RESEARCH ARTICLE

Measurement of Vital Signs Respiratory Rate Based on Non Contact Techniques Using Thermal Camera & Web Camera with Facial Recognition

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ABSTRACT Examination of the respiratory rate is included in the calculation of vital sign parameters used by the medical team to determine whether a person's condition is good or not. Researchers want to develop a method of checking the respiratory rate that is easy to use by the general public and can display fast and precise results. During this pandemic, we are forced to reduce direct human-to-human contact with the aim of suppressing the exchange of viruses. From this condition, the researcher wants to develop a measuring instrument to measure the respiratory frequency with the non-contact method. This method is expected to reduce direct contact between humans and still get the results of the respiratory rate value which can be used as a parameter to determine a person's condition. To get the value of the respiratory rate, researchers have an idea by monitoring changes in temperature using a thermal camera. For the respiratory rate parameter, the researcher observed the nose area by detecting changes in expiratory and inspiration temperatures and then calculating the respiratory rate. To get these results, the researcher uses a method of detecting the face area or called face recognition and then detecting the ROI point in the area of interest in the nose area. In observing the respiratory rate, the temperature value during expiration is 31.05 °C while at the time of inspiration is 30.01 °C. This temperature difference will be carried out in the process of calculating the respiration rate value by the system made by the researcher. In the results of this study, it was found that the respiration rate module can be used as a reference with a normal use range of 60-120 cm with an error value of 1% if the distance is above 100 cm, then the results of this study are that this research can be implemented on a breathing frequency measuring instrument with a non-standard method. - contact

INDEX TERMS Breathing Rate, Non-Contact Method, ROI, Region of Interest, Thermal Camera

I. INTRODUCTION

One of the tests used to assess whether a person is in good health is to check their respiration rate and body temperature. The evaluation of essential vital signs includes this. The process of oxygen and carbon dioxide gases entering and leaving the lungs is referred to as breathing rate. The normal respiratory rate ranges from 12 to 20 beats per minute, depending on age, gender, physical condition, and emotional state [1][2]. The COVID-19 virus resembles the SARS virus in appearance. Fever and shortness of breath are common symptoms. To prevent the spread of the COVID-19 virus, it is vital to have a non-contact measurement technology that

can swiftly and correctly assess the true state of the respiration rate and body temperature [3][4]. Thermal cameras have been widely utilized in medicine to detect heat from the human body, particularly to identify breast cancer [5]. A number of researchers are also working on infrared thermography technologies that use facial recognition to obtain data of respiration rate and body temperature [6]. Using machine learning methods, the AMG8833 thermal camera module with 8x8 pixels and the OV7670 camera module can assess the position of body temperature readings exactly on the face area [3]. The change in temperature

during the inspiration and expiration processes may already be read by the A40 type thermal camera, which is utilized to record breathing films by cropping the image in the nasal area (ROI) region of interest [7][8]. The MATLAB data processing application was chosen because it could detect the ROI region of interest and the ROM region of measurement on face patterns, yielding temperatures of 31.17°C during inspiration and 31.44°C during expiration. The sonolab2 piezoplethysmography tool was used to compare the reading data [9][10]. Using CCL approaches for elliptical detection, determining the point of reading the greatest temperature of 37.02 and the lowest temperature of 27.02. To define the ROI region on the nose, divide the facial area into six equal sections. [11] Researchers hope to detect temperature values during the process of inspiration and expiration by selecting a location near the bottom of the tip of the nose and close to the mouth, which will be reinforced with a butterworth digital low pass filter to reduce noise values from unreliable readings [12].

The combination of the AMG8833 8x8 pixel low resolution thermal camera with the OV7670 camera module has been able to perform face detection to read body temperature in the forehead area and get clear photos, based on the theory from earlier research. The researcher employs a methodology that involves using the algorithm method at the midway of the x and y faces and being able to take data every five seconds [3]. Using the LWIR long wave infrared and MWIR mid wave infrared therma cameras, other journals have created an analysis of respiration rate and body temperature measurements. Because the therma camera already has a pretty excellent resolution in facial recognition to determine the ROI region of interest reading data and ROM region of measurement to get the results of the respiratory rate and body temperature values, it is not integrated with an RGB red green blue camera [6][13]. The problem of employing LWIR long wave infrared and MWIR mid wave infrared therma cameras is that they are pricey and still require extra equipment, such as a boogle to read the images to a computer. According to the researcher's proposals, a low-cost technique of respiration rate and body temperature analysis can be established [13].

