Incorporation of IoT in Information Systems for Digital Notice Boards

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ABSTRACT
In a rapidly evolving world, the convergence of different technologies has led to numerous path-breaking innovations. One such innovation is presented in this paper, which incorporates Internet of Things (IoT) on standard computer monitors, giving rise to Digital Notice Boards. Having migrated from manual recordkeeping of student and teachers' data to modern computerized methods, schools and colleges on the other hand, still continue to use traditional paper pinned notice boards. It is proposed to deploy a PIR (Passive InfraRed) sensor connected to an IoT Device, on a standard computer monitor to give rise to digital notice boards. The necessary GUI (Graphical User Interface) to post information remotely shall be web based, as the IoT device shall be connected to the institution's intranet network. The IoT Device opted for use is a Raspberry Pi Microcomputer, which is a credit-card sized single board device powered by 5V, capable of connecting to a network, a display, and the added functionality of USB for future enhancements. On the whole, this Raspberry Pi based digital notice board shall serve as a smart solution for information propagation.

General Terms
Internet of Things, Raspberry Pi, Digitization.

Keywords
Digital Notice Board, IoT, PIR Sensor, GUI.

1. INTRODUCTION
Notice boards are relied upon for the mass broadcasting of information, especially at places where timely communication of circulars, events and schedules occur on a regular basis. Traditional paper-pinned notice boards played a key role in the dissemination of such information, but at the cost of felling trees and manpower for an important, albeit temporary purpose [1]. Such conventional notice boards overlook a scope of digitization by using a smart, connected and eco-friendly approach using IoT [2] based digital displays, in place of large wooden boards. This effectively directs to a huge saving on human efforts and countless paper. The vast amount of information required to be posted regularly from time to time involves endless printing and pinning, and once the purpose is done, all of that paper goes waste. Although a working system being in use for ages, the maintenance of these notice boards is a herculean task, especially when they are located at different buildings, separated by far distances. Instead of being managed and controlled by one centralized system, this tedious process is delegated to staff and might further be passed on to assistants, becoming prone to mistakes and loss of information. It is learnt from an experimental study conducted at an educational institution, that a lot of information is still passed on by paper notices, P.A. systems and circulars to be read out. Notwithstanding publicity, these methods are highly prone to omission by the recipients (students) leading to communication gap. Occurring at institutions where timely propagation of information is essential, this should be curbed.

Such shortcomings to name a few that are faced by the conventional notice boards, are resolved to the best possible extent, in this paper. It is developed keeping in mind a simple architecture that shall use a web based, authentication enforced GUI for the publication of information. Intranet local area networks being available in every block of schools and colleges today, the deployment of these connected digital notice boards become easy, bringing in new formats of multimedia rich content, to places where there was once nothing a blank wall. It is proposed to build the hardware part of the digital notice board using a Raspberry Pi which is an IoT microcomputer device, which is planned be connected to the intranet server of the campus. Using the IoT device's GPIO (General Purpose Input/Output) pins, a PIR Sensor is proposed to be connected for turning the monitor on and off, automatically, with respect to the presence of a person in front of the system. The capabilities of a Raspberry Pi are almost as much as any desktop computer, and can even extend beyond the system proposed on this paper. To manage information on the digital notice board, the software part, is preferred to be web-based. This web based graphical user interface is designed with HTML, CSS and JavaScript. It is deployed behind a PHP based authentication control for proper administration and to prevent misuse of the system. For the posting of content, as images, Flash and AJAX are used, altogether constituting the software part of the digital notice board. Between these two parts shall lie the PIR sensor connected to the Raspberry Pi, controlled by a Python code which triggers the HDMI display port to ON state when a movement is sensed in front of the sensor, and remaining in STANDBY/SLEEP at other times. This is an indispensable part of the proposed system, as a "smart" solution is complete, only when it is eco-friendly to the best possible extent.

