Chapter 1 : Introduction

1.1 Introduction

All objects, including human bodies, emit electromagnetic radiation or infrared radiation. The wavelength of radiation emitted depends on the temperature of the objects. Such radiation is sometimes called thermal radiation. Most of the radiation emitted by human body is in the infrared region, mainly at the wavelength of 12 micron. The wavelength of infrared radiation is between 0.75 to 1000 micron (1 micron = 10-6 metres). This wavelength is longer than that of red visible light so this explains the name 'infrared', meaning 'beyond the red'.

The amount of thermal radiation emitted by an object depends on its surface temperature, area and characteristics. Warmer object emits more thermal radiation than cooler one. Handheld infrared ear or forehead thermometers are used to probe body temperatures by detecting the infrared radiation emitted by human bodies. We will develop a system which will capture this thermal energy from different objects.

In thermal infrared imaging needs to have control in ambient environment conditions.Therefore,before taking pictures body should acclimatize to the room.Once it is got accustomed to the surroundings,the subtle temperature can be easily managed of the thermal infrared imaging.The dynamic range is greater than 72db,capacity is 18*(10^6) electrons which is digitized to 12 bits.It enables tracking subtle thermal variation .If range is 16 bits and not 12 bits there is more accuracy.

Emissivity plays an important role in thermal infrared imaging .It represents the ability of an object to emit thermal radiation.the emissivity of an object basically depends on two factors temperature and infrared wavelength.A black body has an emissivity of “1” whereas an ordinary body has emissivity less than “1”.

1.2 Problem Statement

To capture the ultra weak photon emission of all the objects in an image and to observe and analyze the energy which surrounds all the objects by using bio-photon emission so as to prevent hurdles such as illness ,diseases, stagnant energy etc, by keeping a healthy environment with the help of holistic healers and practitioners.

1.3 Relevance of the Project

Thermal imaging is the technique of using the heat given off by an object to produce an image of it.It works in environments without any ambient light and can penetrate obscurants such as smoke,fog,haze.Thermal sensor add colour to objects to help users to identify objects at different temperatures. Thermal sensors record the current signatures of the objects based on their heat pattern.

When different colours are gained in an image one can differentiate or classify under which category does the object belong.Once the object is classified it can further be analyzed in various applications.In the field of medical, if the object detects red colour means there is danger over that area.Similarly for other applications it can be used.On the other hand we have classified objects in categories of hot,cold,normal etc. as our project is on a small scale with the help of using tensorflow technique.

1.4 Methodology Used

The system implementation starts with a thermal sensor which captures the infrared radiation from the object as each object emits some radiation. So this radiation gets captured by sensor and converts it into into electrical signal . Captured signals then get divided into matrix and this matrix represents the pixels format as on that pixel what is the value of the radiation. These pixel matrix values get mapped as per their values with respect to it's colours. These colours and their values are computed by microcontrollers which gives pseudo colore images as output.

The scene to be imaged is captured by the thermal sensor as 16 by 4 matrix. Each element of the array is a pixel. The temperature value of each of these 64 pixels is calculated with the help of microcontroller. The sensor and the microcontroller communicate through the I2C bus. The microcontroller reads the calibration values from the sensor's EEPROM. The calibration coefficients are stored in microcontroller's RAM for easy access during calculations. Then the 16-bit result of IR measurement for each individual sensor (64 words) and the 16-bit result of PTAT (proportional to absolute temperature) sensor are read from the sensor's RAM. PTAT sensor measures the ambient temperature of the chip and stores the value in the sensor's RAM. The sensor is by default in continuous mode i.e. it measures the temperature of the scene continuously. Calculation of object temperature includes ambient temperature calculation, pixel offset cancelling, pixel to pixel normalization and object emissivity compensation. The temperature of each pixel of the object in degree Celsius is obtained at the end of the calculations.

Serial data from the microcontroller is read by the PC. Temperature values are divided into different ranges and each range is represented by an RGB value. The 64 temperature values are represented by a pseudo colour depending on the range in which it belongs.

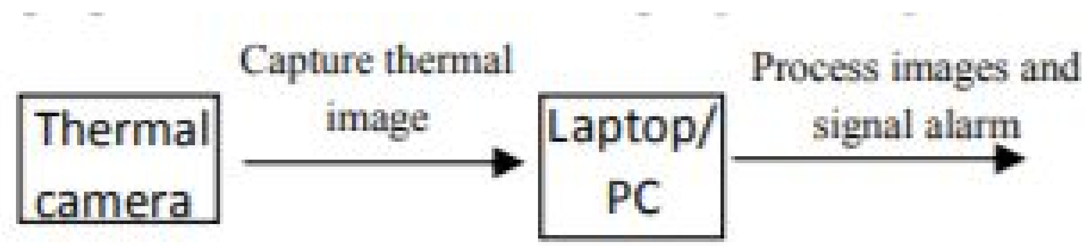
Chapter 2 : Literature Survey

2.1 Literature survey and its various sources

1. An Effective Surveillance System Using Thermal Camera

In this paper, two simple and fast detection algorithms are embedded into a cost effective thermal imaging surveillance system. This surveillance system is not only used for monitoring the functioning condition of different machines in a factory site, but can also use for detecting the trespassers in a poor lighting condition.

The system is very simple, it required a fine resolution thermal camera and a laptop/PC with Matlab ver 7.0 programming.



Fig(1): Working of thermal imaging system.

The experimental results show that the proposed surveillance system achieves high accuracy in monitoring machines conditions and detecting trespassers.

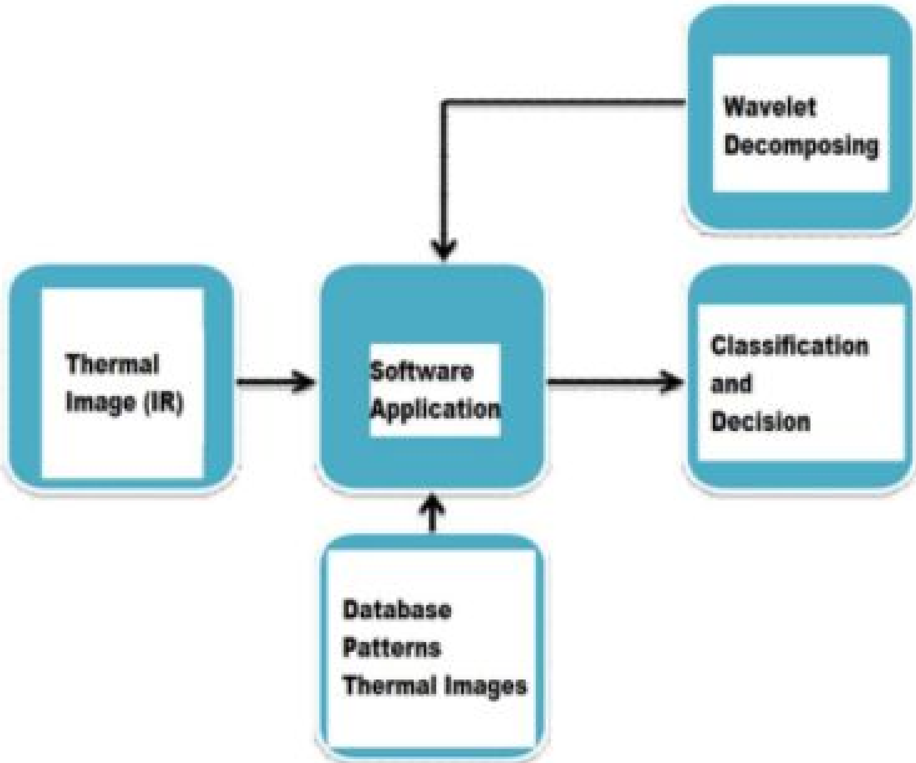
In future, an automatic power supply control system will be added to the machine condition monitoring system. When the monitoring system detected any of the machines overheated, the automatic power supply control system will cut off the power supply of the respective machine(s).This enhancement can reduce hands on workload, man power and maintenance time.

2.Analysis Of Facial Expressions Using Thermal Imaging.

In this study we try to simultaneously analyze the human emotional state by integrating the obtained data from the bio signals and the facial expressions obtained by using a thermal camera (IR). Facial thermograms are not affected by lighting, shadows and so on. In fact, they can be perfectly and entirely captured in the dark (also, no external lighting is required).

The thermal images are decomposed using the wavelet algorithms and multiple levels of decomposing and associated functions (Gabor, Haar, Mexican hat). Since wavelet transformations act like filters, the resulting images will highlight certain areas of the face and implicitly the temperature changes (for example, the changing of the temperature around the eyes and face, in general. Using the correlation functions (convolution) we can compare the images from the database built on patterns with the images obtained in real time. Based on the comparison, a decision can be determined about the emotional state of the investigated person.

The thermal image acquired is processed using the SIFT algorithm (Scale Invariant Feature Transform), then both thermal images (the original and the one processed using SIFT) are decomposed using Haar and Daubechies wavelet functions. The two decompositions are recomposed (data fusion), thus creating two sets of training and testing using a multilayer perceptron for classification.



Fig(2): Class diagram of thermal imaging system

2.2. Papers and books

(1) Biophotons The Light In Our Cells

Abstract

Light is not only what brightens up our world day by day and makes us see things around us,light is also produced by our own cells and forms a major component of man's inner environment and a non material part of our bodies connecting us with the outer environment .The existence of this endogeneous light has been discovered in the 1920's by the Russian embryologist Alexander Gurwitsch and has been conclusively demonstrated by modern biophysicists since the late 1960's with state of art technology and methods.

Inference

Based on the photoelectric effect, appropriate photomultiplier systems have been developed in order to detect this very weak light. Biophotons emission correlates strongly with all the life activities of organism. Biophysical research has measured low light impulses,called biophotonic emission, in cells and biological tissue It is now known that all cells (plant, animal or human) emit a weak, called biophotonic radiation. The emission is extremely low in mammalian cells, it can be efficiently induced by light leading to delayed luminescence.Coherence is one of the important role in biophotons.It gives light with high degree of order due to which information can be transmitted and stable intensity.All molecules of an organism are coupled by a coherent radiation field,so biophotons have to be considered as a whole by an organism.this coherent biophoton field carries all the life processes.

