.

When connected to a 1080p TV screen its noticed that after the default installation the Pi doesn't show the desktop on the entire screen area, there is some margin area on the display screen with raspberry pi doesn't use. This is because Raspberry Pi detected the screen size and its resolution and attempts to display the contents on in best possible and failsafe resolution, to have a full-screen display disable the 'overscan' feature of the Pi edit the boot configuration file of Pi using following command

$ sudonano /boot/config.txt

And uncommenting the following line does the job.

disable_overscan=1

After this raspberry pi will have the entire screen area utilized. The essential settings of the Pi board are done, and all the contents are nicely displayed on the screen, now is time to work on actual task, to have the SOUL WebOPAC contents full screen display. Idea is to instruct Raspberry pi auto start chromium browser in full screen mode, and then open a particular web address (URL of the WebOPAC). This is done by copying the theauto start file from

/etc/xdg/lxsession/LXDE-pi/autostart

To
/home/pi/.config/lxsession/LXDE-pi/autostart

Following code or instructions when added to the autostart file configures the everything required for a kiosk display

@lxpanel —profile LXDE-pi

@pcmanfm —desktop —profile LXDE-pi

@xscreensaver -no-splash //To disable splash logo on start-up

@point-rpi

@xset s noblank //to disable sleep mode

@xset s off   //to disable sleep mode

@xset -dpms //to disable sleep mode

@chromium-browser —kiosk —incognito — disable-restore-session-state http:// opac.iias.ac.in/recent_titles.aspx

Above instruction set tells the Pi to load LXDE-pi profile at the time of start-up, and don't show any splash screen boot logo, then it instructs Pi to not to go on sleep mode so that the network connection and display screen remains ON all the time, and finally it tells Pi to start chromium browser in kiosk mode and open our custom designed OPAC webpage, which displays the newly arrived books of the library and other important News and Notices.

2.4　Pi in Action

Raspberry Pi powered Digital display is connected to the SOUL 2.0 server through a wireless connection, the Pi board itself takes power from USB port available on TV's back panel, which serves it with sufficient 2A 5V DC power. The Raspberry Pi send its video signals to 32" Samsung TV screen via HDMI cable. This makes it a neat looking setup with using minimum cable connections coming outside. This is installed keeping in view of future necessities, it can be easily changed into an OPAC

browsing machine by simply attaching a Keyboard and Mouse, without messing up with the existing software or hardware setup.

Figure 1: Digital display board at IIAS Library Entrance & Circulation area

2.5　Why are we doing this?

Digital Display boards running on Raspberry Pi came up as improvised communication means through dynamically rich contents, also takes one step towards making it to the Green Library. Because this low-cost computer is not so power hungry, it's effective impact on resource utilization and carbon footprints are much less than its contemporary equivalents. It is cost effective also, it does that by reducing paper and printer use. These paperless display boards are not only cluttered free space but are dynamic, flexible and secure. The digital display will always be rich in contents than the paper posters and printed notices, and is also customizable, locally or remotely. Considering this, even if Raspberry Pi doesn't eliminate the possibility of looming environmental disasters, or it doesn't work with all in one approach for all our digital library needs, but still, this 35 USD microcomputer is worth giving a try.

2.6 Other Applications of Pi

Though Raspberry Pi is more popular among DIY enthusiasts, who experiment with this tiny hardware in numerous ways ranging from, Robots, Drones and to home automation systems. But there are N number of ways this sweet cake can be molded to match specific requirement. Here are few more ideas, some of them are already being tested and employed by other Pi geeks.

❖ **Pi Scan**: A Raspberry Pi controlled over head book scanner using medium quality photo cameras.

❖ **NFC/RFID Reader**: A Raspberry Pi controlled RFID tag reader/scanner.

❖ **Automated Circulation Counter**: A Raspberry Pi based auto check-in and check-out point, or in another scenario can also be used manually by a human operator at the circulation counter.

❖ **Kiosk terminal**: A Raspberry Pi-powered Library OPAC, using touch screen or keyboard operated Kiosk terminal.

❖ **An audio Book Reader**: A Raspberry Pi based book reader with reading aloud PDF and EPUB texts using Google's Text to Speech capabilities.

❖ **Book Recommendation Device**: A smart book recommendation device that asks the user about their interests, and provides information or recommendation of available books matching with their interests.

❖ **Humidity and temperature sensor for Archives**: A Raspberry Pi based atmosphere controller and monitor, which keeps a log of humidity and temperature using special sensors.

❖ **Wireless Print Server:** An old and obsolete desktop printer can get a new life when connected to Raspberry Pi working as a print server.

❖ **Media Streaming Server:** Though will not encode video streams as effectively as a high-end workstation does, but with XBMC based Media streaming software like OpenElec and PLEX can turn it into an ultimate Audio and Video streaming box.

❖ **Learn Computer Programming:** As it was originally intended to, it is preloaded with all sorts of command line and IDE based program creation tools for Python, Java, PHP and what not.

3. Conclusion

IoT is the most promising development in the field of Information Technology, and represents a huge opportunity to improve people's lives and experience. Raspberry Pi is one of its energetic companions. Though being a microcomputer, it cannot substitute desktop computers being using it for routine office jobs. But it is ideal for applications where the devices are expected to do only one kind of task and do not need a full computing power of a typical computer. Hence, low-cost computing platforms could be used which specialize in doing only one task and also consume less power. Use of such computing platforms will also help reduce carbon footprints on the environment and save energy. Novices, in particular, may not use this microcomputer to whip up crazy creations, but there are endless practical uses of this bare-bone DIY Kit.

Further Reading

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