RESEARCH ARTICLE

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Role of Embedded System for X-Ray Comparison of Lungs to Detect a COVID-19 Affected Person at the Entry Point of Aerodromes, Railway Stations and Metro Stations in Perspective of India.

Sherry Nasir[1]*, Ashish Verma[2]

[1]Research Scholar, Department of Physics, Dr. Harisingh Gour Vishwavidyalaya Sagar, M.P., INDIA.

[2]Professor, Department of Physics, Dr. Harisingh Gour Vishwavidyalaya Sagar, M.P., INDIA.

Abstract

Nowadays, the biggest threat to mankind is COVID-19. This is a disease caused by severe acute respiratory syndrome coronavirus 2, SARS-Co V-2. It is must to control and stop the spreading of this disease. This paper is proposed to control the spread of this pandemic at the entry point of railway stations, metro stations, and aerodromes. The testing of COVID-19 is the most significant remedy to control, contain and reduce the COVID-19 pandemic. This paper proposes an embedded system design, which can be used at the entry point of aerodromes, railway stations, and metro stations, especially from an Indian perspective. This system can be used to analyze x-ray results of the lungs of the passenger who is entering the railway stations, aerodromes, and metro stations. The proposed system comprises a portable X-ray machine and an embedded system which consists of a Raspberry Pi Board (Model B), that will be interfaced with a data input module, SD card slot, display monitor at HDMI port, LEDs, and buzzers. The system compares the passenger's X-ray image at the entry point of railway stations, aerodromes, and metro stations with the X-ray image of a COVID-19 patient, which is already stored in the SD card. If the similarity is found between the X-ray image taken at entry and the X-ray of a COVID-19 patient, at that moment, buzzers and LEDs will be activated. This system can be very much useful to restrict the spreading of infection of COVID-19.

Keywords: Embedded System, Image Comparison, Python, Raspberry Pi Board.

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Introduction

There are many advances in industrial automation, automotive technology, remote sensing, etc. In many embedded systems, image processing has center stage. Nowadays, image processing tasks in embedded system, where there is no direct connection with a desktop, server, or the cloud, is possible with the help of newer hardware modules specialized with GPUs. The appropriate board for interfacing these hardware modules is required for these types of embedded systems. Embedded systems used for advanced image processing applications, specifically for applications involving machine learning or AI models, require significant processing power and memory. Ideally, these capabilities integrated into a single package having a small form factor and a huge amount of onboard memory for storing data with network or wireless connectivity constitute a powerful machine-learning-based image processing system.[1]

Plenty of work has been done using Raspberry Pi boards in the field of digital image processing field. For example, the image capturing technique is used in an embedded system, using Raspberry Pi 1 Model B, the biometric access systems, speaker recognition, password key systems, stand-alone face recognition system, etc., which make use of Raspberry Pi Model B or B+.[2]

There can be more options too but Raspberry Pi 2 Model B can be a good option for that Embedded System which has

Corresponding Author: Sherry Nasir, Research Scholar, Department of Physics, Dr. Harisingh Gour Vishwavidyalaya Sagar (MP.) INDIA., e-mail: sherrynsiddiqui@gmail.com

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been proposed in the paper, as there are many interfaces on the Raspberry Pi board, which includes 2 USB ports by which a Keyboard, mouse and pen-drive can also be connected. With the help of HDMI output, HD TVs and monitors can be connected. Input modules can be connected using an HDMI port, or HDMI to DVI lead can be used for DVI input monitors. This system can also include Standard RCA composite video lead. Ethernet port can be used for networking. An Audio lead will be available in the system to get the stereo audio in case HDMI is not in use for the system. Otherwise, HDMI will get a digital audio facility with it.[3]

Image processing in embedded systems includes steps like image identification, image segmentation, and image classification, which can be stored for later use.[4]

For medical and industrial purposes, radiography is an imaging technique by using X-rays. During the examination of patients, digital radiography uses X-ray-sensitive plates to capture images and immediately transfers them to a computer system. Because of many technological advancements in digital radiography, many companies and medical practitioners prefer to invest in digital and portable X-ray systems.[10]

System Hardware Devices and Design

The presented system design consists of a portable digital X-ray machine to be placed at the entrance of aerodromes, railway station, and metro station. The proposed Embedded System(ES) has a Raspberry Pi board model B, which includes a USB port through which digital input x-ray is provided to the ES, SD card slot with an SD card to store the x-ray data COVID-19 patients. And also, the input x-ray data has to be provided for comparison, HDMI port to connect display monitor which depicts results, also a buzzer and LEDs, preferably green and red, for the immediate indication of results to the concerned authorities.