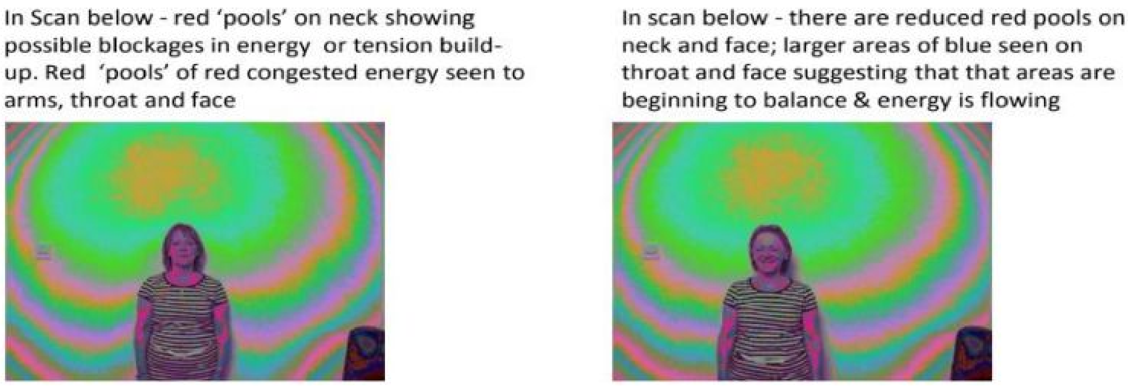


Fig.2 Scan output

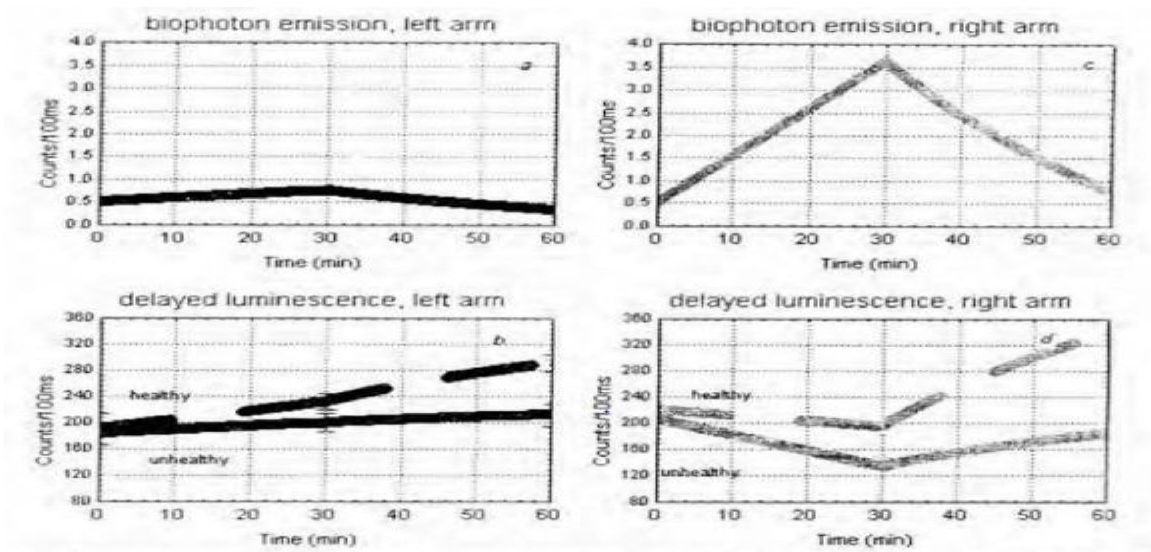
(2) Biophoton Emission Of Human Body

Abstract

In recent years the literature on biophotons has increased drastically, since it is accepted now that biophoton emission is, in contrast to common bioluminescence, a universal phenomenon linked to all living systems and provides a new non-invasive and powerful tool of investigating cellular tissues. Although some theoretical problems are still unsolved, the application of biophoton emission now stretching quickly to new fields such as bio-sensing and food-quality controls.A completely new area of this development is the analysis of the biophoton emission of the human body. \

Inference

For the first time systematic measurements of thc "ultraweak" photon emission of the human body (biophotons) have been performed by means of a photon detector device set up in darkness. About 200 persons have been investigated. In a particular case one person has been examined daily over several months. It turned out that this biophoton emission reflects, thc left-right symmetry of thc human body biological rhythms such as 14 days, 1 month, 3 months and 9 months and disease in terms of broken similarity between left and right side. Light channels in the body. which regulate energy and information transfer between different parts. The results 6 show that besides a deeper understanding of health, disease and body field, this method provides a ncw powerful tool of non-invasive medical diagnosis in terms of basic regulatory functions of the body. eg(psoriasis)



Fig(3): Variation in energy of different body parts.

figure.3-variations of biophotons emission and delayed luminescence of left arm(a, b) and right arm (c, d) of a psoriasis patient after 5 min exposure to UV-A lamp on right arm.

(3)Clinical studies of biofield therapies :Summary ,Methodology challenges and Recommendations.(Article)

Abstract

Biofield therapies are noninvasive therapies in which the practitioner explicitly works with a client's biofield (interacting fields of energy and information that surround living systems) to stimulate healing responses in patients. While the practice of biofield therapies has existed in Eastern and Western cultures for thousands of years, empirical research on the effectiveness of biofield therapies is still relatively nascent. In this article, we provide a summary of the state of the evidence for biofield therapies for a number of different clinical conditions. We note specific

methodological issues for research in biofield therapies that need to be addressed (including practitioner-base outcomes-based, and research design considerations), as well as provide a list of suggested next steps for biofield researchers to consider.

Inference

In this paper,biofield therapies are defined as noninvasive, practitioner-mediated therapies that explicitly work with the biofield of both the practitioner and client to stimulate a healing response in the client. Biofield was defined as “a massless field, not necessarily electromagnetic,that surrounds and permeates living bodies and affects the body.” For this paper, we expand the definition to consider biofields as endogenously generated fields,which may play a significant role in information transfer processes that contribute to an individual’s state of mental, emotional, physical, and spiritual well being.To summarize, the evidence base regarding clinIcal effectiveness of biofield therapies is strongest in symptom management for pain and cancer, the 2 conditions that have received the most study. Studies are more sparse but evidence is promising for clinical populations with arthritis, dementia, and heart disease.To better assess the impact of biofield therapies and evaluate their delivery in various settings, we make recommendations for researchers planning future clinical trials in biofield therapies

(4) Analysis Of Correlation Between BMI And Human Physical Condition Using Resonant Field Imaging System (RFI)

Abstract

This technical paper investigates the correlation of body mass index (BMI) and human physical condition using resonant field imaging system (RFI).The results show the state of health level of students using physiological analysis. Frequency measurement is taken for 40 students including male and female students of electrical engineering around 8 am to 6 pm. The objective is to investigate the relationship of different health condition with different BMI category such as underweight, normal, overweight and obese. Based on the results presented, it is concluded that the samples with normal BMI are generally healthier. This shows that there is a clear and direct psychosomatic connection to the area of bioenergy. It also implies that pure and high frequency electric field energy is projected from parts of the body.

Inference

RFI basically deals with the psychosomatic (Interaction Of Mind and Body) connection of areas related to bioenergy. The bioenergies get affected due to physical and emotional conditions.Metaphysical energies consist of immediate surroundings electric field energies that carry information.Electromagnetic fields are identified by their frequencies so can metaphysical energies be identified.Color is also defined by it's frequency.Frequency reveals type and function of energy.Aura itself is an electromagnetic radiation of diverse frequencies so it can be identified by color chart.RFI is external type of Magnetic Resonant Imaging which consists of handheld digital frequency ,specially tuned antenna and computer software. When there is high impedance low current is achieved and so is low frequency detected.RFI has 36 distinct regions : 17 are used for health levels and the rest of the 7 are used for endocrine system.

Chapter 3 : Requirement of Proposed System

3.1 Functional Requirements

- **Distance**

Distance between IR thermal sensor and object should 10-15cm. As the thermal sensor size is small so it can detect objects in this ranges. Object is correctly position then it will give proper readings, colours and shape.

- **Input**

The input provided to the system should be small because the sensor which will detect it is a 8*8 matrix i.e 64 pixels matrix.

- **Proper Connection(No Circuit Break)**

The sensor and all the hardware components should be well connected with the software.We have a command called i2c which helps in checking whether the circuit is connected or not.

- **Capturing Image**

One should make sure that there is no error while capturing an image from the displayed output.

3.2 Non-Functional Requirements

- **System Security**

  Given system should be secure so that no mischief or virus takes place in the trained data as well as with the overall code and system.

- **Response Time**

  Response time is also a major parameter because when system takes less time for processing the computation takes place.

- **Should Be Compatible**

  In today's world there are many products with the same features,so one system should be more efficient and compatible the the rest.

- **Versatile**

  The system should be versatile in any situation.There are many new products developed daily so the system should adapt to the environment and in turn give better performance.

3.3 Constraints

- The range of the temperature should be adjusted according to the surroundings.
- We need to maintain all the necessary conditions of the surrounding i.e. lightning conditions, temperature, distance between the subject and the IR sensor.
- Thermal energies can be reflected off shiny surfaces,so no glass based product should be used as they cannot see through glass.
- The object cannot be detected more than 7m.
- Presence or absence of windows which can alter room temperature.
- Type of heating or air conditioning for thermal regulation of the room.

3.4 Hardware, Software, Technology and Tools

Hardware Specification

- Adafruit AMG8833 IR Themal Camera Sensor
- Raspberry Pi 3 - Model B - ARMv8 with 1G RAM
- 4GB RAM
- 500MB Hard Drive
- Dual core Processor
- Graphic Card

Software Specification

- Python
- Putty
- Xming

3.5 Selection of the Hardware, Software, Technology and Tools

Hardware Selection

- **Microcontroller**

  Raspberry Pi 3 - Model B - ARMv8 with 1G RAM - It gives better interpolation techniques and it is fast processing.
- **Thermal Sensor**

  Adafruit AMG8833 IR Themal Camera Sensor

Software Selection

- **Python**

  Python is an interpreted high-level programming language for general-purpose programming. Python has a design philosophy that emphasizes code readability, notably using significant whitespace. It provides constructs that enable clear programming on both small and large scales.Python features a dynamic type system and automatic memory management. It supports multiple programming paradigms, including object-oriented, imperative, functional and procedural, and has a large and comprehensive standard library.