Intending to be a step towards the digital revolution that educational institutions are actively becoming a part of, this digital notice board project shall serve a long way and soon establish itself as a standard for information circulation. Opening up an arena of possibilities using additional sensors, this digital notice board is bound to upgrade the information and communication technologies (ICT) already existing at

educational institutions [3][4] leap a big step further towards fully "smart" campuses. Additionally, with the Government of India promoting digital initiatives under the "Digital India" banner [5], the proposed system shall be identified as a need-of-the-hour, with the new scope of making information systems fully digital, and more eco-friendly.

2. SYSTEM DESCRIPTION

The goal of this system is to develop a digital notice board out of any computer monitor [6], using a Raspberry Pi, to be able to display information uploaded to it from a web-based interface hosted on the intranet network. The Raspberry Pi, as indicated on the block diagram, depends on the PIR sensor's triggers to toggle the display ON and OFF using a Python based script.

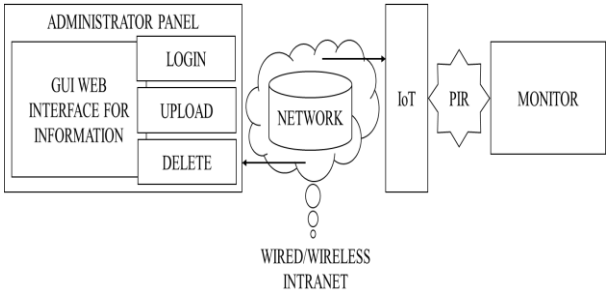

Fig 1. Descriptive Block Diagram of the Proposed System illustrating the Software Implementation (leftmost) and the Hardware Implementation (rightmost) parts, linked by the network (wired/wireless as required).

Information to be displayed on this system is required to be in the form of images, that are uploaded through a simple web-based interface serving as the feed for the display, remaining synchronized on both ends. The administrator is responsible for the posting of correct information through the GUI. For posting, the appropriate menu option (target audience) should be chosen, followed by the authorization using username and password. This information is received on the dynamic page, that each Raspberry Pi is programmed with (using a static URL) and is displayed on the monitor which is turned on based on the state of the PIR sensor. Certain static elements such as logos and frames are designed to remain on the screen. Cross posting policies and hierarchical levels of administrators are described as follows:

- Notice boards exist at different locations (departments) across the campus, and are grouped according to the department they are at
- Every department contains a level of administration, that is imposed over only its group of notice boards.
- There is a higher level of administration, the University level, from where information can be broadcast to all the notice boards, but on an a-la-carte mechanism.
- Information posting from one department to another is not allowed directly, and should thus be sent to the approval of the University level administrator, who can post to the required intra department, having the privilege to do so, as already described.

3. IMPLEMENTATION

This section describes the working of the system on an overall basis and further with specific focus on the hardware and the software part of the digital notice board. An algorithm that elucidates the flow of processes is also included in the overall working implementation, preceded by a design rationale of the entire system.

3.1 Design Rationale

The following criteria are set out to be enforced following the analysis done on existing models, and the goal of the architecture of the proposed system is to meet these essential rationales:

- Faster updating of information: The proposed system runs on top of the intranet network of the institution, and is expected to operate at high speed facing no intentional delays
- Lesser use of manpower: The efforts of staff required to print, pin and later remove the notices by instructed manual work is expected to be completely minimized.
- Accessibility: The information being posted over the intranet, should be facilitated through an easy-to-use GUI, that should assist the administrator in the uploading of images and wherever else required.
- Overall eco-friendliness: The system should remain on a low power standby mode when there is no user in front of the monitor. However, information sync and updating can occur in the background during such standby times.
- Compacting the system: The heart of the system being a Raspberry Pi IoT Device, the system should continue to remain minimal in hardware, and the single board computer should be effectively used without additional hardware.
- Continuous scope of improvement: With the entire system operating over technology inclined to development and innovation, the system should be able to incorporate updates whenever available.

3.2 Working Algorithm

The following subsection is a step-by-step procedure to enhance clarity of the implementation and explain the working of the system in a sequential order:

Step 1) Start

Step 2) Check for the toggle state of the PIR sensor, to power up the monitor

Step 3) Login to access the administrator panel

Step 4) Check the database for the credentials

a. If the user exists, but password is wrong, return "Invalid Password", go to step 1.

b. If the user does not exist, return "User not found", go to step 1.

c. If the user exists and the password matches in the database, proceed to step 4.

