International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Smart Auditorium Automation system based on object recognition

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Abstract*: *The word "smart" is being used in various fields and is worldwide accepted to mean intelligence. Smart services are one of the most emerging technologies being used in the IoT era, which has widely changed the equipment into more intelligent, remotely accessible, and interconnected. To use any electric device, we require to interact with it, or there is a need for the presence of a person at a particular place is needed. Moreover, to overcome this, The System examines the smart auditorium feature that current owners of the auditorium are facing about the power consumption by the auditorium and the wastage of the valuable electric energy. The proposed system helps in providing comfortable, efficient, and effective control of electrical devices like lights, Air conditioner, and achieve insignificant power saving.

Keywords*: *Smart City, Auditorium, Automation, Power saving, Energy Efficient

I. INTRODUCTION

The fundamental pillar is the cause of the development of society, which is involved in communication and information. The theory of information states that it should not be exchanged for the value of money; instead, it should be considered as the rights to humanity. The Internet of Things (IoT) is the latest trend which indicates that by the year 2020 there will be 30 billion devices connected to the internet, which is creating a very high expectation about how the devices will communicate with each other and how life of the people will change when these all objects in the environment having wireless capability.[1]

For the same 2022, the projections indicate that in a conventional home, there would be more than 30 devices all connected to the internet.[1] Keeping this in mind, the need for integration of all these devices together and to reduce the user interaction with this environment is needed. It is now possible to create such an environment at a reasonable price because of the commercial availability of wireless technology.

Sensors and actuators are being utilized as a part of houses and workplaces, which are making our life more agreeable in a few areas: the auditorium lighting can be put to change as per the requirements of the owner of the shopping malls and theatre. The vitality of the power energy can be achieved through consequently switching ON/OFF the electrical peripherals when not required in the auditorium and theatres.

In this proposed work, we took an approach that is efficiently controlling electrical peripheral through the design and implementation of an auditorium automation system for a vast space such as theatres and auditorium, in which the control and supervision of the devices can be done remotely by the network efficiently [19].

II. RELATED WORK

This Bellcore's Auto Auditorium is a system that is being developed on very basic and uses Smart Space for transforming an auditorium into one which can naturally make communications and recordings itself. The framework is being designed to be introduced in a small room and uses optical and acoustic sensors such as TV cameras and mouthpieces to be "mindful" of what is happening in the room. It focuses on the attention to broadcast all the sounds and pictures of the auditorium activities to a solitary individual on a phase. Talking with anticipated visual and voice guides it to a neighborhood gathering of people [3]. In this whole observations and controlling of the apparatuses, it turns out to be exceptionally havoc to an individual. In the case of fewer people entering the auditorium at a particular point of time, then there is no compelling reason to switch on every gadget in the auditorium. If we put all the gadgets ON, then, it is a misuse of energy and electricity. On the other hand, if there are too many people in the auditorium, then we have to rush to the switches to turn ON all the gadgets present in the auditorium such that no person should feel uncomfortable. All things were good enough while using this technique.

However, in the above technique, there was a need for many changes, and to overcome those, another technique was proposed, in which they used it for controlling all the gadgets of the auditorium and also the power supply of auditoriums, which is done by using Image Processing. Initially, they take a picture of an empty auditorium, and if there are any changes in that reference picture, then it is being distinguished,

Manuscript published on November 30, 2019.
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and afterward, that change in the particular area is a separate gear alone, which is to be turned on, and all these things control wastage of electricity and resources. This is a dual-use of a framework such that there is a camera which is utilized for identifying individuals and also different moving objects. This is a straightforward, high output producing, and cost-effective strategy to achieve the power saving objective. Another significant advantage of this kind of dual framework is that it can be implemented in many applications like home automation, Smart Street light, so on [5].

The use of dual framework was good but it had several issues in it and to overcome these issues, In the paper "Automated Room Light Controller with Visitor Counter" the authors has used a robust circuit that takes control of all the room lights and other devices by checking the number of people present in the room precisely. Whenever any individual gets into the room, the counter is increased by '1', and the lights in the room will automatically get ON, and when anybody leaves the room, the counter is decreased by '1'. The lights get turned OFF when everyone gets out of the room, and there is no one present in the room. The total count of the people presents inside the room can be seen on the display screen.

