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IoT system of news by image for internal enterprise communication

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Abstract. This work aims mainly to facilitate the dissemination and standardization of messages and news in an educational institution. Thus, this article describes the development of a Linux embedded system based on Raspberry Pi (RPi) for application in information technology and digital communication. The proposed product generates images with news using the principles of Internet of Things (IoT). Concepts of project-based learning (PBL) were implemented to create the real-time news product called EICS (electronic communication system), which displays short news on monitors distributed internally in a public educational institution. EICS has a friendly interface and the selected news are those with relevance to the internal community, such as important date reminders and event tips. Each monitor has a HDMI connection with the RPi. RPi is responsible for displaying the news and checking for new online uploaded news. This is possible because each RPi is connected via WiFi and constantly communicates with a server where the news is stored. EICS IoT news can also be accessed through any computer device with Internet connection such as laptops and smartphones using the link to the web page. EICS has the potential to be installed in any place that has a constant flow of people, and can be used internally in companies, malls or hospitals.

Keywords: IoT, Linux embedded system, Raspberry Pi, Real-time news.

1 Introduction

The Internet of Things (IoT) enables the development of systems that allow us to control the environment around us in an allows automatic way (ALJAWARNEH et al., 2017). Nowadays we can connect multiple networked devices and exchange control messages, making our daily routines faster, more efficient and generating a wealth of information about our home and work environment (PATCHAVA; KANDALA; BABU, 2015).

Society is constantly changing allongside evolution of technology. Thus, this reaches also the academic sector. Schools and universities already have technologies such as TV, video, DVD, projector, multimedia projector and internet connected labs (CANTINI et al., 2006).

In this article, it is proposed the development of an online real-time news system, which aims to facilitate the dissemination and standardization of messages in an academic community, based on IoT using Raspberry Pi (RPi). The RPi is a full-featured low-cost computer, it is used docked on monitors via an HDMI cable connection. RPi is configured to open a web page using WiFi every time it is automatically started, on this page cyclical images are displayed in the jpg (Joint Photographics Experts Group) format containing information that was previously disseminated through paperwork, which required effort to spend it with paper, as well as

spending it on printer ink and labor to exchange these news manually in tables where they were fixed. For this purpose, a web system called EICS (Electronic Internal Communication System) has been created, which aims to be a tool to enabling those responsible for the communication sector to manage in real time the images displayed on each monitor where the environment necessary for the operation of the EICS is set. EICS was deployed at the IFCE Campus Maracanaú where the monographs were spread by the institution at strategic locations where students could view the messages passed by the communication department. The system as it will be seen later is able to generate the images automatically and following a pattern that has been carefully thought to have a visual identity with each department of the institution, as well as following techniques of spacing among digital sources that aims to make the reading time of the most comfortable news, since each news has a display period and should be enough for the message to be passed efficiently.

This work has as its development principle the project-based learning method (PBL) that allows us to identify real-world problems and transform ideas into products that will meet the needs of the community which are part of it.

2 Related Work

In this section, related work are presented that aiming to disseminate information to a particular group of individuals using the technology to improve the way they distribute news, as well as reduce material costs.

The Multi Electronic Notice Board (SIMHA et al., 2016), uses an alphanumeric LCD to display text messages. The circuit contains a control center with a GSM module, which is used to receive news as SMS. This control center is used to manage all the LCDs that received the texts. Communication between the control center and the display centers is achieved using a wired serial communication protocol, while news can be sent from anywhere in the world. The use of GSM is advantageous, since the sending point need not be linked to a fixed location, substantially increasing the reach of the communication. The introduction of a GSM module in this system makes the message displayed dynamic, that is, the news that is being displayed on the card changes as and when the messages are sent. However, the LCD is limited to displaying text only, although you can vary the size of the LCD it will always display the same format of alphanumeric content.