- **Tensorflow**

TensorFlow is an open-source software library for dataflow programming across a range of tasks. It is a symbolic math library, and also used for machine learning applications such as neural networks.

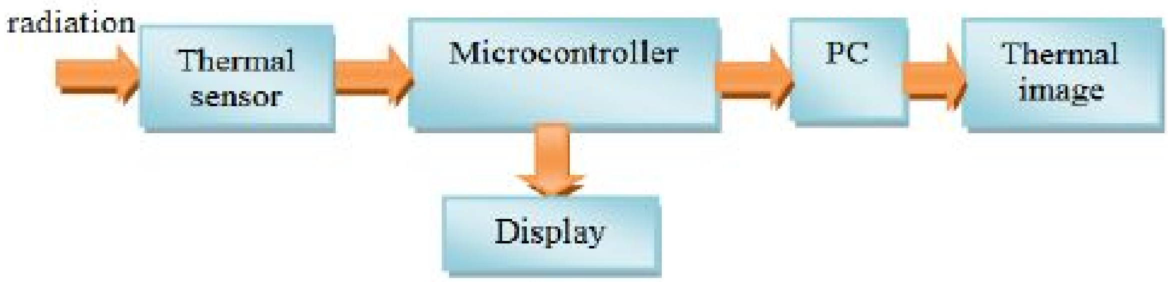
Algorithms: a method (with a finite amount of space and time) used to solve a class of problems. Eg. neural networks.

Libraries: used in implementing the algorithms.

Tensorflow is an open source library developed by Google brain team, used for machine learning applications such as neural networks.So one doesn't use tensorflow for classification. It is used to prepare a neural network that will do the classification (or solve some other class of problem).

Chapter 4 : Proposed Design

4.1 Block diagram of the system



Fig(4): Block diagram of proposed system.

The system consists of IR thermal sensor (Adafruit AMG8833), a microcontroller (or raspberry Pi) and other essential hardware components.The sensor from Panasonic is an 8x8 array of IR thermal sensors. When connected to your microcontroller (or raspberry Pi) it will return an array of 64 individual infrared temperature readings over I2C.This sensor will measure temperatures ranging from 0°C to 80°C (32°F to 176°F) with an accuracy of +- 2.5°C (4.5°F). It can detect a human from a distance of up to 7 meters (23) feet. With a maximum frame rate of 10Hz, It's perfect for creating your own human detector or mini thermal camera. We have code for using this breakout on an Arduino or compatible (the sensor communicates over I2C) or on a Raspberry Pi with Python. On the Pi, with a bit of image processing help from the SciPy python library we were able to interpolate the 8x8 grid and get some pretty nice results.

Wiring up the sensor with Raspberry Pi:

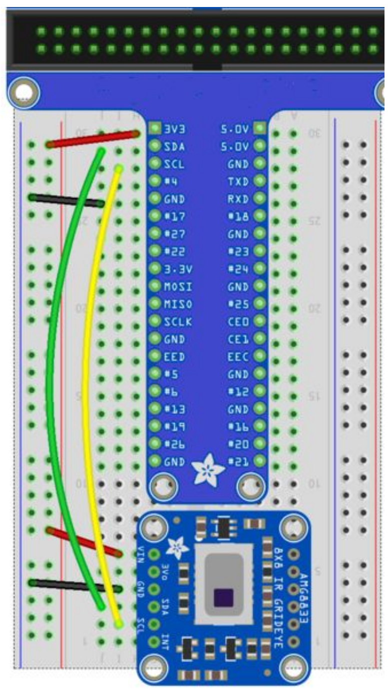
With the Pi powered off, we can wire up the sensor to the Pi like this:

- Connect **Vin** to the 3V or 5V power supply (either is fine).
- Connect **GND** to the ground pin on the Pi.
- Connect **SDA** to **GPIO2** on the Pi.
- Connect **SCL** to **GPIO3** on the Pi.

Now, connect the raspberry pi to a HDMI monitor so as to configure the sensor. We need to enable the I2C bus of Pi so we can communicate with the sensor. If the connection is done correctly, then the raspberry pi will be able to detect the address of sensor on its I2C bus.

As soon as the pi detects the sensor, we can then use it to capture the low level energy readings of the surroundings and from different objects.

We have developed a sample code which maps different temperature readings onto different colours, thereby forming an image. Cool tones (blue and purple) in image are cooler temperatures, and warmer tones (yellow, red) in image are warmer temperatures.



Fig(5): Connection setup of raspberry pi with sensor.

Wiring setup of sensor with Raspberry Pi.

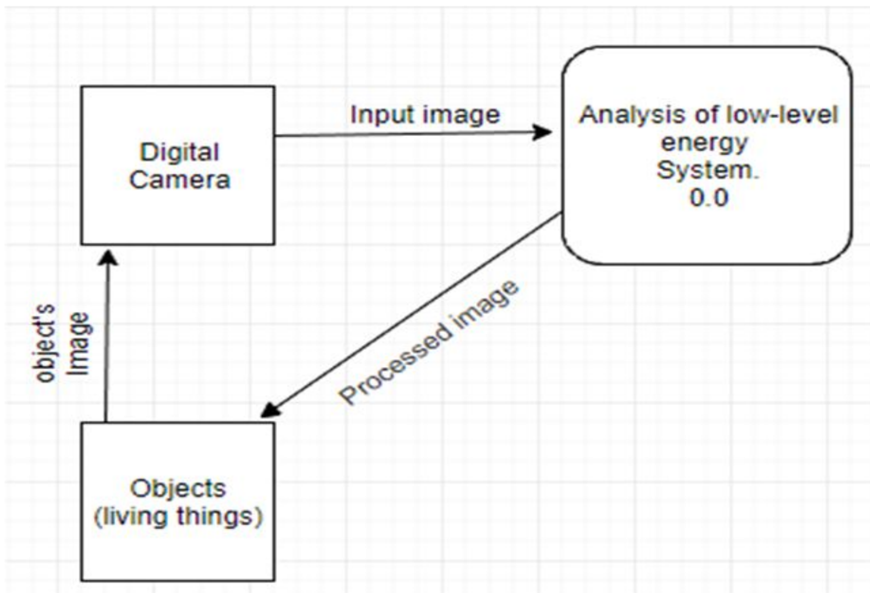
The system implementation starts with a thermal sensor which captures the infrared radiation from the object as each object emits some radiation. So this radiation gets captured by sensor and converts it into into electrical signal . Captured signals then get divided into matrix and this matrix represents the pixels format as on that pixel what is the value of the radiation. These pixel matrix values get mapped as per their values with respect to it’s colours. These colours and their values are computed by microcontrollers which gives pseudo colore images as output.

The scene to be imaged is captured by the thermal sensor as 16 by 4 matrix. Each element of the array is a pixel. The temperature value of each of these 64 pixels is calculated with the help of microcontroller. The sensor and the microcontroller communicate through the I2C bus. The microcontroller reads the calibration values from the sensor's EEPROM. The calibration coefficients are stored in microcontroller RAM for easy access during calculations. Then the 16-bit result of IR measurement for each individual sensor (64 words) and the 16-bit result of PTAT (proportional to absolute temperature) sensor are read from the sensor's RAM. PTAT sensor measures the ambient temperature of the chip and stores the value in the sensor's RAM. The sensor is by default in continuous mode i.e. it measures the temperature of the scene continuously. Calculation of object temperature includes ambient temperature calculation, pixel offset cancelling, pixel to pixel normalization and object emissivity compensation. The temperature of each pixel of the object in degree Celsius is obtained at the end of the calculations.

Serial data from the microcontroller is read by the PC. Temperature values are divided into different ranges and each range is represented by an RGB value. The 64 temperature values are represented by a pseudo colour depending on the range in which it belongs. A pseudo colour image for the scene is hence developed.

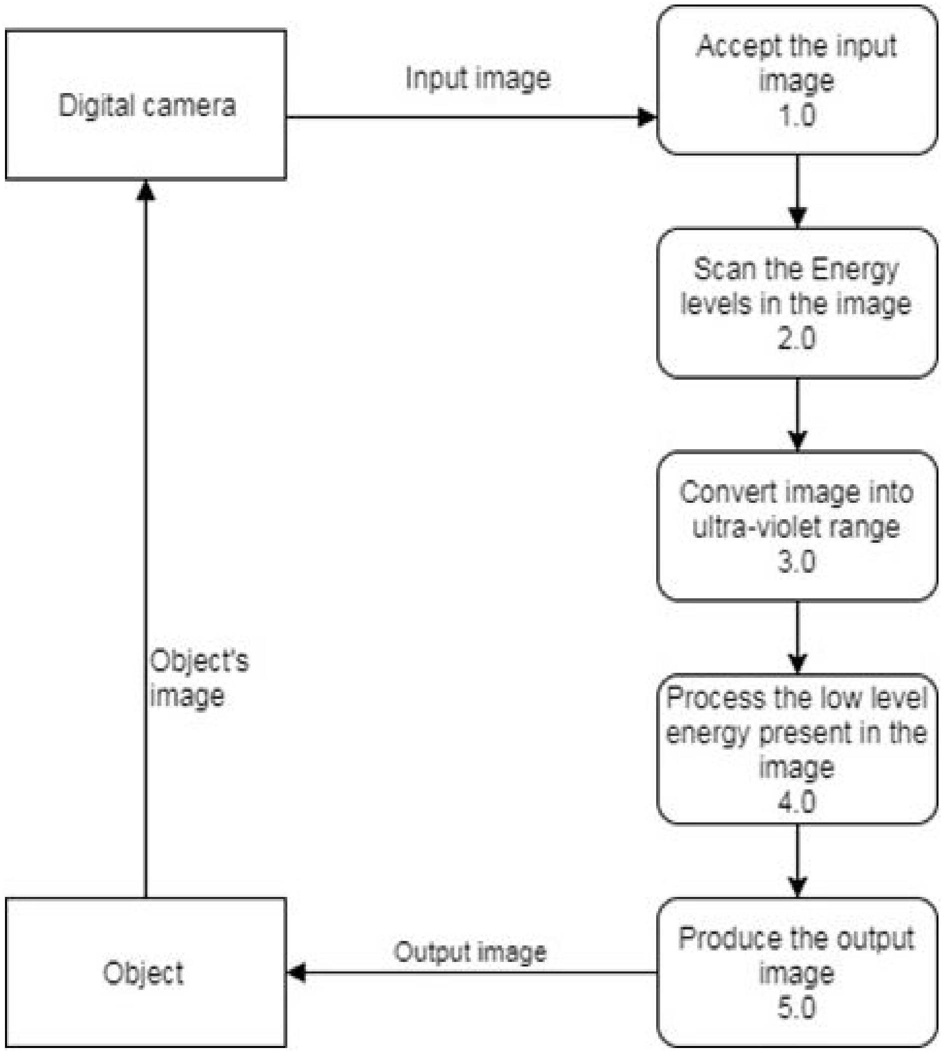
4.2 Detailed Design (DFD - level 0,1,2, State Transition Diagram, ER Diagram, etc...)