Based on the requirement for extensive and extensive non-contact examinations of respiratory rate and body temperature data in order to minimize viral transmission between persons. Researchers want to develop "Measurement of Vital Sign Breathing Rate - Body Temperature Using Non-Contact Techniques Thermal Cameras & WEB Cameras With Face Recognition Methods - Breathing Rate Parameters" - Body Temperature Parameters using facial recognition techniques in the nose area for respiratory rate parameters and the forehead area for body temperature parameters using facial recognition techniques. The researchers employed a UTi-260B series thermal camera with a resolution of 256 X 192 that was combined with a Logitec C270 series web camera with a resolution of 720p/30 fps as hardware components.

This article is consists of Chapter 1 Introduction, Chapter 2 Material and Methods, Chapter 3 Result, Chapter 4 Discussion, Chapter 5 Conclusion, and Chapter 6 Reference.

II. MATERIALS AND METHODS

A. EXPERIMENTAL SETUP

Researchers conducted this technique to calculate the respiratory rate of five participants. Researchers start collecting data on the value of the respiratory rate at a distance of 60 to 120 cm. Before collecting data on respiratory rate values, researchers determine and record ambient factors such as room temperature, light intensity, and humidity.

1) MATERIALS AND TOOLS

The hardware utilized is a Logitec C270 series web camera with a resolution of 720p/30 fps and a UTi-260B series thermal camera with a resolution of 256 X 192. A USB cable is used to communicate data between the UTi-260B series thermal camera and the Logitec C270 series web camera.

2) EXPERIMENT

To test the system, the researcher first classifies the usual adult respiration rate, i.e. (15-20) breaths per minute, and then places a distance indication on the floor, i.e. 60, 70, 80, 90, 100, 110, and 120 cm, as a reference for participants recording data. The breath per minute data took the researchers five minutes for each individual. In addition, five people were used, two of whom were women and three of whom were men.

B. THE DIAGRAM BLOCK

Fig.1 The participant stood silently in front of the web and thermal cameras. Researchers work at a distance of 60–120 cm when conducting analysis and data collection. When there is a face detection method and a nose area detection or ROI region of interest for participants, web cameras and thermal cameras can begin the data gathering process. The data processing for web cameras and thermal cameras is done entirely on a personal computer using Python software. The technology built by the researcher produces graphic data on respiratory rate as its output.

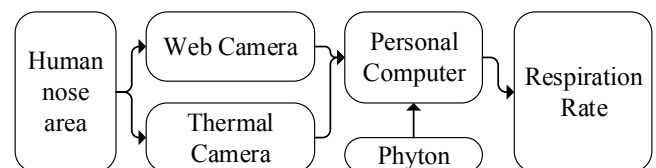**FIGURE 1.** The Diagram Block

C. THE FLOWCHART

Fig.2 The web camera and thermal camera are used in the first stage to initialize the image by recognizing the presence of a face. Inmates must stand silently in front of the web camera and thermal camera at a distance defined by the researcher, which is between 60 and 120 cm. The system's second step will identify the presence of a face marked with

