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Designing an Event-Driven Quasi Real-Time Attendance Tracker with Raspberry Pi

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Abstract*—This project employs the IoT with an intelligent event-driven system in order to realize an efficient, quasi-real-time attendance tracker. The idea is to keep the whole system in standby mode except for the low-power motion sensor. On the detection of an event, when a person enters and originates a motion, the front-end embedded processor is alarmed. Afterwards, it activates the remaining system modules, like the webcam, communication block, etc. The event-driven feature improves the system's performance in terms of resource utilization and power consumption compared to the classical ones. A first system implementation is realized and successfully tested. It is based on a Raspberry Pi 3 board, which is integrated with two passive infrared (PIR) sensors and two webcams. On the occurrence of an event, the webcam is activated, and it captures an image. The image is recorded via the Raspberry Pi webcam server and is shared with other system modules via the Porta Space application, which acts as a hub between the Raspberry Pi and the cloud. Simultaneously, the attendance status is updated via IFTTT on the cloud-based log. Moreover, the concerned authorities are notified via email. The process is repeated every time a person enters or leaves the concerned place. The attendance log remains globally available via the cloud and can be accessed anytime. The system design flow is described. The devised system's functionality is tested with an experimental setup. Results have confirmed proper system operation..*

Keywords--*IoT, event-driven system, raspberry pi, attendance tracker.*

INTRODUCTION

The principle use of attendance is to maintain the record of intended people in an organization. It serves as an elementary tool to maintain organizational discipline [1]. Most of the existing attendance systems are expensive and need continuous maintenance [2–3]. Such a technology is not affordable for small and medium-sized organizations. If they adopt the traditional attendance-sheet-based, record, then they will need additional employees to sort and maintain it. Consequently, it will increase the number of employees, and the company will spend more on wages. In this context, this work focuses on the design and development of an event-driven and cost-effective attendance tracker. The proposed system can be effectively used in small and medium-sized organizations to automatically manage the attendance record. After getting inspired by the works presented in [4, 5], the event-driven feature is embedded in the devised solution. It promises to improve the devised system's performance in terms of resource utilization and power consumption compared to the classical ones.

THE PROPOSED SYSTEM

The proposed system principle is shown in Figure 1. The system's functionality is described in the following subsection.

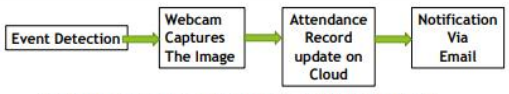

Figure 1: The proposed attendance system workflow.

A. The Devised System Functionality

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The system algorithmic state machine (ASM) chart is shown in Figure 2. It shows that on the detection of an event, the processor is signaled by the motion detection sensors. Afterwards, it activates other system modules and manages the system's functional states.

By default, the system remains in standby mode. In this state, all system modules remain on standby, except for the low-power motion detection sensors. One PIR sensor is placed on the entrance side. It indicates the entrance of people. The other is placed on the exit side. It indicates the departure of people. On the detection of an event, the system state is changed to active.

In the active state, the camera takes a snapshot, and the processor stamps the date and time. Later on, the processor shares this information with other system modules via the Prota Space. Finally, IFTTT executes the developed applet, which updates the attendance record on Google Drive and notifies authorities via email [7-9]. IFTTT is a cloud-based service to create a structure of cascaded conditional statements.

In attendance, record the exact time of each person's entrance or departure with a picture, and the total number of persons present that day is marked. If a person reaches the workplace after 12:00, then he is marked absent. The interface between Porta Space and the cloud is realized with the IFTTT-based applet. On successful execution of the developed applet, the attendance record gets updated on the cloud, and a notification email is sent to the concerned persons. In the absence of any further events, the system state is updated as STANDBY_Mode_Activation. In the STANDBY_Mode_Activation state, all system modules are turned to standby mode except for the motion detection sensors. Later on, the system state is updated as STANDBY.

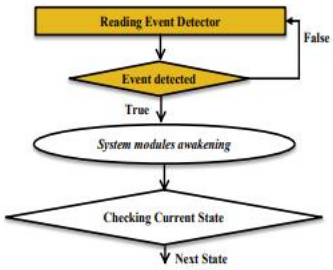

Fig 2-a: The system ASM chart common for all states

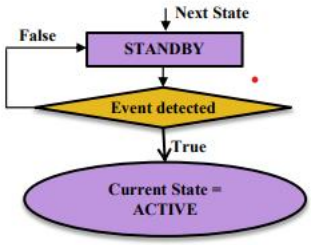

Fig 2-b: The ASM chart for the standby state

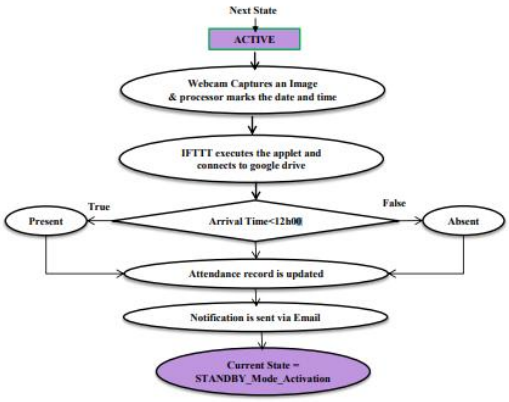

Fig 2-c: The ASM chart for the active state

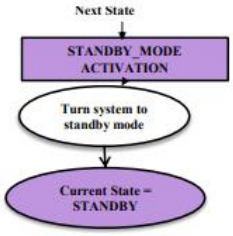

Fig 2-d: The ASM chart for the STANDBY_MODE_Activation.

