A Raspberry Pi Based Event Driven Quasi Real Time Attendance Tracker

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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 the 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 webcam, communication block, etc. The event-driven feature improves the system performance in terms of resources utilization and power consumption compared to the counter 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 the IFTTT on the cloud-based log. Moreover, the concerned authorities are notified via an email. The process is repeated every time when 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 functionality is tested with an experimental setup. Results have confirmed a proper system operation.**

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

I. INTRODUCTION

The principle use of Attendance is to maintain the record of intended people in an organisation. It serves as an elementary tool to maintain the organisational 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 size organisations. If they adopt the traditional attendance, sheet based, record then it will need additional employees to sort and maintain it. Consequently, it will increase the number of employees and company will spend more on wages. In this context, this work focus 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 size organizations to automatically manage the attendance record. After getting inspired from works presented in [4, 5, 16, 17], the event driven feature is embedded in the devised solution. It promises to improve the devised system performance in terms of resources utilization and power consumption compared to the counter classical ones.

II. THE PROPOSED SOLUTION

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

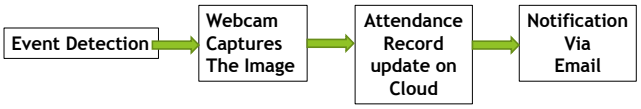

Figure 1: The proposed attendance system workflow.

A. The Devised System Functionality

The system algorithmic state machine (*ASM*) chart is shown on 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 functional states.

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

In *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 an Email [7-9]. The *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/departure with a picture and the total number of persons present that day is marked. If a person reaches the work place after 12h00 then he is marked absent. The interface between *Porta Space* and cloud is realized with the *IFTTT* based applet. On a successful execution of the developed applet the attendance record gets updated on the cloud and a notification Email is sent to the concerned

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persons. In the absence of any further event, the system state is updated as *STANDBY_Mode_Activation*.

In *STANDBY_Mode_Activation* state all system modules turned to the standby mode except for the motion detection sensors. Later on, the system state is updated as *STANDBY*.

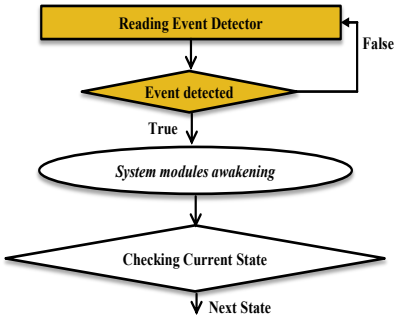

Figure 2-a: The system *ASM* chart common for all states.

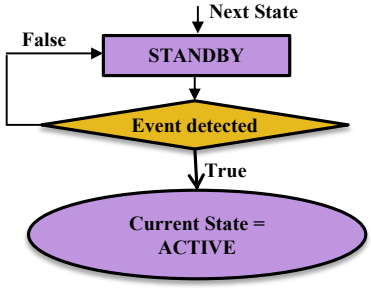

Figure 2-b: The *ASM* chart for the STANDBY state.

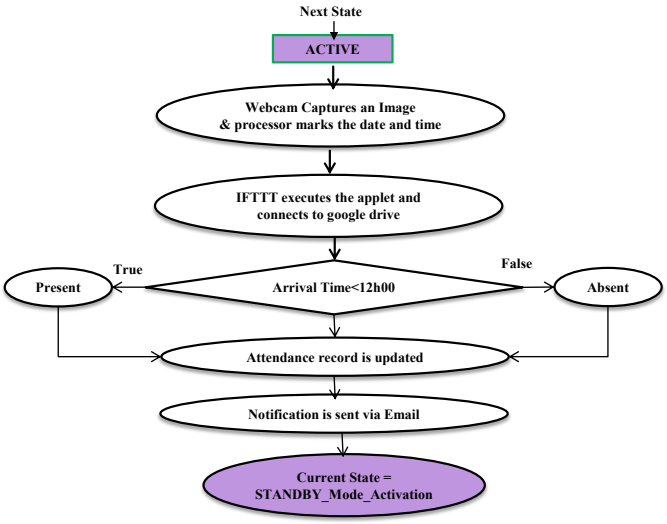

Figure 2-c: The *ASM* chart for the ACTIVE state.

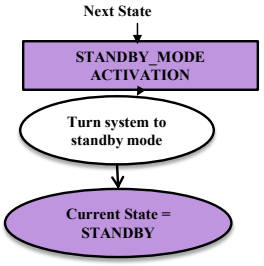

Figure 2-d: The *ASM* chart for the STANDBY_MODE_Activation state.

B. The System Components

The proposed attendance system components level schematic is shown on 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 devised system and is based on the *ARM Cortex-A53* processor, which acts as the brain of proposed system. It is an inexpensive credit-card sized electronics card. It can be easily configured by using standard programming languages like C, Python, etc. Because of its simple interfacing, cost effectiveness and ease of configuration, recently it is 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, camera 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 a real time image storage, transfer of information from cameras to the SD card, and transfer, transfer of information between SD card and processor [7].

Two PIR sensors are also employed in the devised system [11]. The outputs of PIR sensors are digitized and passes to the *Raspberry pi*. The A/D conversion process is clear from [23]. 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. Other is placed on the exit side which indicates the departure of people from the concerned locality.