III. HARDWARE AND SOFTWARE USED

Technical Specification	NodeMCU (ESP-8266)	Arduino Uno	Raspberry Pi Model B+
Operative Voltage	3.3V	5V	5V
Processor	Tensilica L 106	ATMega328P	Quad-core ARM Cortex A53
Clock Speed	26 Mhz-52 MHz	16 MHz	1.2 GHz (Quad core)
Flash Memory	up to 4MB	32 KB	-
System Memory	128 KB	2 KB	1 GB
Development Environment	Arduino IDE, Lua programming	Arduino IDE	any Linux Compatible IDE
Operating System	XTOS	-	Raspbian (many)
Communication Supported	IEEE 802.11 b/g/n	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0 via Shield	IEEE 802.11 b/g/n IEEE 802.15.4 433RF BLE 4.0Ethernet Serial
Price (Rs.)	>350	1500	2600 - 3000

Table: - 1. The basic difference between Micro-controller

	Raspberry Pi 3 Module B	Raspberry Pi Zero	Raspberry Pi 2 Module	Raspberry Pi Module B+
Introduction Date	2/29/2016	11/25/2015	2/2/2015	7/14/2014
SoC	BCM2837	BCM2835	BCM2836	BCM2835
CPU	Quad Cortex A53 @ 1.2Ghz	ARM11 @ 1Ghz	Quad Cortex A7 @ 900MHz	ARM11 @ 700MHz
Instruction Set	ARMv8-A	ARMv6	ARMv7-A	ARMv6
GPU	400Mhz VideoCore IV	250Mhz VideoCore IV	250Mhz VideoCore IV	250Mhz VideoCore IV
RAM	1GB SDRAM	512 MD SDRAM	1GB SDRAM	512 MD SDRAM
Storage	Micro-SD	Micro-SD	Micro-SD	Micro-SD
Ethernet	10/100	None	10/100	10/100
Wireless	802.11n / Bluetooth 4.0	None	None	None
Video Output	HDMI / Composite	HDMI / Composite	HDMI / Composite	HDMI / Composite
Audio Output	HDMI / Headphone	HDMI	HDMI / Headphone	HDMI / Headphone
GPIO	40	40	40	40
Price(Approx.)	2450	350	2450	2450

Table- 2: Difference between versions of Raspberry Pi

A. Raspberry-Pi:

The Raspberry pi is easy to use as it contains large system memory and is compatible with any device and can be used to do processing as well as controlling of a system. It is a little device that enables people to explore computing and to learn programming languages like Python. It is capable of doing things like browsing the internet, playing video, making spreadsheets, word-processing, playing games, etc.

It also has the ability to communicate with the outside world and has been used in digital projects such as music machines, parent detectors, weather stations, and tweeting birdhouses with the help of infra-red cameras.[6]

The table-1 gives us the comparison between the different micro-controller and the benefits of using Raspberry Pi as the main micro-controller, and the main reason for using raspberry pi is that in this, we can store some amount of data onto it[20,21]. And the other storage capacity depends upon how much storage size SD card we are using, and in our project, we need to store the images and then compare it, and for that, we need storage space. The most important thing is that in Raspberry Pi, we don't require any kind of IDE to run raspberry pi. Raspbian is the OS for raspberry pi, and it is built on the Linux base, so it is easy to use.

The table-2 shows the different versions of Raspberry Pi modules, and then the leading cause of using raspberry Pi 3 Module B in comparison to other versions is that raspberry pi is around 40 times faster than Arduino and around 26 times faster than NodeMCU in clock speed. Raspberry pi can perform multi-tasking and is suitable for our project as in our project,

we need to capture an image then store image and compare it with the previous one. Raspberry pi is also a kind of minicomputer.

Also, the Raspberry pi can be easily connected with the internet, and in our future work, we have mentioned connecting our project with cloud[16,22].

For IoT based projects, the best programming language is the python, and the advantage of using Raspberry Pi is that python is pre-installed in Raspberry pi. Additionally, a raspberry pi support camera and have its own in-built raspberry pi camera, which became a perfect thing for our project and fulfilling all our requirements. We choose to use the Raspberry Pi.

B. Camera:

The camera is an optical instrument to catch pictures or to record moving pictures, which are put away in a physical medium. A camera comprises a focal point which concentrates light from the scene and a camera body which holds the picture catch instrument. In this proposed model camera is used for clicking the images of the auditorium frequently and overrides with previous clicked images. After clicking the image it will divide the image into parts, and each part will have label on it and size is also the same as the original image then compare each part with original auditorium image which is clicked when there is no one in the room and if it found that some changes had been there then it will send signal to raspberry pi that on this area the changes have been occurring so turn on the light of this area.

C. Python:

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. It is used for rapid application development as well as for scripting to connect existing components together. Python is simple, easy to understand and learn syntax emphasizes readability and hence reduces the cost of program maintenance. Python has no compilation step, and the edit-test-debug cycle is incredibly fast; thus, debugging Python programs is easy. The Python's debugger is also made in python language itself. [7]

D. OpenCV:

OpenCV is an open-source PC vision library. The library of OpenCV is created in C and C++, and it deals with various operating systems, including Windows, Mac OS, and Linux. Moreover, it also an interface for different dialects, such as Python or Matlab. OpenCV was intended to be computationally productive with the goal of making applications working progressively and mainly.