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a green box in the face region; if this does not happen, the web camera and thermal camera initialization processes will resume. The technology will detect the nose area (also known as the ROI region of interest) in the third stage. The value of the color code variable in the expiry and inspiration processes was determined in the fourth stage of the ROI region of interest detection method. The value of the color coded variable that can be retrieved will be added in the fifth stage using the program that the researcher has produced. The value's sixth stage is represented by a chart of respiratory rate in RR units (respiration rate).
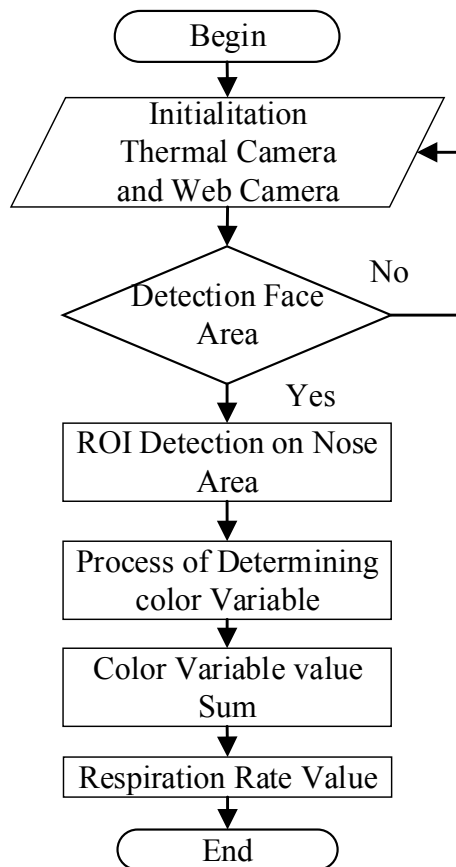
used two circumstances to test the accuracy of the web camera and thermal camera modules: conditions with maximum light and conditions with medium light. So that researchers can collect a wider range of data. The difference in the value of each distance that has been identified for further investigation is acquired by researchers using data on the value of the respiratory rate based on the distance that has been previously determined.
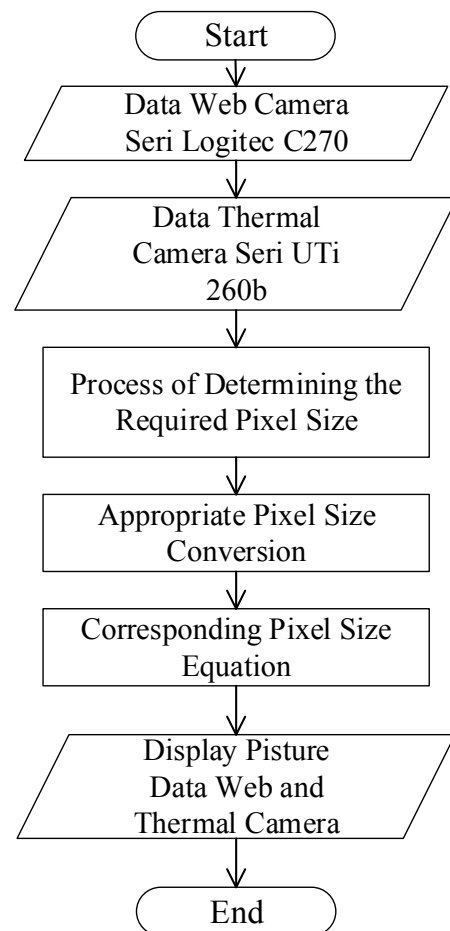

FIGURE 2. The Flowchart Program

Fig.3 The researchers employed a web camera and a thermal camera with varied pixel properties. On the web camera, there's a landscape, and on the thermal camera, there's a portrait. Researchers must modify the sizes of the two photographs due to the differences in pixel size features in the hopes of obtaining the correct pixel value. The original image's pixel size table and the image after conversion are attached.

III.   RESULT
A.   DESIGN MODULE BUILD
Fig.4 The researchers collected data from five distinct people at a distance of 60-120 cm. The researcher compared the results with the data from the patient who was monitoring the breathing rate parameter during the analysis. The researchers

FIGURE 3. The Flowchart of Conversion Picture Pixel

B. RESULTS OF COLLECTING BPM VALUE DATA FROM RESPONDENTS

Table I shows that the average value of the respiratory rate module data is 13.8-14.6, whereas the comparison value is 13.8-14.6. Participants with the lowest STDV value, mainly those named Devi, had a value of roughly 0.44 and a correction value of 1. Meanwhile, the participant with the name Roni has the highest STDV value of 0.89, and the correction value is ranked second.