DFD Level 0:-



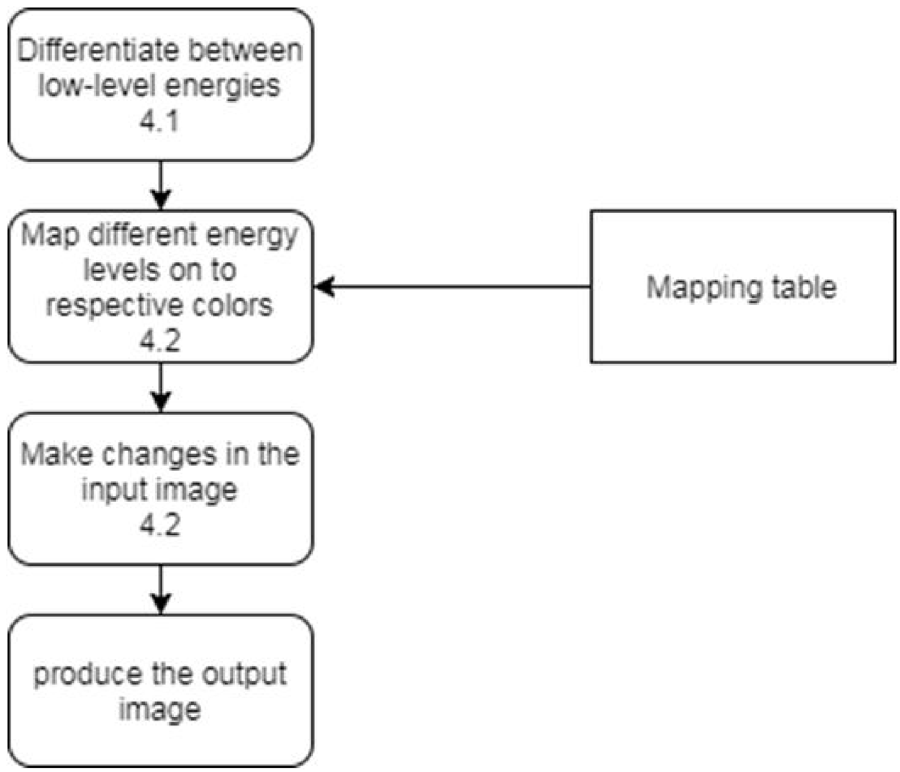
Fig(6): DFD Level 0 diagram of proposed system.

DFD Level 1:-



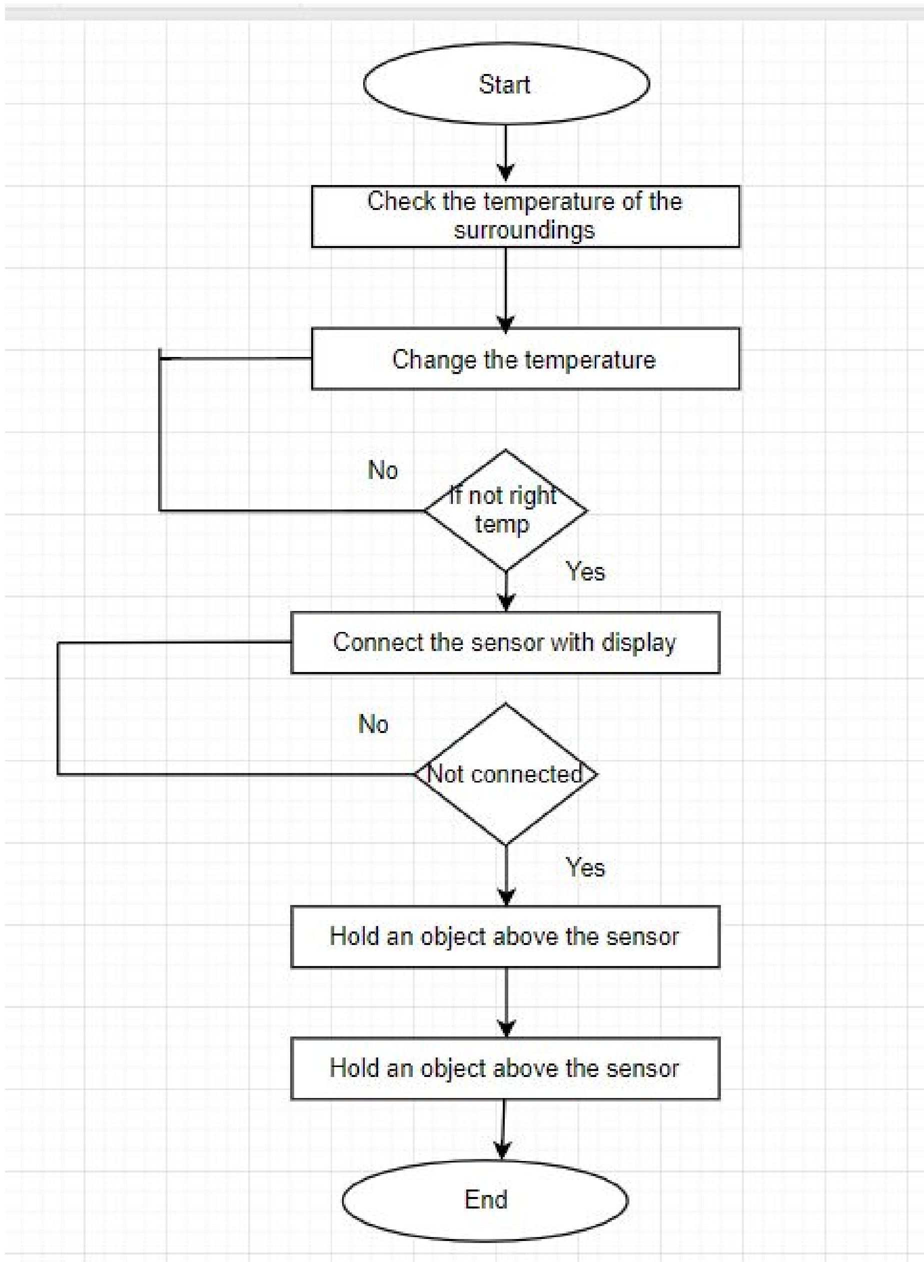
Fig(7): DFD Level 1 diagram of proposed system.

DFD Level 2:-



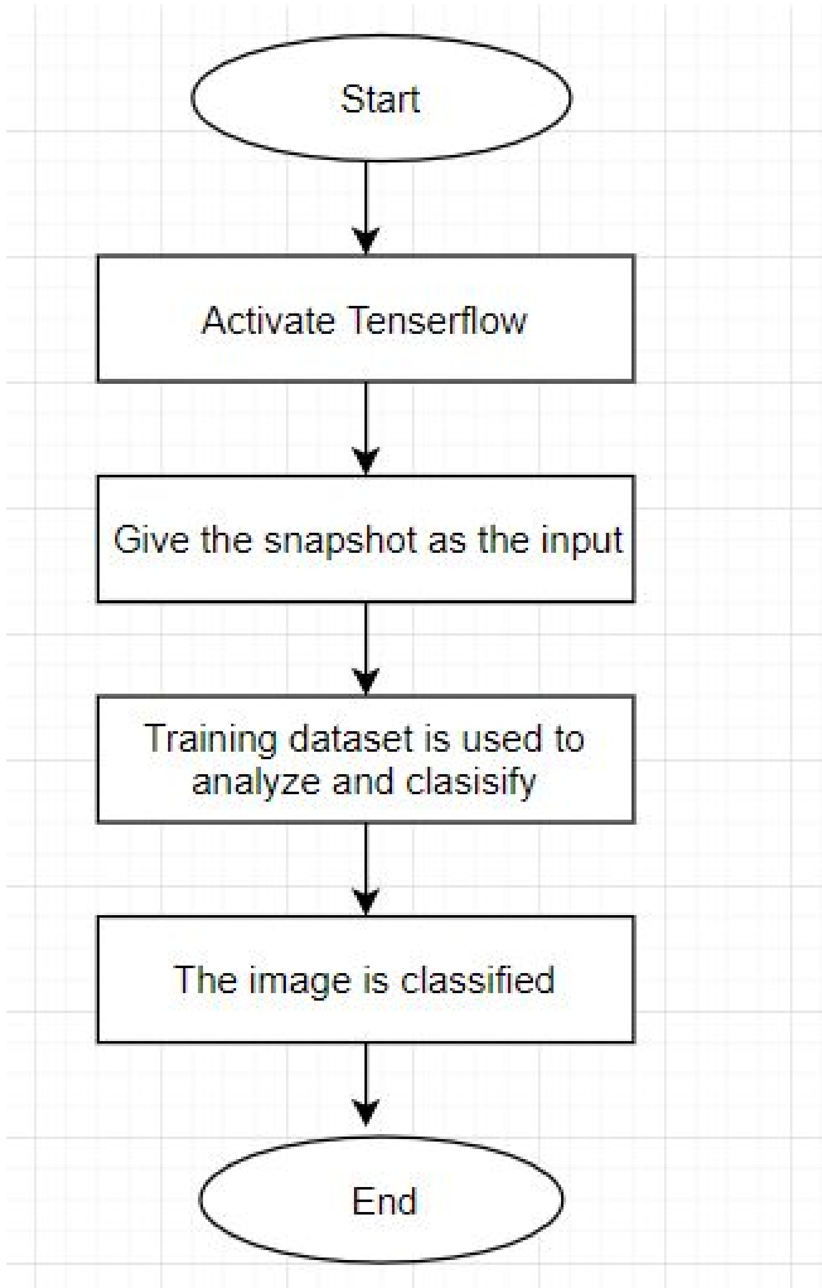
Fig(8): DFD Level 2 diagram of proposed system.