Dissemination of PC vision information by giving a typical foundation that designers could construct on, with the goal that code would be more promptly accessible and transferable. Advancement in PC vision-based business applications by giving compact and performance-optimized code accessible for nothing and with a permit that did not require business applications to be open.

The OpenCV library contains more than 500 capacities that range numerous zones in PC vision, including mechanical item examination, therapeutic picture investigation, video observation, graphical UI, camera adjustment and amendment, stereo vision, and apply autonomy. It comprises of 4 principal parts: basic data structures and content (Core)[18,19], necessary image processing and higher-level computer vision algorithms (CV), machine learning library (ML), functions for the user interface and file I/O (HighGUI).[11]

IV. PROPOSED MODEL

A. Steps:

step 1 – Firstly, we have to click the image of an empty auditorium or the place where this system is to be installed for e.g., Malls, Theatre, etc.

Step 2 – Then the next thing which will happen is that the camera will click the real-time image of the place, i.e., auditorium.

Step 3 – Then, after getting both the images, the code will divide the image into different equal halves (in the proposed system, we are dividing the image into 4 equal halves. Actually, in the real world, when we will apply this model, then it will depend on the actual size of the auditorium, how big the auditorium is, and what number of halves the image has to be divided).

The size of the actual image should always be equal to the size of the original image.

Step 4 – After getting both the image now, the code will compare each part of the current image with the actual image which was previously captured.

Step 5 – As and when the comparison is made and if there are any changes found in the image as compare to the original image, then it sends the signal to that part of the sensor where there is a difference in the comparison.

Step 6 – Once the signal is being passed to the sensors of the particular area, then that area's light and air-conditioner systems get started. **Note: Each divided halves of the auditorium will have sensors installed within them, which will receive the signal and start the systems) **.

B. Figures:

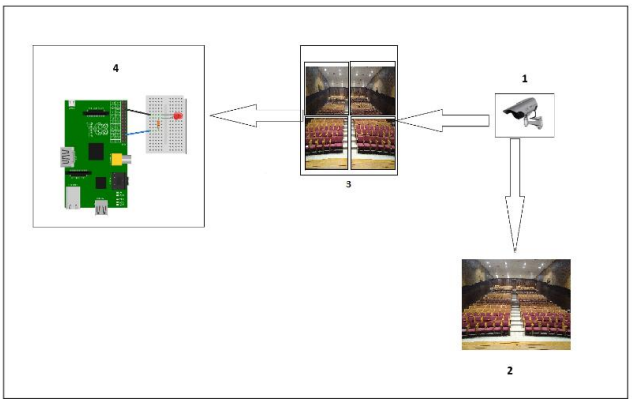

Fig: - 1 Proposed system chart.

1: Camera.
2: Nirma Empty Auditorium Picture.
3: Auditorium divided in parts.
4: Pictorial representation of actual Model.