Table II shows data collected at a distance of 120 cm. The STDV value and correction value are fairly substantial, particularly for the participant Febri, who has an STDV value of 2.3 and a corrective value of 5.14.

The data received on the web camera and thermal camera modules are completely influenced by distance, as well as

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lighting conditions and room temperature, according to the examination of the two tables above. Because the thermal module of the camera is designed to read the ambient temperature.

TABLE 1

Data collection in distance of 60 cm between object and cameras

Subjects	Mean (RR)		SD (RR)	Correction (RR)
	Design	Standard		
1	14,2	14,2	0,44	1
2	14,4	14,6	0,54	1,22
3	13,8	13,8	0,44	1
4	14,6	15	0,89	2
5	14,6	14,6	0,54	1,22

TABLE 2

Data collection in distance of 120 cm between object and cameras

Subjects	Mean (RR)		SD (RR)	Correction (RR)
	Design	Standard		
1	14,2	14,2	0,44	1
2	14,4	14,6	0,54	1,22
3	13,8	13,8	0,44	1
4	14,6	15	0,89	2
5	14,6	14,6	0,54	1,22

FIGURE 4. Measurement setup between the design and standard device

The thermal camera uses a portrait image format with a resolution of 476 x 863 pixels, while the web camera uses a landscape image format with a resolution of 1280 x 640 pixels. Due to the disparity in picture formats, researchers must perform size conversions in order to obtain the same pixel value in the hopes of obtaining the correct reading point in the nose's regional ROI area of interest. The images below were captured using web cams and thermal cameras. We can see the pixel size of the image before and after it is converted using Python software.
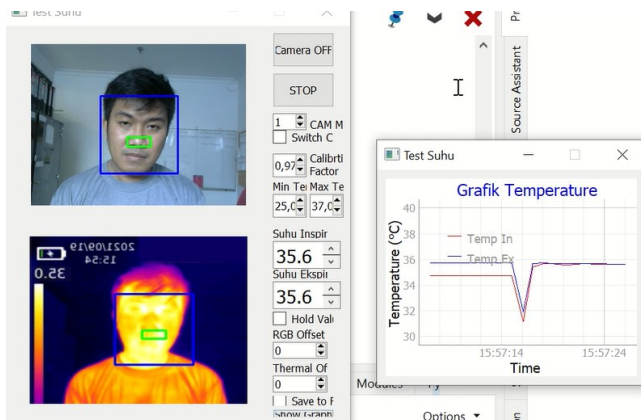
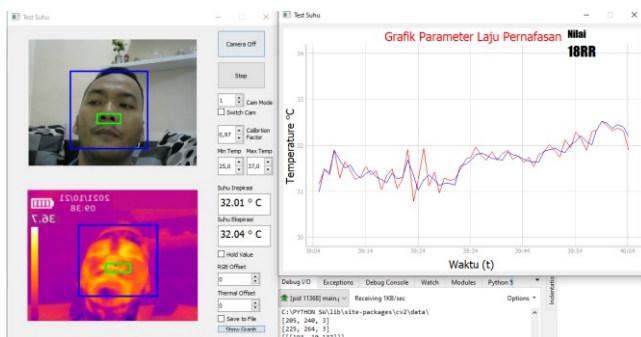**FIGURE 4.** The Respondent's trial process with the proposed system

FIGURE 5. Testing respiration rate system with Face and Nose Area detection

IV. DISCUSSION

In this study, the pixel values of web cameras and thermal cameras differ because the web camera format is landscape while the thermal camera format is portrait. A conversion step is required to equalize the pixel sizes of the two cameras, allowing the researcher to read the results of the respiratory rate from changes in expiratory and inspiratory temperature data. The software will automatically transform the image to fit the available frame because the frame in the GUI graphical user interface application has a pixel size of 640x360, but the web camera's pixel specifications are 1280x720 and the thermal camera's pixel specs are 647x843. The program system must be able to perform two phases in order to read the respiration rate value, the first of which is detecting a face or face detection, which is indicated by a blue box when a face is discovered. The second stage is to locate the ROI region of interest in the nasal area, which is indicated by a little green box. The two stages are linked so that the value and graph of the respiratory rate can be displayed.

