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DESIGNING AN EMBEDDED SYSTEM FOR ANALYSIS OF X-RAY RESULTS FOR COVID-19 PATIENTS AS X-RAYS COMPUTED TOMOGRAPHY DEVICE FOR LUNGS DIAGNOSIS

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Abstract

COVID-19 is a disease caused by Severe Acute Respiratory Syndrome Corona Virus 2, SARS-CoV-2 .Those who have symptoms of CORONA VIRUS that triggers respiratory tract infection, it can affect their upper respiratory tract (sinuses, nose, and throat) or lower respiratory tract (windpipe and lungs).The disease becomes a threat to life when it infects the lower respiratory tract, specially lungs. The present paper tends to propose alow-cost Embedded System design which can analyze X-Ray results of lungs of a COVID-19 patient using image processing system comprising Raspberry Pi 2 Board (Model B) interfaced with data input module, SD card slot and HDMI display monitor, and compare the input data with the already stored data in the SD Card. The system acts like a Computed Tomography (CT) device for early diagnosis of COVID-19.

Keywords: Embedded System, Computed Tomography, Raspberry Pi Board.

Introduction

With advances in industrial automation, automotive technology, remote sensing, and much more, image processing is taking center stage in many embedded systems.Today, newer hardware modules with specialized GPUs are enabling image processing tasks in embedded systems without a direct connection to a desktop, server, or the cloud. These embedded systems require the right board to interface with these hardware modules. Embedded systems for advanced image processing applications, especially applications involving machine learning or AI models, require significant processing power and memory. Ideally, these capabilities integrated into a single package with a small form factor and plenty of onboard memory for storing data with network or wireless connectivity, constitute a powerful machine-learning-based image processing system. (1)

Since there are number of works have been done using Raspberry pi models in digital image processing field. Like image capturing technique in an embedded system with Raspberry Pi 1 Model B. Especially the biometric access systems like voice based access, speaker recognition, password key systems, standalone face recognition system, etc. all using Raspberry pi 1 model B or B+.Moreover the face recognition system are worked deeplyfor the security purpose and surveillance and calculation of different parameters like false rejection rate and false acceptance rate are done as an aspect as non-living things such as smart-cards, plastic cards, PINS, tokens, keys are used for authentication.(2)

Raspberry Pi 2 model B is a good choice for the system proposed in the paper,as plenty of interfaces are contained on the Raspberry Pi board, including 2 USB ports through which a Keyboard and mouse can be connected, also pen-drive can be connected to give input data, an HDMI out for connecting HD TVs and monitors with HDMI input or HDMI to DVIlead for monitors with DVI input. Other peripherals like a standard RCA composite video lead to connect to analogue display if HDMI output is not used. Ethernet port is used for networking even though it is optional, although it makes updating and getting new software for Raspberry Pi board much easier. An Audio lead is also provided for getting the stereo audio if HDMI is not used, otherwise HDMI will get digital audio with it. (3)

Image processing in embedded systems includes image identification, image segmentation and image classification, which it can store for later use. (4)

System Hardware Devices and Design

Raspberry Pi Board

This board acts as brains of the whole embedded Image processing system as given in figure 1. Its main parts include: main processing chip, memory, power supply HDMI Out, Ethernet port, USB ports and abundant global interfaces. It contains 40 pin GPIO pins, 4 x USB 2.0 ports, HDMI port, Camera display connector, Micro SD port for operating system, Micro USB power source, Video Core IV 3D graphics core, etc. (5)

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Figure 1 RASPBERRY Pi 2 (Model B)

Main Processing Chip

The main signal processing chip proposed in the system is a Broadcom BCM2836 900 MHz quad-core ARM Cortex-A7 (~6x performance) including 1 GB LPDDR2 SDRAM (2X memory) combinedto form SOC. Since it has ARMv7 processor, it can run the full range of ARM GNU/Linux distributions like snappy Ubuntu & Windows 10.

Interfaces

The SBC used is amass interfaced module. But here only an Input module is to be connected with USB port.A display monitor for recognition can be connected via HDMI output. A wi-fi communicated keyboard-mouse setup interfaced and for power enabling, MicroUSB power cable can be used. Ethernet port may also be used for networking for the whole module, though it is optional for this setup.