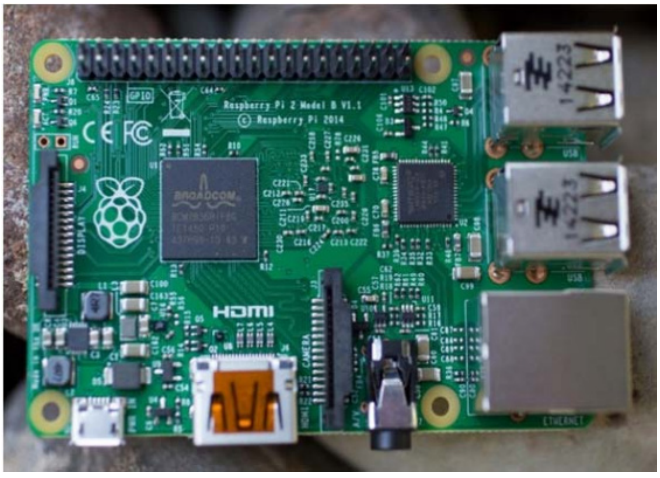

Figure 1: RASPBERRY PI 2 (MODEL B)[12]

Raspberry PI Board

This board acts as the brains of the whole embedded Image processing system, as shown in Figure 1. The main parts of the system are the main processing chip, memory, power supply module, HDMI Output, Ethernet Port, ports for USB, and many more global interfaces. It consists of 40 pin GPIO pins, 4 x USB 2.0 ports, Camera display connector, Micro SD port for the operating system, Micro USB power source, Video Core IV 3D graphics Core, etc.[5]

Pi camera can also be used in the proposed system, which is a compact, lightweight camera compatible with the Raspberry Pi microcontroller board.[11]

Main Processing Chip

Broadcom BCM2836 900 is the main signal processing chip proposed in the system.

There is MHz quad-core ARM Cortex-A7 which includes 1 GB LPDDR2 SDRAM with 2X memory that is combined to form SOC. It has an ARMv7 processor, which is able to run the full range of ARM GNU or Linux distributions like snappy, Ubuntu & Windows 10.

Interfaces

A mass interfaced module(S BC) is used. An input module is connected to the USB port. There is a display monitor connected via HDMI output. Keyboard-mouse setup, communicated with Wi-Fi, is interfaced, and Micro USB power cable can be applied for enabling power. Ethernet port may

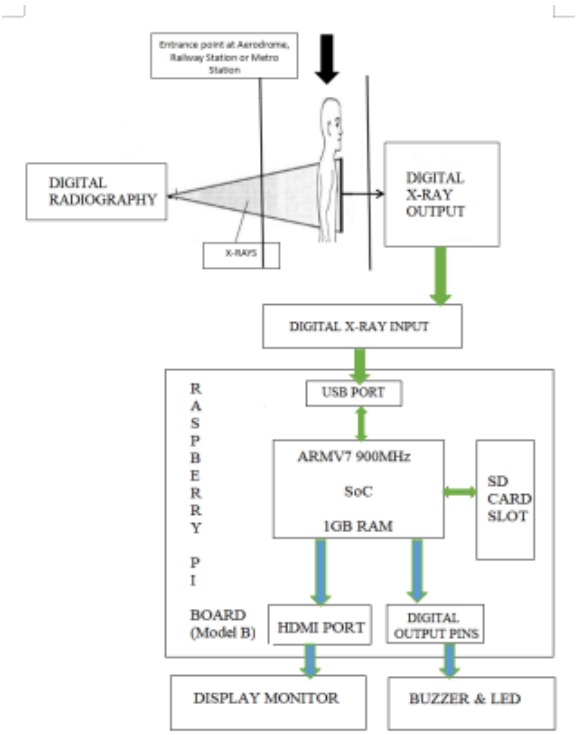

Figure 2: HARDWARE DESIGN

also be an option to be used for networking for the whole module (Figure 2).

Methodology for Processing

The system algorithm designed here works in three phases for implementation. The first phase is to take input of the X-ray image and create a database in the memory. The second phase digitally converts it into a gray-image or byte array. The third phase is to store the converted image at memory location to compare the image, which is already stored. And use it for indication of immediate results to the concerned authorities so that quick action can be taken (Figure 3).