Another project the authors proposed a system using Bluetooth or WiFi wireless serial communication in message display in a remote digital notification frame (KHERA; SHUKLA; AWASTHI, 2016). The Android-based application programs available for Bluetooth and WiFi communication for personal digital assistant (PDA) devices are used to transmit alpha-numeric text messages. Hence, a low-cost microcontroller board (Arduino Uno) is programmed to receive alphanumeric text messages in any of the selected communication modes. The Arduino Uno microcontroller board is programmed to receive the remote user's message in Bluetooth wireless technology and WiFi. Like the Multi Electronic Notice Board, the proposed system is limited to displaying alphanumeric content as well.

The EICS, presented in this article, improves the systems presented in this section by not limiting to an alphanumeric LCD to display the news, since the EICS uses any monitor with HDMI input, such as computer monitors, TVs, etc. By using the graphical mode of RPi the system uses a web browser to display, so you can use all the features and formats accepted in a browser like jpg, png, gif, mp4, etc. In the case the jpg format was chosen to display fullscreen images on the monitors. As EICS uses a browser to display the news images makes it possible that even in case of disconnection, news will continue to be displayed because jpg images are in the browser cache.

3 Methodology

This topic describes the components and tools used to perform this project.

3.1 Apache

Apache was chosen for being consistent, enabling a large number of tools and for compatibility with the operating system of RPi. The choice for EICS to be a web system occurred because it made the updating of the news more dynamic and in a way that occurs in all the embedded systems used in the monitors simultaneously.

3.2 Raspberry Pi

RPi (Figure 1), considered the smallest computer in the world, is the size of a credit card, USB connections to connect the keyboard and mouse used in desktop computers. You can connect it to TVs with RCA or HDMI output, as well as having a low hardware cost and zero

cost in your embedded system software. All hardware is integrated into a single board. They have the ability to develop everything a conventional computer does, such as browsing, creating spreadsheets, playing videos, processing texts, games, among other more complex tasks, such as online monitoring. That way, it is used by children around the world to learn how computers work, how to manipulate the electronic world around them, and how to program them.

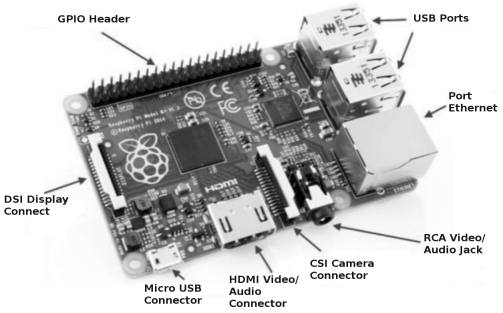

Figure 1: Raspberry Pi (RICHARDSON; WALLACE, 2013).

3.3 PHP programming language

PHP is used in most of the sites seen on the web. It has a large structure and tools to make the programmer's life easier. Its integration with HTML and JavaScript was one of the reasons for choosing PHP to be the language that EICS would develop.

3.4 HTML/CSS/JavaScript

The combination of these three languages made it possible to create the site, which is responsible for the part of the front-end of the system. A user-friendly interface has been created to allow users with no technical knowledge of computers or programming to manage EICS easily and quickly. Creating a news message is also user-friendly. That way, any registered employee can send IoT news, he will only fill out a form created in the HTML language, soon after the image will be generated already in the standard format.

Using the principles of PBL (NOBRE et al., 2006), we analyzed the academic environment in search of problems where the use of technology could become present. We observed how advertisements were made internally within the academic community, what methods and resources were used. In the higher education institution used in the research, it reflected what is possible to see in many educational institutions, the use of flannelgraphs scattered around the institution, where the notices are fixed by the communication sector, which is responsible for the distribution of notices in each flannelgraph, which causes excessive consumption of paper.

The EICS provides a webpage where jpg news are displayed cyclically. RPi connected to the monitor via HDMI cable, opens the page in a browser every time it is initialized, this automated task was created using a custom image of the Raspbian operating system which is the OS used in the embedded system, which has a initialization script being responsible for executing an task routine that will leave news on display every time the RPi is turned on without requiring any human interaction. In this way, we have been able to create an ideal autonomous environment to transmit a message quickly reducing operational costs, such as saving time, reducing impressions, and working time to fix reports at each exhibition site. The page can also be accessed by students via mobile devices, as can be seen in Figure 2.