Hardware Design

Figure 2 depicts the block diagram of the hardware design of the proposed system

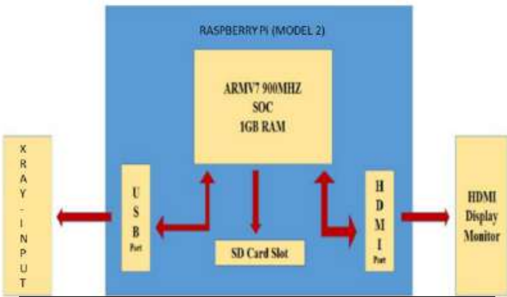

Figure 2 HARDWARE DESIGN

Methodology for Processing

The system algorithm designed here works in threephases for implementation, one is to take input of the X-ray image and creating a database into the memory,second phase is digitally converting it into a gray image and the third phase is to store the converted image at a memory location for comparing it with already stored image and use it for further data applications. It depends upon the user,one can use thealgorithm for digital image conversion applied by changing the value for red, blue & green values i.e., RGB processing.

3.1 Working of the System:

It is divided into two modes

a.) Training mode

b.) Recognition mode.

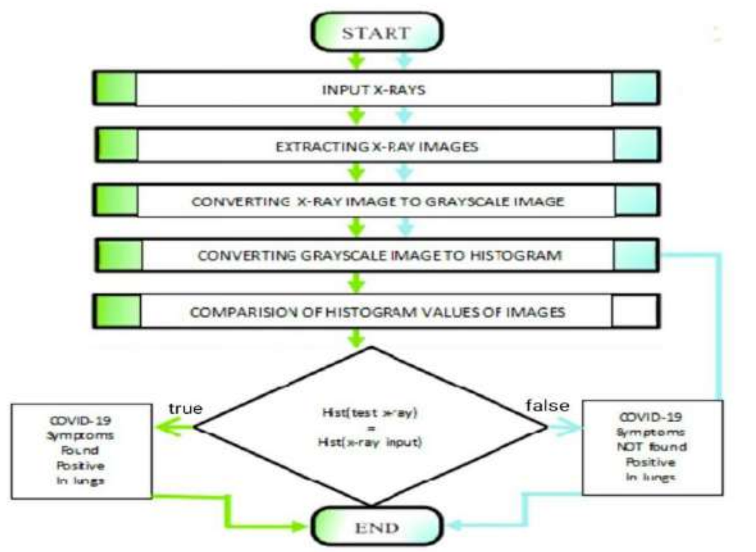

Figure 3 Algorithm for X-Ray Image Comparison using Raspberry-Pi board

Training Mode: In this mode, the system takes the X-Ray images as input in order to generate an image database, which are later sent to the Raspberry Pi board using CSI flat cable connector. An HDMI compatible Display is used to show the user about the image which is in turn stored in the image database. Like this, a large number of images of different users can be taken as input and an image database is created and stored in the SD card memory.

Recognition Mode: In this mode, the images which are taken as input from the input module are processed and compared with theimage database available in the SD card memory.

Coding

Raspberry Pi is compatible with many languages like Python, C, C++ etc., but Python is the most popular and useful one.

Here, we present an approach for writing code for the comparison of input Xrays with the Xray of COVID-19 patient. In this approach, Python language is used to compare input Xrays to a test Xray image.

CODE in Python for comparison of X-rays

This approach involves three steps, first, conversion of Xray image to gray scale image; second, conversion of grayscale image to histogram; third comparison of histogram of images.

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')
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')
```

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```
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 either X-Ray")
```

In the proposed system, the X-Ray data of lungs of COVID-19 patient is given as input and is processed by the Raspberry Pi Board, the X-Ray image is then compared to the already stored images in the SD Card and diagnosis of the infection caused by SARS-CoV-2can be done.

Conclusion

The results obtained from the proposed Embedded System help in early diagnosis of the lung infection in COVID-19 patient and hence the system works as Computed Tomography (CT) device for the diagnosis of COVID-19.This paper presents an economical and technically smart method for X-Ray comparison of COVID-19 patients, since the contents are light weighted, lower power consuming and efficient. It is easy to perform and is effective in the case of using Raspberry Pi as the central module for getting optimum results.

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