Flowchart for taking an infrared image:-



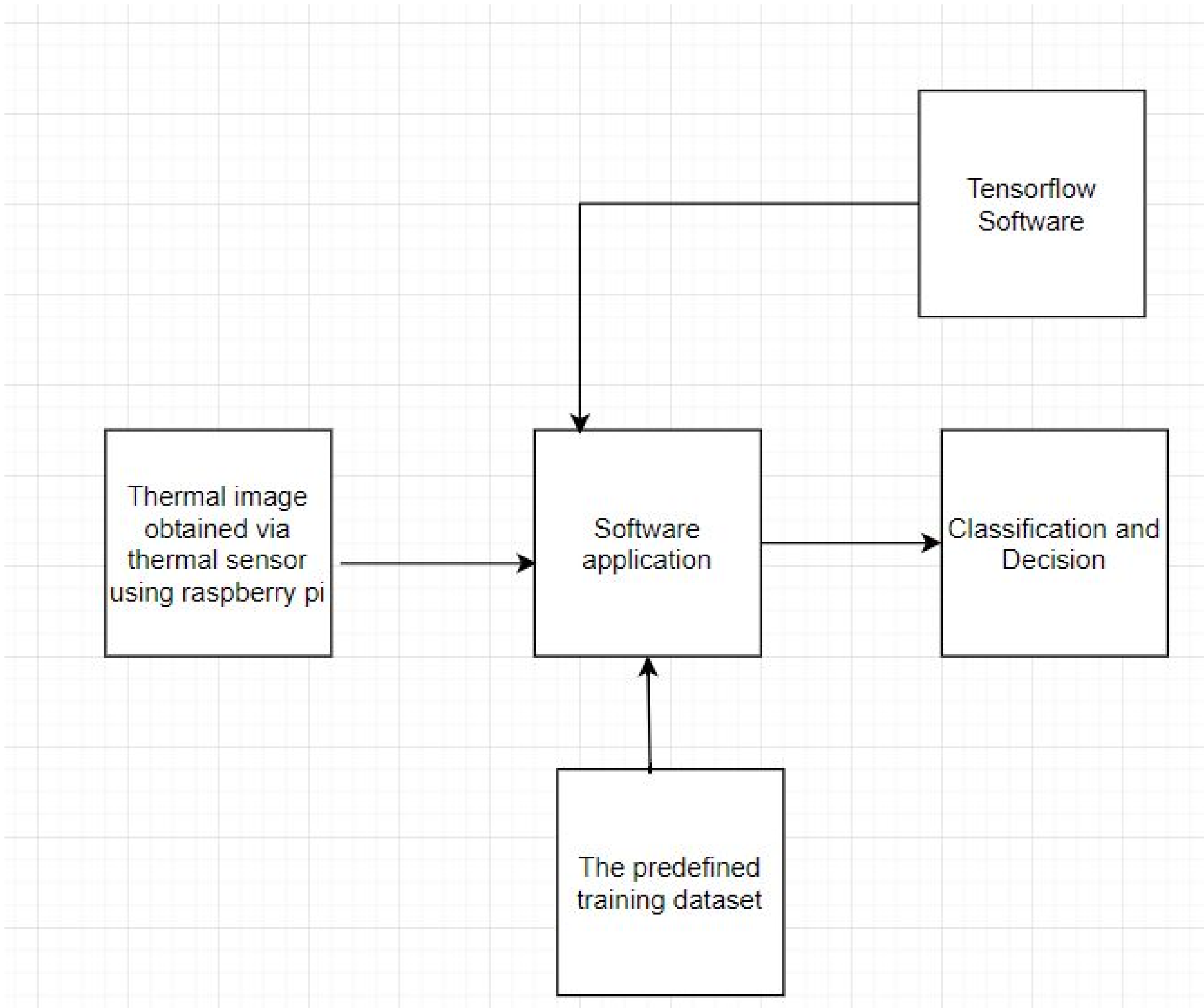
Fig(9):Flowchart of capturing images in proposed system.

Flowchart for classification:-



Fig(10): Flowchart for Classification process in proposed system.

4.3 Architecture Diagram of the system



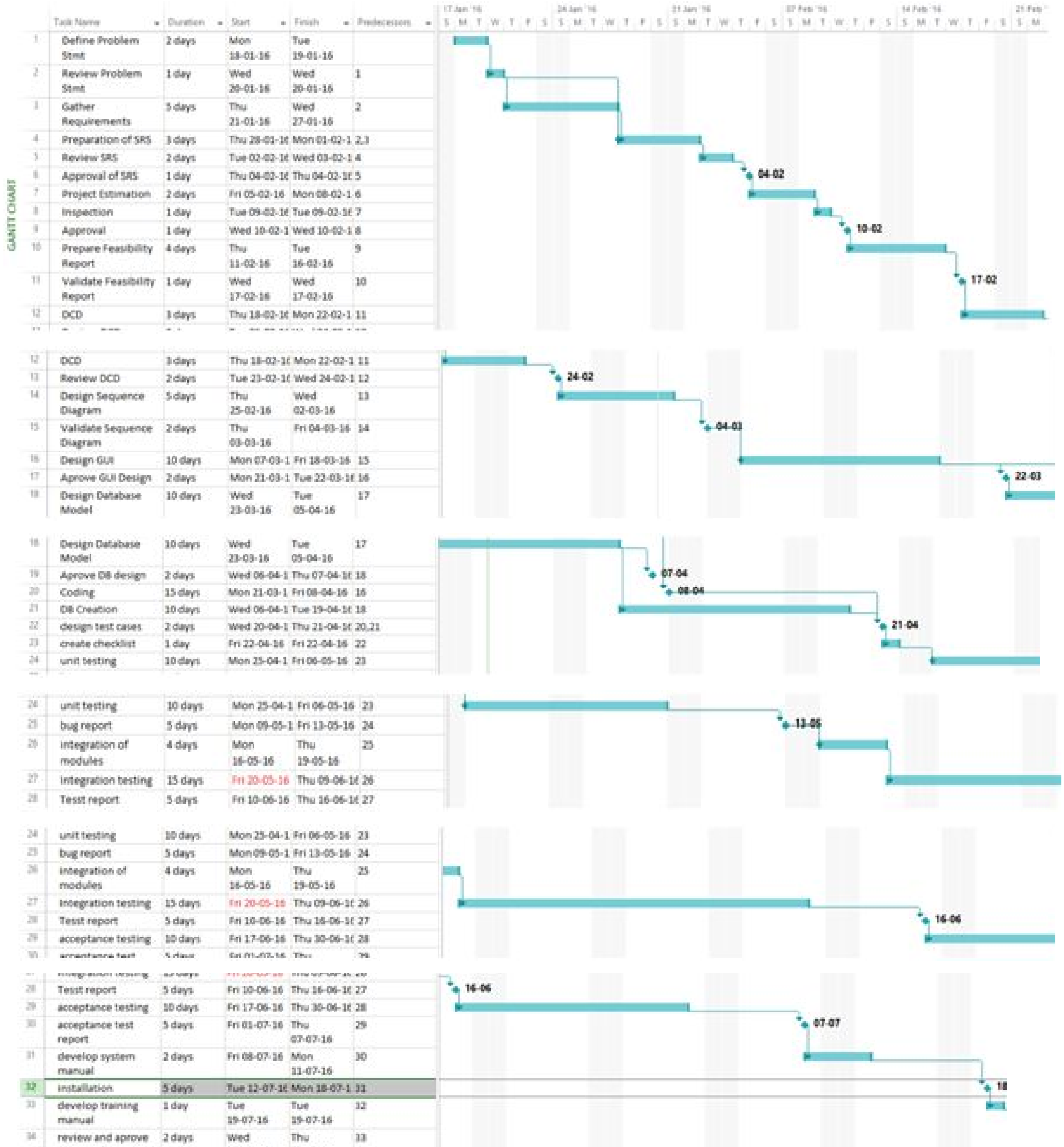
Fig(11): Architecture of proposed system.

4.4 Plan Of Work Activity

Plan Of Work Activity	Start Time	Duration	End Time
1.Analysis of project definition	16-07-2017	15 days	30-07-2017
2.Finalizing the problem definition	31-07-2017	4 days	04-08-2017
3.Literature-Statistical analysis and survey	04-08-2017	10 days	14-08-2017
4.Analysis of previous work	15-08-2017	10 days	25-08-2017
5.Design of our implementation	26-08-2017	15 days	02-08-2017
6.Analysis of our design	02-09-2018	10 days	12-09-2017
7.Creating a prototype of our design	13-09-2017	15 days	28-09-2017
8.Coding	29-09-2017	20 days	19-10-2017
9.Generating an UI for application	20-10-2017	5 days	25-10-2017
10.Debugging and building	26-10-2017	4 days	30-10-2017
11.Testing Using Different types of i/p.	01-11-2017	10 days	11-11-2017
12.Simulation and result analysis	12-11-2017	6 days	18-11-2017
13.Adding some extra functionalities	19-11-2017	10 days	30-11-2017
14.Creation of device	05-01-2018	10 days	15-01-2018

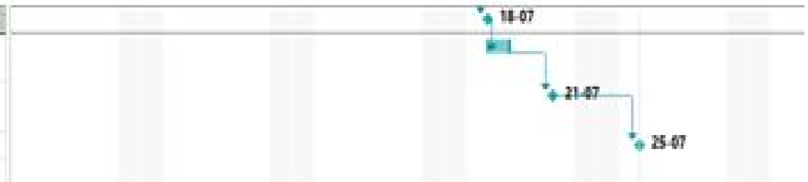
15.Final testing with device	16-01-2018	15 days	31-01-2018
16.Review	02-02-2018	5 days	07-02-2018
17.Release	08-02-2018	4 days	12--2-2018

