

Final Exam, 2020/2021

CENG2400 Embedded System Design

(50%) Question 4: Temperature Measurement and Face Mask Detection System

With the severe Covid-19 epidemic, temperature measurement and face mask detection systems are in high demand, especially for densely-populated areas. This is a typical embedded system and you should be able to build a prototype with what you have learnt in this course. Please answer the following questions.

(a) Let us consider the face mask detector first. Suppose we have an off-the-shelf face mask detector, which can detect whether a person is wearing the face mask or not using deep learning techniques. The input to this face mask detector is the image captured by a camera and the output is a Boolean value, indicating whether a person is wearing the mask or not. We use **MaskDetector()** to denote this function and it is provided. You're asked to use **Timer** interrupt to call **MaskDetector()** at a regular frequency and send the returned binary value to GPIO port F pin 4. Please write the complete code for initialization (both timer and GPIO) and interrupt handler. The function **MaskDetector()** is called 5 times per seconds, and the timer to use is **Timer0**.

(b) Next, let us consider temperature measurement. Suppose we have a well-calibrated infrared camera based on vanadium oxide. The parameters of the infrared detector is listed as follows: 1) Resolution: 224×224 ; 2) Temperature measurement range: $25.0^{\circ}\text{C} - 45.0^{\circ}\text{C}$; 3) Detection accuracy is 0.1°C ; 4) Effective distance range is $0.5\text{m} - 1.5\text{m}$. Based on the data from the infrared camera, we need to implement a function to detect whether a person in front of the infrared camera has fever ($>37.5^{\circ}\text{C}$) or not. To simplify the problem, let us assume that only one person is measured each time. The detection criteria is that if more than 10 pixels' temperature value in the same region (i.e., the pixels are adjacent) is higher than 37.5°C , then a person with fever is detected. Please write the code for this function **TemperatureAbnormalDetector()**, which return the Boolean value of whether a person with fever is detected.

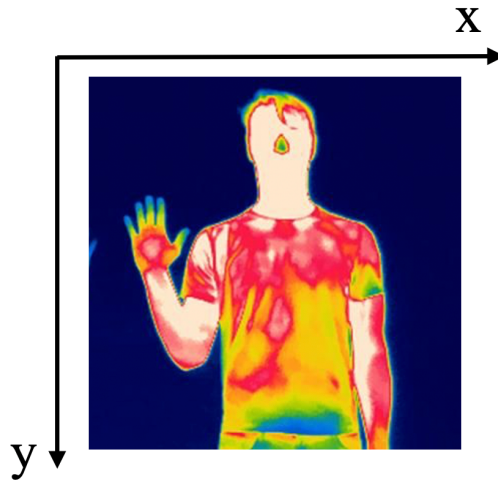


Fig 1. An example of infrared camera data. The image size is 224x224, with the value of each pixel is in range of [25.0, 45.0].

You can use function **InfraredCameraDataGet()** to get the two-dimensional temperature values and assign it to a 2-Dimensional array, e.g., **InfraredCameraDataGet()[0][0]** is the most upper-left pixel value.

(c) Please consider the task of temperature measurement and mask detection from a system perspective, write down any possible peripherals or sensors that might be useful in this system and elaborate their functionality. For example, you may use a screen to show the captured videostream.

(d) Write the task-level diagrams of whole system (including temperature measurement, mask detection and the functions you propose in question (c)). How do they interact with each others to achieve the system objectives?