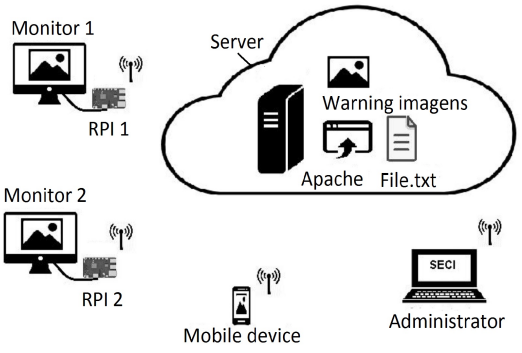

Figure 2: Illustration of system flow.

The Administrator (Figure 2) represents the sector responsible for moderating the news that will be displayed in the slideshow, so it was necessary to create an access (Figure A) control in order to guarantee security to the system. When you log in to EICS, the administrator will have control over the news being displayed, and you can override them by uploading a .jpg image to the server. When a news image is sent to the server, a control file is changed informing this change. The RPIs are checking this file every 5 seconds, if any changes have occurred the web browser is updated, thus displaying

the news on all the monitors and the page accessed by the mobile devices.

Figure 3 shows a news created using the system, each element of the image is positioned in a specific place to ensure harmony between the elements.

Figure 3: Example of a news created by EICS

The development process of the project as well as its implementation can be divided into two parts, the first being the development of the Web system (Figure 4) and the second the configuration of RPi that will be connected in the monitors via cable to HDMI, being responsible for performing routines automated IoT. In the Web part we used HTML, CSS, JavaScript and PHP to create the EICS that is hosted on an Apache server. When the login administrator logs in a preview of the news being displayed in monitors, are displayed, as well as the option to upload news images.

To facilitate the disclosure of text-only communication, a mechanism was created for generating simple images containing textual messages, thus facilitating the propagation of short information internally within the institution. The administrator selects the source sector of the release, sets a topic, and briefly summarizes what it wants to report. Figure 5 shows the main page of the developed EICS.

When we are creating an image to transmit a message using text we are not only creating a set of character designs but a harmony of elements that must be carefully positioned to keep the focus of who is observing the news. To generate a news image the EICS provides a form where the texts will be inserted, such as the title and the description, soon after it will use the function imagettftext of the php language. This function is responsible for writing the texts provided in the form in the image, also through it are passed the x, y coordinates for each text.

In the book How to create types: from sketch to screen, the spacing it's defined: "(...) definition of lateral spaces (lateral protections or sidebearings) that each character has left and right. Their goal is that regardless of which character comes before or after, the rhythm remains harmonious and predictable."(HENESTROSA; MESEGUER; SCAGLIONE, 2015) The news images generate spaced texts to make the reading of the news more fluid and not to force the viewer to read. This carefulness with the spacing was taken for some reasons, the monitor being an electronic tool to be fixed on a wall people were distant to read the news, then a good size for text font and also a good spacing between the characters will make the Comprehensive text or not, because characters very close to each other can hurt the reader. As a solicitation from the department staff, the letters spacing were enlarged to facilitate reading from distance. To serve it, it was necessary to modify the imagettftext function of the php language, this modification made the spacing between the letters of the larger font as can be seen in Figure 6, the characters inside the red grid show the spacing of the original function imagettftext and the inside of the EICS function blue grid.

A form was applied with the students of the institution to evaluate if the size of the text of the news was adequate and if they were able to read properly, more than 90% answered yes. This form was applied with students attending the academic restaurant, where two TVs were implanted with EICS. This implementation was carried out in August 2017 and is working so far. Due to success, the institution is expanding the number of EICS monitors in other blocks of the campus.