4.5 Project Scheduling & Tracking using Gantt Chart



	Task Name	Duration	Start	Finish	Predecessors
1	Define Problem Stmt	2 days	Mon 18-01-16	Tue 19-01-16	
2	Review Problem Stmt	1 day	Wed 20-01-16	Wed 20-01-16	1
3	Gather Requirements	5 days	Thu 21-01-16	Wed 27-01-16	2
4	Preparation of SRS	3 days	Thu 28-01-16	Mon 01-02-1	2,3
5	Review SRS	2 days	Tue 02-02-16	Wed 03-02-1	4
6	Approval of SRS	1 day	Thu 04-02-16	Thu 04-02-16	5
7	Project Estimation	2 days	Fri 05-02-16	Mon 08-02-1	6
8	Inspection	1 day	Tue 09-02-16	Tue 09-02-16	7
9	Approval	1 day	Wed 10-02-1	Wed 10-02-1	8
10	Prepare Feasibility Report	4 days	Thu 11-02-16	Tue 16-02-16	9
11	Validate Feasibility Report	1 day	Wed 17-02-16	Wed 17-02-16	10
12	DCD	3 days	Thu 18-02-16	Mon 22-02-1	11
13	Review DCD	2 days	Tue 23-02-16	Wed 24-02-1	12
14	Design Sequence Diagram	5 days	Thu 25-02-16	Wed 02-03-16	13
15	Validate Sequence Diagram	2 days	Thu 03-03-16	Fri 04-03-16	14
16	Design GUI	10 days	Mon 07-03-1	Fri 18-03-16	15
17	Aprove GUI Design	2 days	Mon 21-03-1	Tue 22-03-16	16
18	Design Database Model	10 days	Wed 23-03-16	Tue 05-04-16	17
19	Aprove DB design	2 days	Wed 06-04-1	Thu 07-04-16	18
20	Coding	15 days	Mon 21-03-1	Fri 08-04-16	16
21	DB Creation	10 days	Wed 06-04-1	Tue 19-04-16	18
22	design test cases	2 days	Wed 20-04-1	Thu 21-04-16	20,21
23	create checklist	1 day	Fri 22-04-16	Fri 22-04-16	22
24	unit testing	10 days	Mon 25-04-1	Fri 06-05-16	23
25	bug report	5 days	Mon 09-05-1	Fri 13-05-16	24
26	integration of modules	4 days	Mon 16-05-16	Thu 19-05-16	25
27	Integration testing	15 days	Fri 20-05-16	Thu 09-06-16	26
28	Tesst report	5 days	Fri 10-06-16	Thu 16-06-16	27
29	acceptance testing	10 days	Fri 17-06-16	Thu 30-06-16	28
30	acceptance test report	5 days	Fri 01-07-16	Thu 07-07-16	29
31	develop system manual	2 days	Fri 08-07-16	Mon 11-07-16	30
32	installation	5 days	Tue 12-07-16	Mon 18-07-1	31
33	develop training manual	1 day	Tue 19-07-16	Tue 19-07-16	32
34	review and aprove training document	2 days	Wed 20-07-16	Thu 21-07-16	33

32	installation	5 days	Tue 12-07-1	Mon 18-07-1	31
33	develop training manual	1 day	Tue 19-07-16	Tue 19-07-16	32
34	review and aprove training document	2 days	Wed 20-07-16	Thu 21-07-16	33
35	feedback	2 days	Fri 22-07-16	Mon 25-07-1	34



Fig(12): Schedule of the proposed system.

Chapter 5 : Implementation Details

5.1 Algorithms

The algorithm used in this project is as shown below:

1.Dividing the temperature range.

We divide the temperature range into five different categories as shown in figure (3), i.e. “MINTEMP-a-b-c-d-MAXTEMP”.

We compute the values of a,b,c,d using following code:

```
void Getabcd() {
  a = MinTemp + (MaxTemp - MinTemp) * 0.2121;
  b = MinTemp + (MaxTemp - MinTemp) * 0.3182;
  c = MinTemp + (MaxTemp - MinTemp) * 0.4242;
  d = MinTemp + (MaxTemp - MinTemp) * 0.8182;
}
```

2. Calculate RGB components.

After dividing the temperature range, we compute the RGB color component for every temperature value sensed by the sensor using the following equations:

```
{
red = constrain(255.0 / (c - b) * val - ((b * 255.0) / (c - b)), 0, 255);
  if ((val > MinTemp) & (val < a)) {
        green = constrain(255.0 / (a - MinTemp) * val - (255.0 * MinTemp) / (a - MinTemp), 0,
255);
  }
  else if ((val >= a) & (val <= c)) {
        green = 255;
  }
```

```
else if (val > c) {
        green = constrain(255.0 / (c - d) * val - (d * 255.0) / (c - d), 0, 255);
}
else if ((val > d) | (val < a)) {
        green = 0;
}
```

5.2 Execution

- Check the surroundings temperature by performing the command of temperature readings.

  Command python pixel_test.py
- Adjust the surroundings min and max temperature accordingly.

  Eg : Min temp = 27 celsius , Max temp = 35 celsius
- Take a snapshot of the display .

  Command python-d 5-u
- Take the snapshot display as the input for analysis.
- Then activate Tensorflow.

  Command: “source ~/tensorflow/bin/activate”
- Go into “tensorflow-for-poets-2” directory.
- Now give the display snapshot as the input
- Classify it .

Command: “sudo python -m scripts.label_image --graph=tf_files/retrained_graph.pb --image=input.jpg”

5.3 Comparative Analysis

The image developed by the IR sensor is stored in the database. We have used 200 such images for training our model. We have used tensorflow classifier to train 5 datasets including 40 images each. These datasets are as follows:

- **Hot - (Red)**
- **Warm - (Yellow, Orange)**
- **Moderate - (green)**
- **Cool - (Light blue)**
- **Chilled - (Dark blue, Purple)**

This classification basically demonstrate Hot To Cold variations in an image. Using this, our classifier predicts the class to which our output image belongs.(Hot or Warm or Moderate or Cool or Chilled).

5.4 Evaluation of the Developed System

Accuracy

This system real time thermal values which are according to surrounding also the values of temperature is close to real temperature. The shape of hand and all other objects are clearly visible in window.

Effectiveness

The thermal sensor is taking real time input and giving output immediately so the all values are visible to users also user can change the Minimum and Maximum values so users can adjust values according to its surrounding.

Efficiency

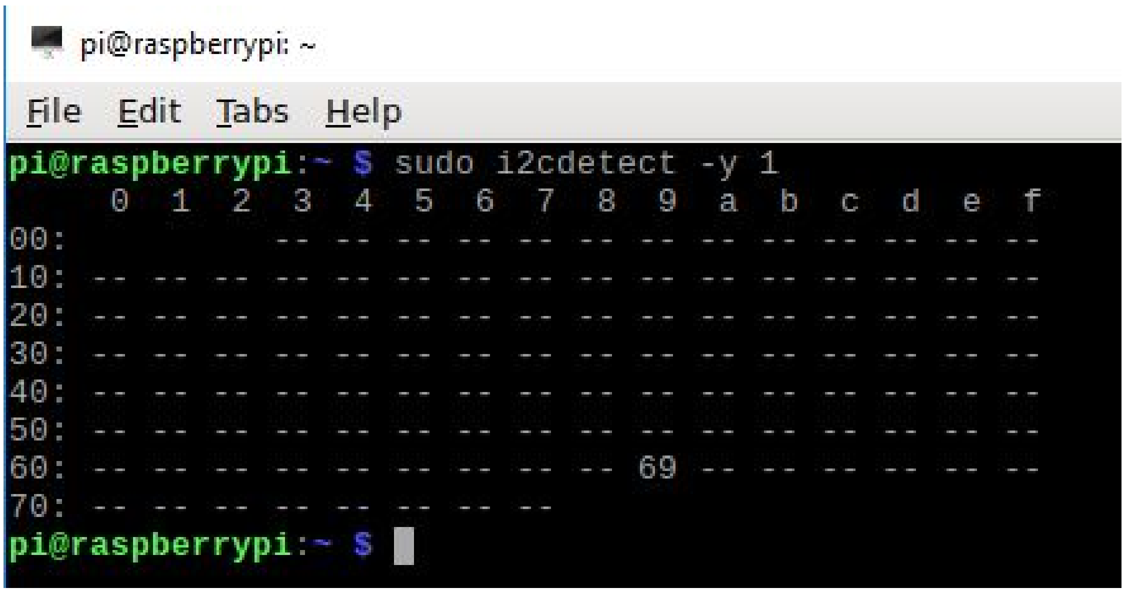
Our System gives output in graphical form that is in images with RGB colors as well as it can also provides output in temperature readings that is in numbers form. So user want output can get from system in less time.

Chapter 6 : Testing

Test 1

To detect whether the sensor is properly connected or not

Command: “Sudo i2cdetect –y 1”



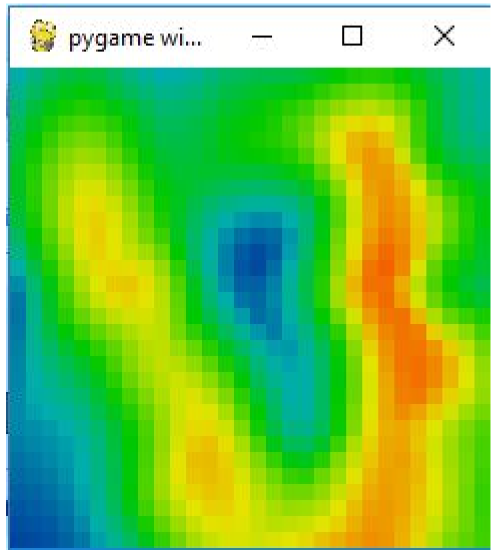
Fig(13): Detection of IR sensor.

- In the above screenshot it shows **“69”** in hexadecimal which conveys that the sensor is connected properly with the system.
- If the sensor is not connected properly with the system it shows **“- -”**.

Test 2

To check and start the display of the system.