The devised system also employs two VGA webcams of 1.3 megapixels' image resolution [12]. They capture the picture of entering or departing people. The $Camera_0$ is paired with the PIR_0. This pair is placed on the entrance side of the concerned locality. The $Camera_0$ is activated by the processor as a function of the PIR_0 output (cf. Section II-A). Once activated it captures 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 $Camera_1$ is activated by the processor as a function of the PIR_1 output. Once activated it captures image of the departing person.

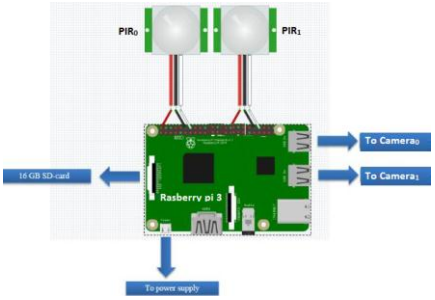

Figure 3: The proposed attendance system components level schematic.


Figure 4: The Raspberry pi 3 board.

III. Implementation and Results

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 applets which run on the smartphone. After downloading it on the *PC* it is configured on the *SD* card [10]. Later on, this *SD* card is plugged, 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 Google store on the smart phone [13]. The use of this app is to monitor the activity of *Raspberry pi* and control it via the cell phone [14]. It also acts as a hub between the *Raspberry Pi* and the *IFTTT*.

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 *Raspberry pi*. The third step is to register and activate the *Porta Space* via a *Wi-Fi* connection [15]. Finally, in fourth step a home screen is opened which allows to link different applications via the Porta Space. The process is clear from Figure 5.

Figure 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. Cameras test is conducted to ensure their proper connectivity [7]. It is ensured that on the occurrence of each event, the concerned camera captures a picture and store 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 three terminals 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 the 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 the "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.

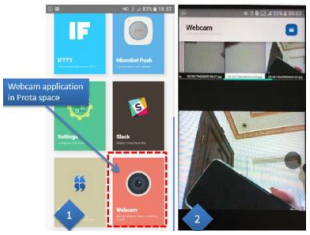

Figure 6: The camera setup.

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 the 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.

Figure 7: The IFTTT account setup.

G. The Attandance Record

The attendance record is managed with three excel sheets. The google Drive is used as the cloud storage. Therefore, these sheets are managed on the 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 on 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 on Figure 8-b.

iii) Attendees count: This sheet records the total number of attendees during the day. A person is considered absent if he reached the work place after 12h00. The process is depicted on Figure 8-c.

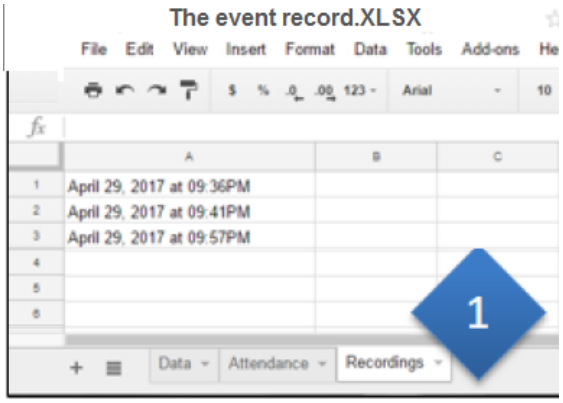

Figure 8-a: A snapshot of the event record sheet.

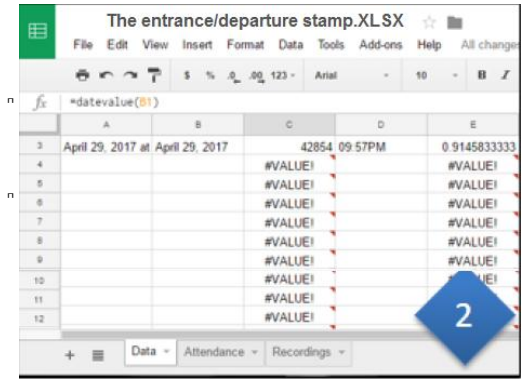

Figure 8-b: A snapshot of the entrance/departure time stamp sheet.

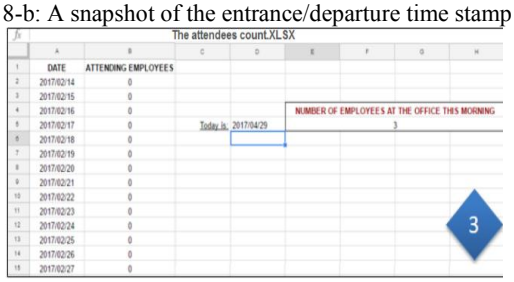

Figure 8-c: A snapshot of attendees count sheet.

H. The Applett Developement

In the *IFTTT* account, "create applet" is chosen from the dropdown menu. The designed applet is composed of: If the storyline is executed, then add a row to 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 *Raspberry pi* is established.

IV. 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 an increased system resources utilization and power consumption. However, in the suggested solution all system modules remain in the 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 lessening in the utilization of system resources like memory, processing and transmission activity compared to the counter classical solutions [4, 5, 18-22]. It aptitudes a significant reduction in the proposed system activity and power consumption as compare to the traditional ones [16-22]. These attractive features are achieved by smartly embedding the event driven feature in the devised system.

The system functionality is demonstrated with the help of a prototype. It is developed by 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 acts as communication link 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 a proper functionality of the proposed system. It concludes that the devised system is an attractive candidate for atomizing the attendance record of small and medium size enterprises.

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

V. FUNDING

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