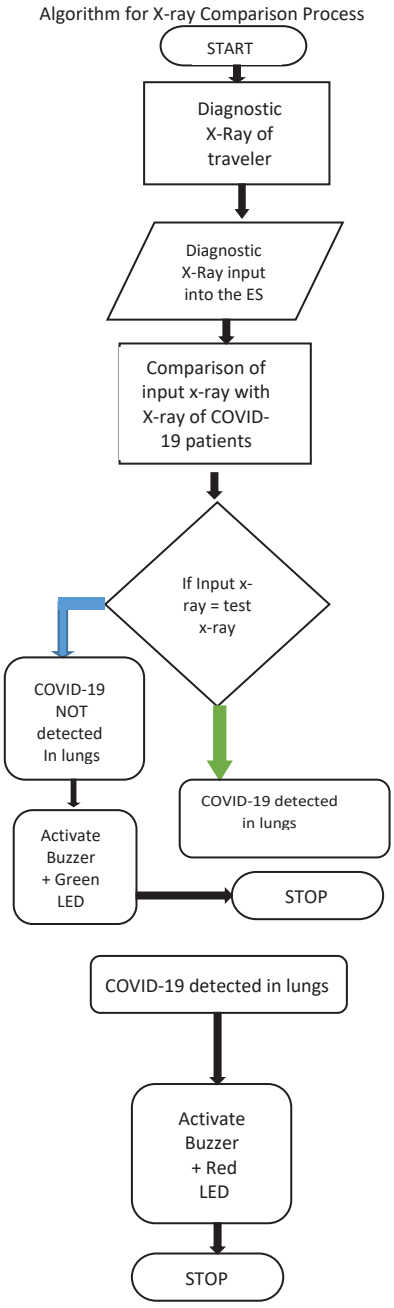

Figure 3: Algorithm for X-ray Comparison Process

In the proposed idea, the travelers at the entrance of aerodromes, railway stations, and metro stations go through an x-ray scan of their lungs. The output is then given as input into the Embedded system, which is then compared with the already stored image of x-ray of COVID-19 patient. And if the two images match, a buzzer shall be activated along with it, a Red LED will have glowed with a monitor displaying COVID-19 detected in lungs, and the infected patient can be quarantined immediately, hence further spread of the pandemic can be controlled.

Coding

Raspberry Pi Module is compatible with many programming languages like Python, C, C++, etc.

CODE in Python for comparison of X-rays

This approach involves three steps, first, conversion of X-ray image to grayscale image; second, conversion of grayscale image to histogram; third comparison of a histogram of images (Figure 4).

Code for image conversion to grayscale, histogram, and comparison

```
import cv2
# test image of x-ray of lungs of COVID-19 patient
image = cv2.imread('x_ray_test.jpg')
gray_image = cv2.cvtColor(image, cv2.COLOR_
BGR2GRAY)
histogram = cv2.calcHist([gray_image], [0],
        None, [256], [0, 256])

# x_ray_1 image
image = cv2.imread('x_ray_1.jpeg')
```

Figure 4: Portable X-ray device

```
gray_image1 = cv2.cvtColor(image, cv2.COLOR_
BGR2GRAY)
histogram1 = cv2.calcHist([gray_image1], [0],None, [256],
[0, 256])

# x_ray_2 image
image = cv2.imread('x_ray_2.jpeg')
gray_image2 = cv2.cvtColor(image, cv2.COLOR_
BGR2GRAY)
histogram2 = cv2.calcHist([gray_image2], [0],None, [256],
[0, 256])
c1, c2 = 0, 0
# Euclidean distance between x_ray_1 and x_ray_test
i = 0
while i<len(histogram) and i<len(histogram1):
        c1+=(histogram[i]-histogram1[i])**2
        i+= 1
c1 = c1**(1 / 2)
# Euclidean distance between x_ray_2 and x_ray_test
i = 0
while i<len(histogram) and i<len(histogram2):
        c2+=(histogram[i]-histogram2[i])**2
        i+= 1
c2 = c2**(1 / 2)

if(c1<c2):
        print("x_ray_1.jpg is more similar to x_ray_test.
        jpg, COVID-19 threat to patient 1")
Else if(c2<c1):
        print("x_ray_2.jpg is more similar to x_ray_test.
        jpg, COVID-19 threat to patient 2")
Else :
        Print("COVID-19 symptoms NOT found in any input
        X-Rays")
```

The X-ray image of the passenger is sent as input, and the Raspberry Pi board then processes it. The input X-ray image is compared with the image already stored in the SD card, and travelers can be tested for COVID-19 infection and can be quarantined to stop the further spread of the disease.

Conclusion

The result that is obtained from the proposed embedded system is helpful in the diagnosis in the lungs infection in COVID-19 patients at the entry point of railway stations, metro stations and aerodromes which are main sources of spread of the pandemic and therefore the system works as a computed tomography (CT) device, used for the diagnosis of COVID-19. This paper tends to propose a very economical and technically updated method for X-ray analysis for detecting COVID-19 patients. As the contents of the system are very much light weighted, less power consuming, and very much efficient, it is easier to apply, and the use of Raspberry Pi board makes it an efficient system. It is useful for getting optimized results.

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