Command: "Python thermal_cam.py"

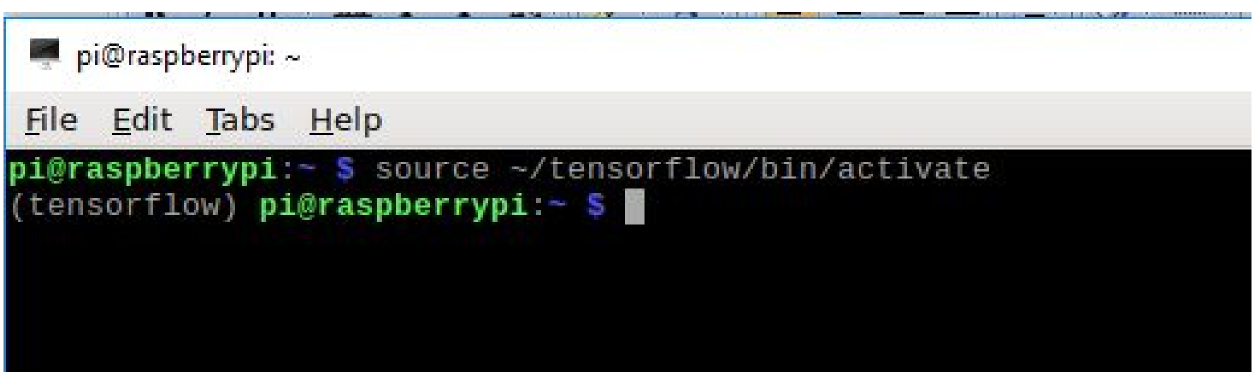


Fig(14): Activation of IR sensor.

Test 3

To check and activate tensorflow.

Command: "source ~/tensorflow/bin/activate"



Fig(15): Activation of tensorflow classifier.

Chapter 7 : Result Analysis

7.1 Simulation Model

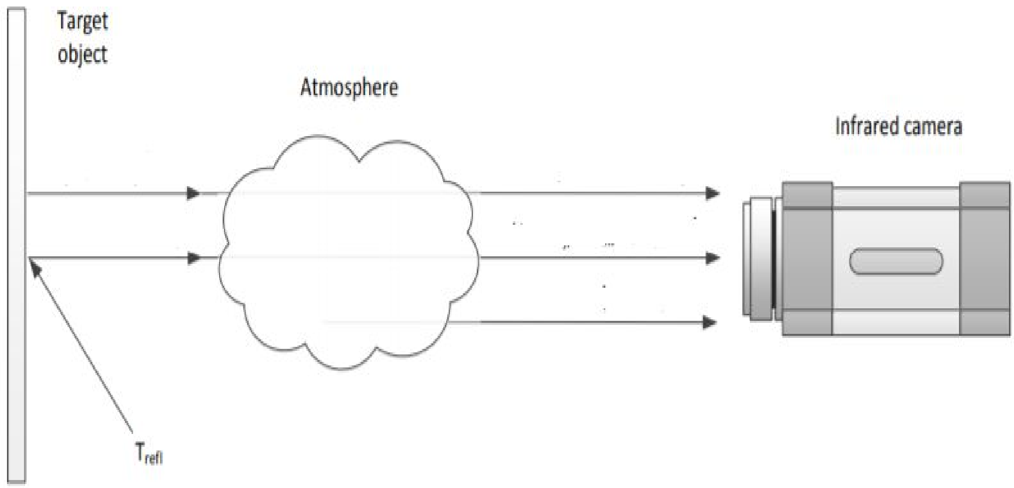
Simulation is the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviors/functions of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.

Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training, education, and video games. Often, computer experiments are used to study simulation models. Simulation is also used with scientific modeling of natural systems or human systems to gain insight into their functioning. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Simulation is also used when the real system cannot be engaged, because it may not be accessible, or it may be dangerous or unacceptable to engage, or it is being designed but not yet built, or it may simply not exist.

The application of virtual simulation technology gives a convenient、efficient and low cost method in maintenance teaching and training for the thermal equipment, which is out of the dependent of the complex equipment mounting. We have used Python for the simulation algorithms of the main function of the thermal system.

Temperature is one of the most frequently measured physical quantities. Temperature measurement provides information about the object internal energy, so its regulation and control is of vital importance in many industrial processes.Temperature measurement using IRT (Infrared Radiation) measures the infrared radiation emitted by an object and converts the energy detected into a temperature value. However, as not all of the radiation received comes from the target object, to measure temperature accurately, radiation from other sources (such as surrounding objects or the atmosphere) must be removed in the conversion to temperature. This called compensation. The total radiation received by the camera (Wtot) comes from three sources: the emission of the target object (Eobj), the emission of the surroundings and reflected by the object (Erefl) and the emission of the atmosphere (Eatm).

$$W_{tot} = E_{obj} + E_{refl} + E_{atm}$$



Fig(16): Simulation model.

We provide two types of simulations, both with the aim of realizing an algorithm for the image processing of thermo graphs. In particular, the first step, simulates the temperature trend on the sample surface subject with the help of thermal sensor. The second step is to simulate the input given by using the predefined training dataset for classification

7.2 Parameters /Graphs

The real time temperature measurements were carried out several times. Measurements of various objects of known temperature showed that the last 64 pixels of second row of the array give more accurate results. The pseudo colour representation of these 64 pixels. This algorithm will map the image's pixel value to five different colours:- violet, green, orange, red, and blue based on the temperature sensed by the IR-thermal camera.

Relationship between red , blue and green. At minimum temperature : Blue = 255 , Green = 0 , Red = 0.At maximum temperature :Blue = 235 , Green = 0 , Red = 255 . At average temperature : Blue = 0 , Green = High , Red = 0. In maximum temperature red is high, blue is also taken to give it a gentle colour and green is low .For the colour segments equation used is : y= mx + b.

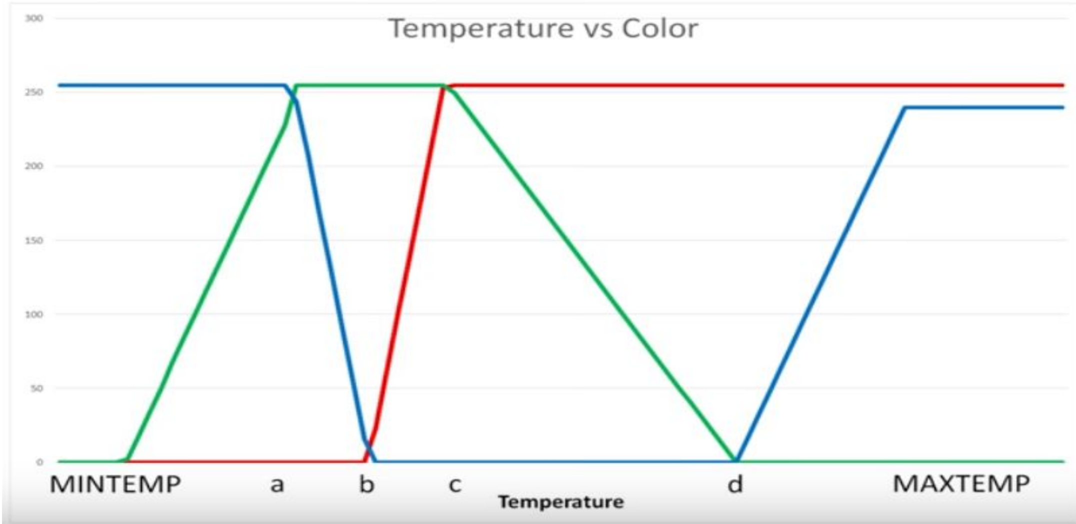


Fig (17): Temperature vs Color graph.

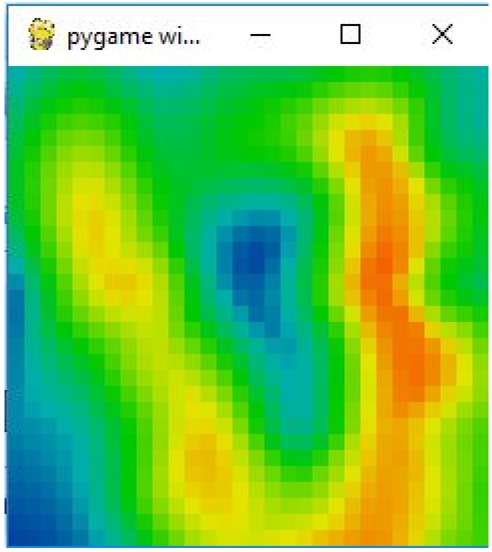
7.3 Screenshots of User Interface (UI)

We have created two shell scripts to execute two main functions i.e.

1. Starting the IR camera - camera.sh
2. Taking screenshot of output window - screen.sh

Fig(18): Shell Script files.

ii. Open camera output:-



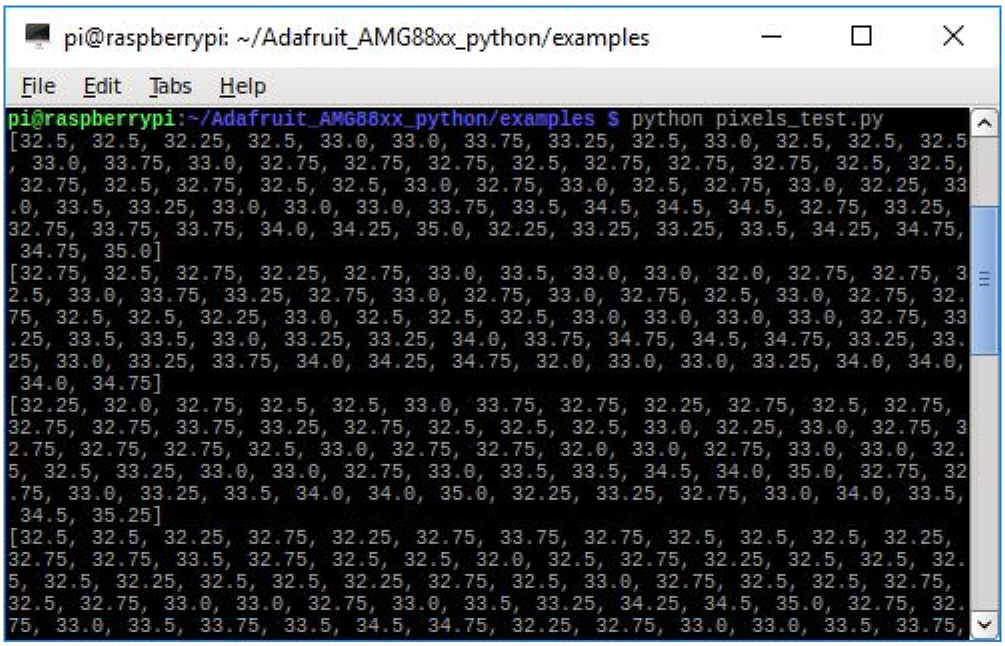
Fig(19): Output Image formed by the sensor.