B. The System Components

The proposed attendance system component level schematic is shown in Figure 3. It shows that the devised system employs a Raspberry Pi 3 model B card (cf. Figure 4). It is the core component of the

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devised system and is based on the ARM Cortex-A53 processor, which acts as the brain of the proposed system. It is an inexpensive credit card-sized electronic card. It can be easily configured by using standard programming languages like C, Python, etc. Because of its simple interface, cost effectiveness, and ease of configuration, it has recently been used in the development and prototyping of a variety of medium-complexity embedded systems [6]. In the devised system, the Raspberry Pi acts as a bridge between PIR sensors, cameras, and smart phone-based applications.

A 16GB SD card is employed as an external memory module. It possesses a reading and writing speed of 90 megabytes per second, which is suitable for real-time image storage, the transfer of information from cameras to the SD card, and the transfer of information between the SD card and processor [7].

Two PIR sensors are also employed in the devised system [11]. The outputs of PIR sensors are digitized and passed to the Raspberry Pi. The A/D conversion process is clear. The PIR sensors serve as motion detectors. One sensor is placed on the entrance side. It indicates the entrance of people in the concerned locality. Another is placed on the exit side, which indicates the departure of people from the concerned locality.

The devised system also employs two VGA webcams with 1.3 megapixels' image resolution [12]. They capture the picture of entering or departing people. The camera is paired with the PIR. This pair is placed on the entrance side of the concerned locality. The Camera0 is activated by the processor as a function of the PIR0 output (cf. Section II-A). Once activated, it captures an image of the entering person. Similarly, the Camera 1 is paired with the PIR 1. This pair is placed on the exit side of the concerned locality. The Camera1 is activated by the processor as a function of the PIR1 output. Once activated, it captures an image of the departing person.

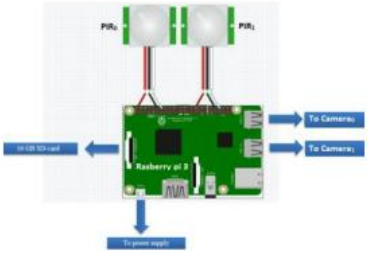

Fig 3: The proposed attendance system components level schematic

Fig 4: The Raspberry pi 3 board

IMPLEMETATION AND RESULS

A. The The Porta Operating System (OS)

The Porta is a free OS for the Raspberry Pi [7–9]. In this project, it is employed to establish a liaison between the Raspberry Pi and the IFTTT-based apps that run on smartphones. After downloading it on the PC, it is configured on the SD card [10]. Later on, this SD card is plugged in as a daughter card on the Raspberry Pi SD card socket [6, 7].

B. The Porta Space App

The Prota Space app was downloaded from the Google Store on the smart phone. The purpose of this app is to monitor the activity of the Raspberry Pi and control it via the cell phone. It also acts as a hub between the Raspberry Pi and IFTTT.

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The first step is to install Porta Space on the mobile phone. The second step, after installation, is to establish a connection between Porta Space and the Raspberry Pi. The third step is to register and activate the Porta Space via a Wi-Fi connection. Finally, in the fourth step, a home screen is opened, which allows you to link different applications via the Porta Space. The process is clear from Figure 5.

Fig 5:The steps in the establishment of porta space application

C. The Camera Setup

The VGA webcams [12] are connected to the Raspberry Pi via two USB ports [6-7]. The Raspberry Pi webcam server app is downloaded and installed on the smart phone [7]. Later on, this app is linked to other system modules via the Prota Space app. Camera tests are conducted to ensure their proper connectivity [7]. It is ensured that on the occurrence of each event, the concerned camera captures a picture and stores it on the on-board SD card. Later on, this picture is transferred by the Raspberry Pi to the smart phone via the Raspberry Pi webcam server. Finally, this data is made available to other system modules via the Porta Space app. The process is clear from Figure 6.

D. The PIR Sensors

The employed PIR sensors have a three-terminal interface [11]. The red cable (+) represents power, the white cable represents ground, and the black cable represents alarm (AL). The red cables of both sensors are respectively connected to 5V via PIN02 and PIN04 of the Raspberry Pi. The white cables of both sensors are respectively connected to the ground via PIN14 and PIN20 of the Raspberry Pi. The black cables are respectively connected to GPIO17 (PIN11) and GPIO18 (PIN12).