Using Python software, the web camera and thermal camera module applications can read the respiration rate values in the nasal area. For the face detection method, a web camera with the OpenCV library's Cascade Classifier was employed. This distinguishes this research from others [7][8].

There are still discrepancies in the reading of the respiratory rate value when compared to the monitor patient phantom, which is one of the limits of the researcher's web camera and

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thermal camera module system. When data retrieval is performed across a distance of 100 cm, it can be difficult to view the findings using the web camera and thermal camera modules. This occurs because the two cameras have trouble detecting the position of the nose on the face, resulting in an illegible ROI region of interest value.

As for development suggestions, one is to use a more pocket or portable thermal camera to read the respiratory rate, so that it can be integrated directly with smartphones with online data storage using the Open Java android application.

V.   CONCLUSION

The goal of this research is to create a non-contact body temperature measurement system that can decrease direct human contact while still obtaining the results of the respiration rate value, which can be utilized as a metric to identify a person's condition. The temperature value during expiration is 31.05°C, whereas it is 30.01°C during the inspiration phase, according to the respiratory rate. This temperature difference will be calculated as part of the researcher's system's calculation of the respiratory rate value. The respiration rate module can be used as a reference with a normal usage range of 60-120 cm and an error value of 1% if the distance is greater than 100 cm, according to the findings of this study. contact.

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APPENDIX

1) INITIALITATION PROGRAM WEB CAMERA AND THERMAL CAMERA.

```
        """Initialize camera.
        """
    if self.cameraMode:
        #captureCheck = cv.VideoCapture(1,
    cv.CAP_DSHOW)
          if (self.checkCAM.isChecked()):
            #captureCheck.release()
            print(self.spinCAMMode.value())
            if (self.spinCAMMode.value() == 0):
              self.captureRGB = cv.VideoCapture(0,
    cv.CAP_DSHOW)
              self.captureThermal = cv.VideoCapture(1,
    cv.CAP_DSHOW)
            elif (self.spinCAMMode.value() == 1):
              self.captureRGB = cv.VideoCapture(0,
    cv.CAP_DSHOW)
              self.captureThermal = cv.VideoCapture(2,
    cv.CAP_DSHOW)
            else:
              self.captureRGB = cv.VideoCapture(1,
    cv.CAP_DSHOW)
              self.captureThermal = cv.VideoCapture(2,
    cv.CAP_DSHOW)
            print("Go")
        else:
```

2) A PROGRAM TO DISPLAY IMAGES ON A GUI (GRAPHICAL USER INTERFACE) FRAME.

```
"""Read frame from camera and repaint QLabel widget.
    """
    try :
      _, self.frameRGB = self.captureRGB.read()
      self.frameRGB  =  cv.cvtColor(self.frameRGB,
cv.COLOR_BGR2RGB)
(self.labelRGB.frameGeometry().width(),
self.labelRGB.frameGeometry().height()),  interpolation
= cv.INTER_AREA)
        height, width, channels = self.frameRGB.shape;
        scale_percent = 50 # percent of original size
        width   =   int(self.frameRGB  .shape[1] *
scale_percent / 100)
        height  =  int(self.frameRGB  .shape[0] *
scale_percent / 100)
        dim = (width, height)
```

3) OPENCV LIBRARY FOR FACE DETECTION AND ROI IN THE NOSE AREA

```
self.face_cascadeRGB                          =
cv.CascadeClassifier(cv.data.haarcascades      +
'haarcascade_frontalface_default.xml')
        self.nose_cascadeRGB =
cv.CascadeClassifier(cv.data.haarcascades +
'haarcascade_mcs_nose.xml')
```