Step 5) Display the access level and respective target department on the administrator panel

Step 6) Display the file uploader and upload queue with progress indication

Step 7) Upload the image files required with multi-file support

a. If the uploaded image is of appropriate file size, dimensions and resolution, proceed to step 7.

b. Else return the respective error message and go to step 5.

Step 8) Store the uploaded files in the working directory with necessary access privileges

Step 9) Focus on the preview option in the administrator panel to display the newly uploaded files

Step 10) Display the uploaded notice images on a Last in First out (LIFO) order

Step 11) Check for new uploads using the background script on the page

a. If a new information is to be posted, return to step 5 by clicking the upload button

b. If an information is to be deleted, perform delete operation on the latest file by clicking the delete button

c. Refresh the page using the background script

Step 12) Continue to perform the above steps irrespective of the toggle state of the PIR sensor

Step 13) Stop.

3.3 Hardware Implementation

In this section, the assembling of the hardware components is described keeping the Raspberry Pi as the heart of the system, and the interfacing of a monitor, and the PIR sensor to the appropriate ports as shown in Fig 2. The PIR sensor is coded to interface with the Raspberry Pi's 40pin GPIO, and appropriately toggles the power state of the video output (HDMI) with respect to the presence of a person in front of it. With the overall system powered at different voltages as needed for the

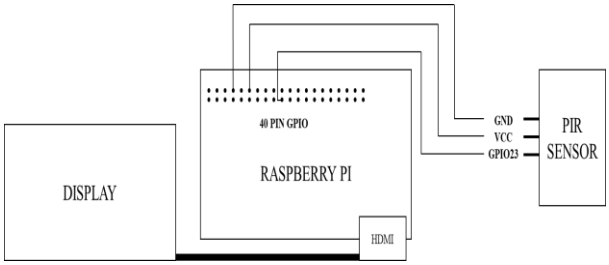

Fig. 2. Interfacing of the PIR Sensor to the IoT Device using the appropriate GPIO pins (selecting pin 11).

Raspberry Pi IoT Device requiring 5V (a supply rated 2A is recommended), the monitor variably requiring 110-240v (certain 'energy efficient' monitors work on power adopters and require only 12V) and the PIR Sensor, drawing around 3.3V from the Raspberry Pi, the system is powered up using proper switched power supplies providing the correct rated current for each device. The network connection to the system is provided via LAN cabling, directly to the RJ45 port on the Raspberry Pi as depicted in Fig. 3. Static / Dynamic IP configurations are taken care according to the network infrastructure. It is under consideration to work with a preloaded GUI based operating system [7] and wireless technologies [8], such as wireless fidelity (Wi-Fi) in the future, to further increase portability of the system, reducing cabling and certain other constraints, at an overall higher cost of the system. The notice board is connected to the intranet network, and is identifiable using its MAC address which is unique for each device on every notice board, regardless of a static or a dynamic IP configuration.

The Raspberry Pi is programmed in such a way that a preconfigured URL is initialized to be opened during bootup time. Realizing the graphical capabilities of the web browser installed, the boot up web page hosted on the intranet is designed with graphics, on an organized layout. The administrator panel is not accessible from the notice board as there are no input devices connected to the IoT device. Only at times of upgradation or other maintenance, a USB keyboard may be connected.

3.4 Software Implementation

The digital notice board is fully backed by a web application, which is hosted on the intranet network that the Raspberry Pi of each notice board is connected to. This forms a GUI on the administrator side as the admin panel, and a dynamic interface on the notice board side to display the content. Together, both these are seamlessly deployed on the network, being:

- Intuitive and easy to configure in real-time over the network
- Fast to use and lightweight, occupying practically no space on each IoT device
- Responsive and functioning regardless of the availability of the intranet link, without connectivity, the webpage and elements loaded shall remain to run from cache, and once network is restored, the contents are synced and refreshed again
- Addresses to the complexity of information being posted by having a standard image uploader, and continuous, seamless broadcast of information