E. The Raspberry pi GPIO

The Raspberry Pi GPIO app is downloaded and installed on the smart phone. Later on, this app is linked to other system modules via the Porta Space. In the GPIO application, the GPIO17 and GPIO18 are selected. Then, from the select mode, “interrupt” is chosen, and from the set pull-up/down resistor, “pull-down” is chosen. In this way, both sensors are set up, and their operation is verified. On the detection of an event, the concerned GPIO successfully gave a notification of the “rising interrupt” on the GPIO app.

Fig 6: The camera setup

F. The IFTTT Account Setup

The IFTTT application was downloaded and installed on the smart phone. Later on, the IFTTT account is configured and accessed via Porta Space. The IFTTT acts as a liaison between the Porta Space and the cloud storage. In the search tab of the IFTTT account page, two applications, email and Google Drive, are searched and linked to the Porta Space by using the connect button. The process is clear from Figure 7.

Fig 7: The IFTTT account setup

G. The Attendance Record

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The attendance record is managed with three Excel sheets. Google Drive is used as cloud storage. Therefore, these sheets are managed on Google Drive. It allows the concerned persons to access the attendance record anywhere and at any time and to interact timely whenever required. Three different sheets are developed:

i) The event record: This sheet logs the number of events signaled by the PIR sensors. The process is depicted in Figure 8-a.

ii) The entrance/departure time: It records the intended person's pictures with entrance/departure time and date information. The process is depicted in Figure 8-b.

iii) Attendee count: This sheet records the total number of attendees during the day. A person is considered absent if he reaches the workplace after 12:00. The process is depicted in Figure 8-c.

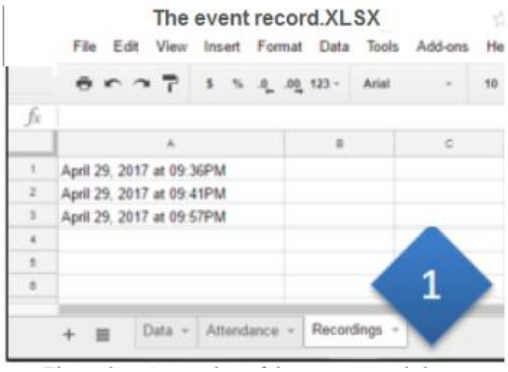

Fig 8-a:A Snapshot of the event record sheet

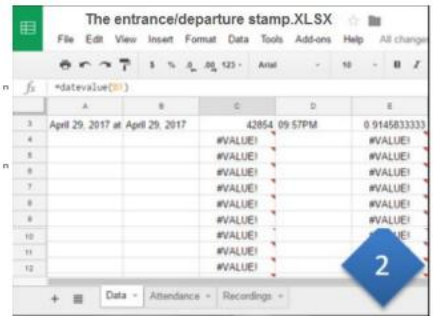

Fig 8-b: A snapshot of the entrance/departure time stamp sheet.

Fig 8-c: A snapshot of attendees count sheet

H. The Applett Development

In the IFTTT account, "create applet" is chosen from the drop-down menu. The designed applet is composed of: If the storyline is executed, then add a row to the spreadsheet in Google Drive. The story is composed of the following commands:.

When GPIO pins detect a rising interrupt on GPIO17 or GPIO18, then the webcam takes a snapshot.

The IFTTT runs the porta applet, and presence_pi@gmail.com sends a message to presence_verify@gmail.com.

The above-mentioned story only executes when the connection between Porta Space and the Raspberry Pi is established.

CONCLUSION

A Raspberry Pi-based event-driven, quasi-real-time attendance tracker is suggested. The classical attendance systems remain active all the time, regardless of the presence of intended objects in the system range. It results in increased system resource utilization and power consumption. However, in the suggested solution, all system modules remain in standby mode except for the low-power motion detection sensors. The system only functions on the detection of an event of interest. It promises a noteworthy reduction in the utilization of system resources like memory, processing, and transmission activity compared to the counter-classical solutions [4, 5]. It results in a significant reduction in the proposed system activity and power consumption as

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compared to the traditional ones. These attractive features are achieved by smartly embedding the event-driven feature in the devised system.

The system's functionality is demonstrated with the help of a prototype. It was developed using a Raspberry Pi 3 board along with two PIR sensors, two VGA webcams, and a 16-GB SD card. On the software side, Porta Space is used as a hub among the Raspberry Pi webcam app, GPIO app, and IFTTT-based applets. The webcam app and the GPIO app act as communication links between Porta Space and the Raspberry Pi 3 board. The IFTTT acts as a liaison between the Google Drive and the Porta Space. A specific applet is created in the IFTTT account. This applet executes on the occurrence of each event, and it updates the cloud-based attendance record after each execution. Results have shown the proper functionality of the proposed system. It concludes that the devised system is an attractive candidate for atomizing the attendance records of small and medium-sized enterprises.

A study on the comparison of the proposed system's power consumption compared to the traditional ones is in progress. A future project is to integrate the face detection and recognition features into the system. It will improve its performance in terms of robustness and will help suppress the generation of false alarms.

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