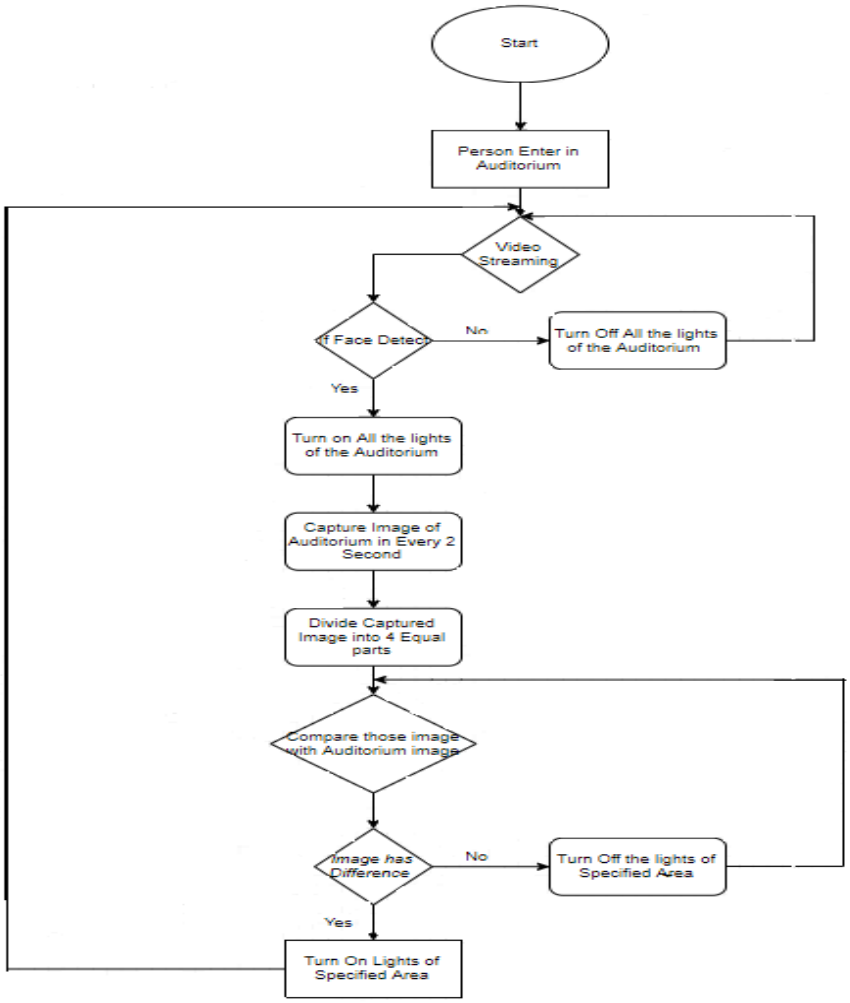

Fig: - 2 Functionality chart

V. OUTCOME

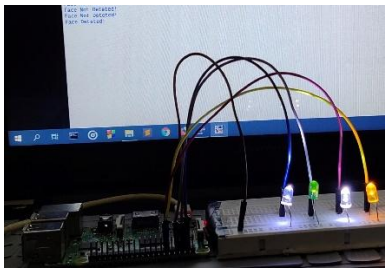

Fig:-3

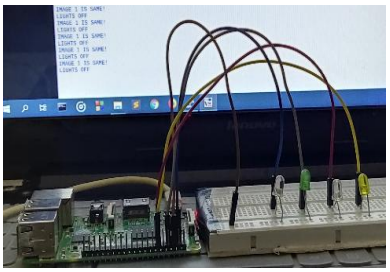

Fig:-4

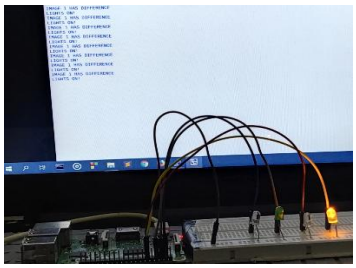

Fig:-5

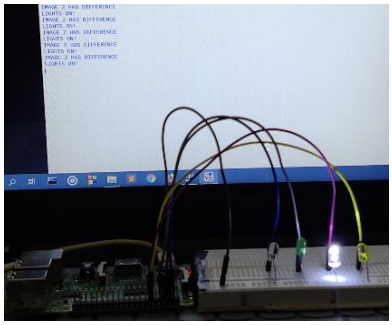

Fig.6

The figures illustrate that whenever someone enters the room, the camera will detect the motion of the object and then turn on all lights present in the room, as shown in fig:- 3, it will keep detecting until the motion becomes static. When there is no motion in the room, the camera will not detect anything, and all the lights present in the room will remain turn off as shown in fig:- 4.

But whenever someone enters the room the camera will capture the photo of the room and divides the clicked photo into 4 different parts and each part will be compared with the previous one if both the images are same then the light will remains turn off as shown in fig:- 4 or else it will turn the light on of the particular part where there is motion detected as shown in fig. 5,6 respectively.

VI. EVALUATION

The confusion matrix is an error matrix or a table that describes the performance of an algorithm or data set. It has a tabular form that has two dimensions, Actual and Predicted. It reports the number of false positives, false negatives, true positives, and true negatives.

	Predicted NO	Predicted YES	Total
Actual YES	TP 60	FP 15	75
Actual NO	FN 5	TN 20	25
Total	65	35	100

Table 3 : Result

Accuracy: A data set can be said to be accurate if the average value is closer to the real value of the attribute that is measured.

Accuracy = (TP+TN)/(TP+TN+FP+FN)=(60+20)/(60+20+15+5)=80 i.e: 80%

Recall: Recall gives us an idea about when it's actually yes, how often does it predict yes.

Recall = TP/(TP+FN)=60/(60+5)=60/65*100=92%

Precision: Precision tells us about when it predicts yes, how often is it correct.

Precision = TP/(TP+FP)=60/(60+15)=60/75*100=80%

In our system, there is nearly 80% accuracy (represents in table -3), and it is achieved such that if there is any person's face in front of the cameras then also the camera can detect it and even if we show a picture of any person the light gets ON.

VII. CONCLUSION

The use of IoT in Auditorium automation gives many benefits such as quick response, less work, and energy-saving as well as power saving. It can also be deployed at different places such as Home, Movie Theatres, Shopping Mall, Stadiums, etc. Although the system is very successful in achieving the goals, with reference to the accuracy and outcome, it has to undergo many changes and modifications. Considering that the developed system is just a simple prototype and much more work has to be implemented in order to create a final working device. Several sectors where there is a need for improvement are the size and cost of the device, energy resources, and the communication range. Raspberry Pi is easy to fit into an electrical switch box behind the wall. There are several more things in which improvements can be made in the future.

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