The web-based graphical user interface for the notice board and the administrator panel is designed with HTML, CSS and JavaScript. Before accessing the admin panel, it is necessary to pass through a PHP based authentication control enforced for proper administration and to prevent misuse of the system. Once logged in, for the posting of content in the form of images, a standard Flash based file uploader running on PHP file uploading framework is embedded on the page. To pass the image as a parameter to the notice board page, a combination of JavaScript and AJAX are used, altogether constituting the working software part of the digital notice board. All of the said designs are ensured to remain responsive and lightweight, while containing the necessary static and dynamic information to make the interface appear presentable. With the inclusion of frames and frameset support, it becomes possible to retain certain elements on the screen, while the notices published remain synced and changing without altering the standard information, such as the name of the institution, date/time, notice board serial etc.

4. CONCLUSION

The primary goal of this project is to take a step towards a truly paperless community, using green technology. Educational institutions are rapidly advancing towards techno schools and fully digital campuses, for them, the digitizing of conventional paper-pinned notice boards with efficient, digital notice boards is a need of the hour. Proposed to be built on an

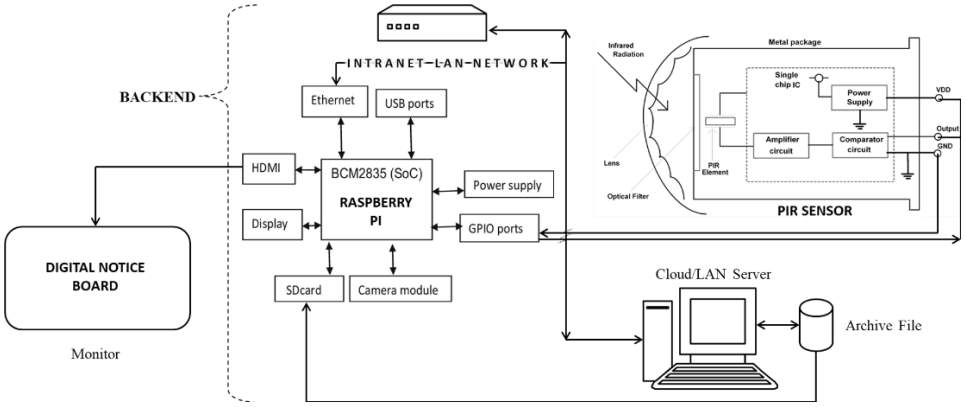

Fig 3: An overall architecture diagram, representing the entire Backend of the system, containing the IoT Device, the PIR Sensor and the Administrator Panel in a computer on the intranet network. The monitor (digital notice board) is the frontend.

intranet network [9], the system ensures synced real-time delivery of information to the desired audience, in just a few clicks. Utilizing the Raspberry Pi IoT microcomputer [10] device to the fullest, with attractive and relevant graphics, the digital notice boards are sure to attract audiences wider than expected, thereby disseminating essential information to a greater number of people. With user friendliness on both the notice board side and the admin panel, this project shall make its way easily into its target environments. This paper presents a clear view of the overall system from the implementation aspect to the technical nitty gritty details of the system. The system being under feasibility study at SCSVMV University, once implemented and following a successful run, it shall certainly be ready in the most sought-after plug and play model at other institutions, scaled to the requirements.

5. FUTURE SCOPE

Every project has its own limitations in deployment. Although this system onsets to eliminate numerous drawbacks of the current system, and migrates a fully manual system to the best possible digital extent, the proposed approach still has an underlying scope to be improved.

Since the current deployment requires active fetching and updating of the content to be displayed, similar to that of an RSS Feed mechanism, it can be done over Wi-Fi instead of the wired LAN method. This is easier to implement at institutions which have their own Wi-Fi network spread across the entire campus, than running ethernet cabling to each digital notice board.

The idea of a smart campus and the digitization of ICT in universities is a voluminous arena of innovation, and this project shall be a drop from the said ocean. Efficiency, eco friendliness and smartness describe this project in short, the intention to take institutions a step closer towards fully techno campuses, expanding their facilities and services better, shall be a more elaborate definition.

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