4) PROGRAM FOR MAKING SQUARES ON THE FACE AND NOSE AREA

```
self.facesRGB                                 =
self.face_cascadeRGB.detectMultiScale(gray, 1.3, 5)
          for (x,y,w,h) in self.facesRGB:            #B,
  G, R

  cv.rectangle(self.frameRGB,(x,y),(x+w,y+h),(0,0,255),
  2)
            roi_gray = gray[y:y+h, x:x+w]
            roi_color = self.frameRGB[y:y+h, x:x+w]
            #nose                               =
self.nose_cascadeRGB.detectMultiScale(roi_gray)
            offsety = int(0.4 * h) + self.spinRGB.value()
  + 8
            #offsety    =    int(0.90   *   h)   +
self.spinThermal.value()
            hh = int(h/160*20)
            ww = int(w/160*50)
            offsetx = int(0.5*(w-ww))
self.noseRGB = [[offsetx,h-offsety,ww,hh]]
            for (ex,ey,ew,eh) in self.noseRGB:

  cv.rectangle(roi_color,(ex,ey),(ex+ew,ey+eh),(0,255,0),
  2)
            self.objectDetect = 1
      image         =         QImage(self.frameRGB,
  self.frameRGB.shape[1], self.frameRGB.shape[0],
                self.frameRGB.strides[0],
  QImage.Format_RGB888)

self.labelRGB.setPixmap(QPixmap.fromImage(image))
```

5) EQUATION TO DETERMINE THE VALUE OF THE RESPIRATION RATE BASED ON TEMPERATURE DATA.

```
self.temp  =  ((t_max-t_min)/(0xFFFFFF)*(h_color)  +
t_min) * self.spinCal.value()
                self.temp                       =
self.averagetemp.process(self.temp)
self.tempArray.process(self.temp)
                self.thres                      =
(max(self.tempArray.values)+min(self.tempArray.value
s))/2
                self.thres =
self.averageThresh.process(self.thres)
```

6) A PROGRAM TO DISPLAY IMAGES ON A GUI (GRAPHICAL USER INTERFACE) FRAME.

```
"""Read frame from camera and repaint QLabel widget.
    """
    try :
      _, self.frameRGB = self.captureRGB.read()
      self.frameRGB  =  cv.cvtColor(self.frameRGB,
cv.COLOR_BGR2RGB)
```

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```
(self.labelRGB.frameGeometry().width(),
self.labelRGB.frameGeometry().height()),   interpolation
= cv.INTER_AREA)
        height, width, channels = self.frameRGB.shape;
        scale_percent = 50 # percent of original size
        width    =    int(self.frameRGB   .shape[1]   *
scale_percent / 100)
        height   =    int(self.frameRGB   .shape[0]   *
scale_percent / 100)
        dim = (width, height)
```

7)   PROGRAM TO DISPLAY REAL TIME.

```
xtime                                      =
str(datetime.now().hour).zfill(2)+":"+str(datetime.now()
.minute).zfill(2)+":"+str(datetime.now().second).zfill(2)
        data                               =
[str(xtime),str(self.tempIn),str(self.tempEx),str(self.temp),str(self.thres)]
        print(data)
        self.csvWriter.writerow(data)
```

8)   PROGRAM TO DISPLAYRESPIRATION RATE
     GRAPH.

```
if self.checkSave.isChecked():
        self.filename                      =
str(datetime.now().year)+str(datetime.now().month)+str(
datetime.now().day)+'-'
        self.filename                      =
self.filename+str(datetime.now().hour)+str(datetime.now().minute)+str(datetime.now().second)+'.csv'
        print(self.filename)
        self.file = open(self.filename, 'w',newline='')
        self.csvWriter = csv.writer(self.file)
        header = ['time','temp in','temp ex']
        self.csvWriter.writerow(header)
        self.isSave = 1
    else:
        self.file.close()
        self.isSave = 0
        print('else')

  def slotBtnShow(self):
     print("OK")
     self.graphWindow.show()
```

ATTACHMENT

- Schematic and Board :
  https://drive.google.com/drive/folders/1mB_rJTfaiAfz
  9O_RTY8XcFzfMf8yclSR?usp=sharing

- Listing Program :
  https://drive.google.com/drive/folders/1mB_rJTfaiAfz
  9O_RTY8XcFzfMf8yclSR?usp=sharing