7.4 Observation And Analysis

- These results will vary depending on the temperature of objects.
- The output image will have following colour gradient:-
  (hot to cold), i.e. Violet -> Red -> Orange Yellow -> Green -> Blue.
- The subject’s hand is taken and the energy emission taking place from his hand is recorded in the output image and it is as shown in figure (21) and figure (22).
- It is seen in fig(21), that because of body temperature, fingers of his hand are displayed as yellow and orange colour, as the body temperature is warm and it is more than that of surrounding temperature.
- It is seen in fig(23), that because of body temperature, fingers of his hand are displayed as violet and bluish, as the body temperature is cool and it is less than that of surrounding temperature.
- The object used for in fig(24), is a laptop charger after charged.So the output is blood red which shows that the temperature of the object is quite high then the temperature in its surroundings.

7.5 Report generated/ Tables obtained

After successful connections and setup, We can perform various operations like reading temperatures values of the surrounding by executing “pixel_test.py” file and the result is as shown in figure(20). After reading the temperature values, we can map these values onto five different colours using image processing, the algorithm is formulated in “thermal_cam.py” and the output is shown in figure(21).



Fig(20): Temperature readings of the surrounding.

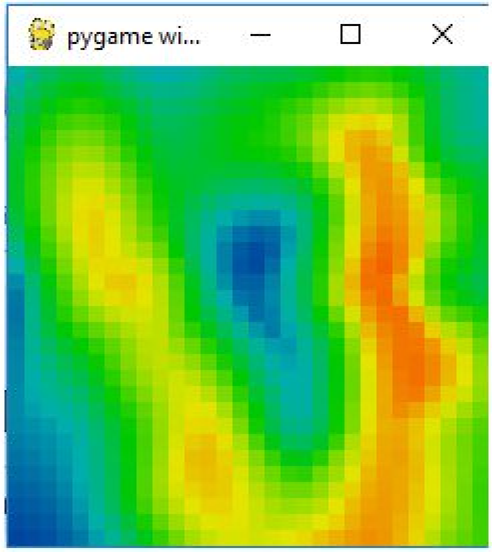


Fig (21): Image obtained from the sensor.

Fig(22): Classification of the output image.

The output from the IR sensor can be captured as a screenshot and can be further used for classification using tensorflow and the report generated from the tensorflow is as depicted in figure(22).

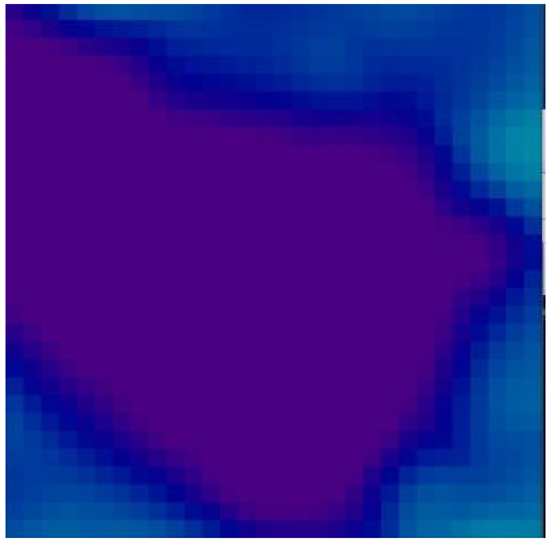


fig (23): Image obtained from the sensor.

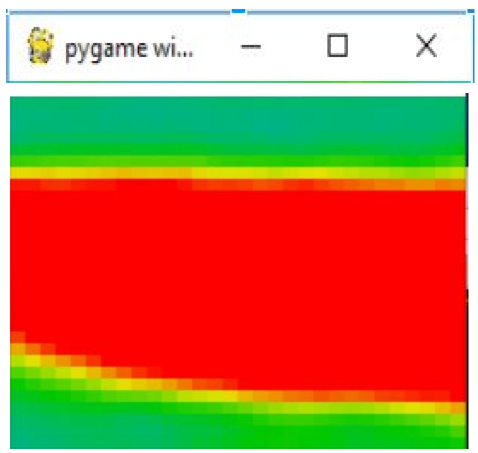


fig (24): Image obtained from the sensor for hot object.

Chapter 8 : Conclusions

8.1 Applications

- Thermal radiation is very useful for fast screening of travelers with a fever at airports, ports and border crossing.
- It is also used to find cracks and various repairs in the house.
- It is also used in industries to check the status of various machines.
- It also finds application in meteorology.
- It allows firefighters to see areas of smoke,darkness or heat permeable barriers.
- It also finds application in healing such as early detection of breast cancer.
- Disease and virus monitoring
- Monitoring changes in overall health
- Also used for night vision.

8.2 Limitations

- Small objects can be detected because it has a small display of 8*8 matrix i.e 64 pixels
- Infrared thermal imaging is wonderful but given it's inherit nature, is impacted by the weather.
- Accurate temperature measurements are hindered by differing emissivities and reflections from other surfaces.
- Thermal imaging cameras cannot be used to see objects under water.
- Only able to directly detect surface temperatures.

8.3 Conclusion

The system is a suitable for thermal imaging, because it gives a faster output,cost is less and there is no need of special training. With the help of image processing and python(Scipy), algorithm is developed and Outputs obtained from this methods is satisfactory and also the generated pseudo images can be stored and used further by retraining them. This information can be used for the further analysis by the practitioners and healers for improving the well being of the humans.

8.4 Future Scope

In today's times,thermal imaging is used in various applications.It is not only a technology that will save lives but change lives.A thermal imaging camera also known as infrared camera can see through various modes like darkness,snow,rain etc.Further,it can also be used in automobiles and electric equipments.

Imaging can give valuable information about electrical equipment. Fuses, connections, cables, but also high voltage equipment like transformers, power lines and many more, it can all easily and contactless be inspected with a thermal imaging camera. The advantage is that thermal imaging can help maintenance managers to see an anomaly before a real problem occurs. This way, costly breakdowns can be avoided and time and money can be saved.

A major step to the volume production of thermal imaging cameras was taken a few years ago. At that point in time, BMW one of the major automobile manufacturers in the world, decided that it would implement a thermal imaging camera for driver vision enhancement into their top-of-the-line 7-series. Increasing passenger and driver safety is one of the priorities for BMW. Since a lot of accidents happen during nocturnal driving, BMW was looking for a solution to reduce this number of accidents.

Installed in airplanes, thermal imaging be used as a landing aid. It can help pilots by enhancing the ability to see terrain and other aircraft at long ranges, even in total darkness, light fog, dust and smoke.

It can also be used for security and protection.Thermal imaging exposes threats hidden in the darkness, concealed by adverse weather, and veiled by obscurants like dust, fog, and smoke.Thermal imaging is also used by the police and other law enforcement agencies. It allows them to find and follow suspects in total darkness. Suspects can not hide in bushes or shadows since their heat signature is easily picked up by a thermal imager.

Thermal imaging is widely accepted as an accurate and reliable tool for medical assessment and diagnosis. Changes in the thermal conductivity of the skin caused by burns, skin ulceration or grafting can easily be detected and monitored with a sensitive thermal imaging system. Other common applications include early detection of skin cancer, pain management, burn depth assessment, fever detection, open heart surgery.

Thermal imaging cameras will follow the same path as other products followed before. The equipment will become even compact, image quality will even further improve and more features will be implemented in the thermal cameras.

As thermal imaging cameras are finding their way in more and more consumer oriented applications like driver vision enhancement and home security, the interest for the product will rise, production volumes will go up and prices will come down.

Where this will lead to, nobody knows. But chances are high that within a very short time-frame, every policeman, firefighter, security guard, ... will have its own thermal imaging camera. The majority of cars, truck, trains and other vehicles might be equipped with thermal imaging technology.

Chapter 9 : References

1. Nicholas.A.Diakides and Joseph. D. Bronzino, “Medical Infrared Imaging”, CRC Press, 2012
2. N. Bouzida, A. Bendada and X.P. Maldague, “Visualization of body thermoregulation by infrared imaging”, Journal of Thermal Biology, Vol.34, pg 234-253, 2009
3. J. Govindarajan, “A Case for Joint Development of IR Cameras in India”, Journal on Intelligent Electronic Systems, Vol.1, No.1, 2007
4. Thomas.L.Williams, ‘Thermal Imaging Cameras”, CRC Press, 2009
5. Aweda M. A., Adeyomoye A. O. and Abe G. A, “Thermographic analysis of thyroid diseases”, Adv. Appl. Sci. Res., Vol. 3, pg 2027-2032, 2012
6. Iven, G., Chekh, V., Shuang Luan, Mueen, A., Soliz, P., Wenyao Xu, Burge, M., “Non-contact Sensation Screening of Diabetic Foot Using Low Cost Infrared Sensors,” Computer-Based Medical Systems (CBMS), 2014 IEEE 27th International Symposium, vol., no., pp.479-480, 27-29 May 2014.
7. Herbert Kaplan, “Practical Applications of Infrared Thermal Sensing and Imaging Equipment” SPIE Tutorial Text, Vol. TT75,pg 20-25, 2007
8. B.B. Lahiri, S. Bagavathiappan, T. Jayakumar, John Philip, “Medical applications of infrared thermography: A review”, Infrared Physics & Technology, ELSEVIER, Vol. 55, pg 221-235, 2012
9. Mohammed Henin and Manijeh Razeghi, “Handbook of Infra-red Detection Technologies”, ELSEVIER, 2012.

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Department of Computer Engineering

1st Inter-College Project Competition 2017-18

CERTIFICATE

This is to certify that SUBHDRA JAISINGHANI *has presented the project titled* ANALYSIS OF LOW LEVEL ENERGY EMISSIONS *in the 1st* ***Inter-College Project Competition*** *organized by* ***Department of Computer Engineering, St. Francis Institute of Technology*** *on* ***7th April 2018.***

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