The second part has the configuration of RPi to act as the CPU attached to each monitor, and is responsible for displaying the slideshow with news as soon as its power supply is turned on. To automate the RPi routine a Script was used to start with the boot of the embedded system. The settings of this script allow the browser to be automatically displayed in fullscreen mode at startup time and also responsible for checking for updates to the server images.

The changes made to the RPi operating system were:

1) Open firefox automatically: *Copy firefox.desktop startup file located in /usr/share/applications to /etc/xdg/autostart.*

2) Run the shell script when starting the system: *Need to add at the end of the .bashrc file that is located in the user's Pi directory to the following command line: ./f5.sh&. This will cause the f5.sh script to be called at S.O.'s boot and run in the background.*

These changes allow the Rpis connected to the mo-

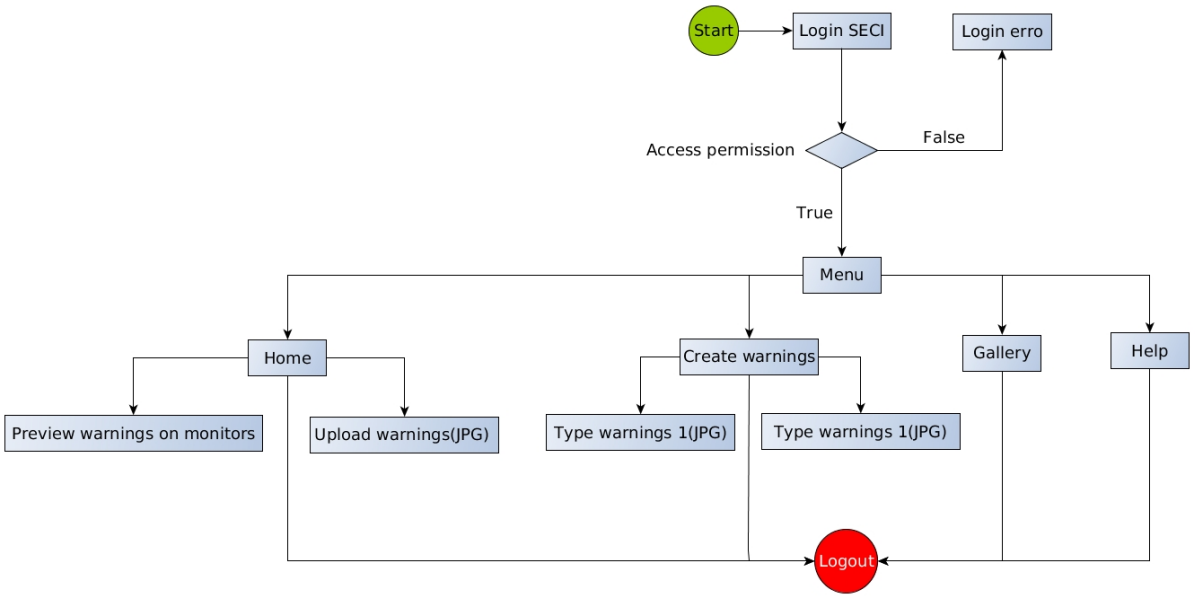

Figure 4: System Flowchart.

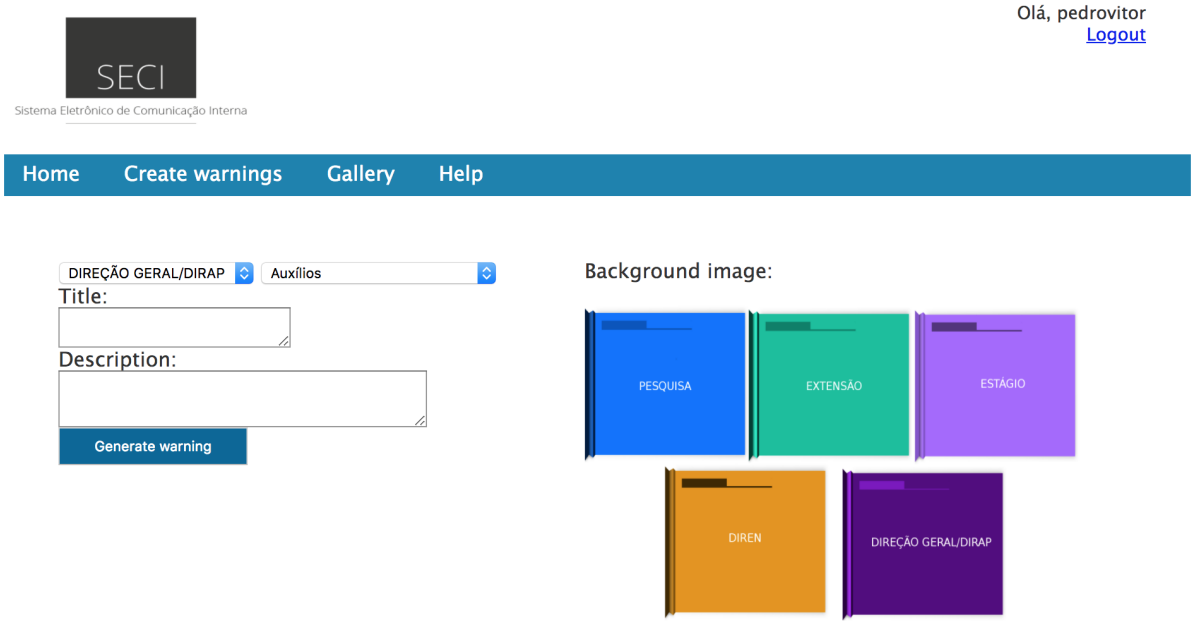

Figure 5: EICS web interface for generating news images.

Space between letters

Space between letters

Figure 6: Spacing improves read time.

nitors do not need to be accessed to make any type of configuration, so as soon as they are connected they will already be displaying the web system responsible for the news.

In the f5.sh script there is a repeat structure that gets every 5 seconds querying a text file hosted on the server. A check on this file is required to see if any new images have been added for display. At the moment the EICS administrator sends news, this text file is modified, so when it is queried again, the RPi knows that there has been a change in the server, so f5.sh executes the following commands:

```
# Selects the Rpi display
export DISPLAY =: 0
# Firefox window number
Window = 'xdotool search –name"Mozilla Firefox"
# Select Window to receive command
xdotool windowactivate $Window
# Executes the F5 key updating the browser
xdotool key F5
```

4 Results

After updating the news messages, the f5.sh script will modify the text file on the server, returning its information to the previous state. Finally, Figure 7 shows the EICS in operation in the academic restaurant. The EICS can also be viewed through mobile devices (smartphones, tablets and PCs) via the system's responsive access link (SANUSB, 2018).

5 Final Considerations

As it was seen in this work, the Linux embedded system (RPi) is used as controller of the IoT real-time news system of display of news, and works as designed using PBL didactic method and the IoT-based techniques and principles.

The EICS was inaugurated at the Federal Institute of Ceará (IFCE) Campus Maracanaú in August 2017, becoming a product used internally. This IoT news system is the first developed and installed at IFCE and became a communication method more economical and more efficient than using papers manually fixed on walls, as previously done by the institution.

IoT news can be accessed by any computer device such as laptops and smartphones, so that, in addition to the monitors scattered throughout the institution, academic community can view news from anywhere using the link to the web page.

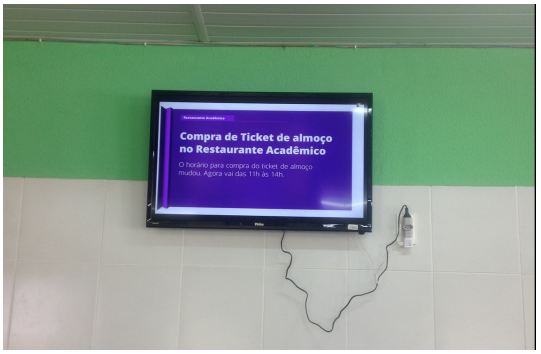

Figure 7: EICS in functioning academic restaurant.

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