HEAT VISION BASED AC AND LIGHT AUTOMATION IOT

Prathap Sagar S[1], Reshma L [1] Prajwal R[1], Sushma L[1]

[1]*Students, Dept. of Electrical and Electronics Engineering, Acharya Institute of Technology, Bangalore, Karnataka, India*

Abstract - IoT as a system helps in deployment of smart and connected devices which helps in reductions of human interference in carrying out day to day works. IoT is said to be the booming technology for the next 10 years. With development in fields of Artificial Intelligent, Machine learning etc., devices can be built by the applications of these technologies which are more reliable and can learn to carry out tasks on their own. Our project is one such device which helps in reduction human involvement in daily life and our product is going to be one its kind since no such product is actually available in the market. By the application of thermal imaging camera body temperature of individuals can be monitored like never before. Our devices can perform on board calculations within the help of raspberry pi in order to extract useful information and communicate with connected devices in order to automate Ac and lights. By the application of powerful software tools like image processing and object detection by Machine learning enable our device can perform the required Air conditioner and Light adjustment continuously as per individual preferences.

Key Words: IoT, Thermal Camera, Automate AC and Light, Object detection, Image processing.

1. INTRODUCTION

IoT is the use of network-connected devices, embedded in the physical environment, to improve some existing process or to enable a new scenario not previously possible. It creates a simplified and self-monitoring solution to enable smart handling daily activities which otherwise is cumbersome process. IoT is also said be a 520-billiondollar industry by the year 2021 by Forbes. The Heat Vision Based AC and Light Automation IoT is one such system which provides novel and futuristic automation solution with the aid of Thermal Imaging and Image Processing Techniques.

Thermal Imaging refers to detecting infrared energy (heat) and converting it into an electrical signal, with the aid of cameras build for this purpose, which is then processed and used temperature calculations. Image processing is a process in which certain image processing tools and operations are applied on an image or a video, in order to enhance the image properties as required and to extract required data from it.

The current systems which operate on sensors only measure the surrounding air temperature and provide cooling, which is a rudimentary approach. Not all human bodies, objects react and produce heat the same way. The way they produce heat depends and varies with kind activity being performed. The system which operates using thermal camera that gives heat signature of the body and object in real time is a more consumer centric product. In hospitals where different patients and infants react differently to the type of medication provided and their bodies may produce heat and release heat in an unpredictable way which is why it is crucial to have a system which can handle such quick changes and provide a healthy atmosphere for better recovery.

Our system can be used to develop models which can take care such requirement like never before. In companies and office rooms, where the employees work in extreme conditions the use of obsolete sensors which only measure surrounding air can never suffice for a pleasant and optimum cooling system no matter how many sensors are used. This system can deploy a better and pleasant ambience for employees to work .In future when these cameras are more affordable than now our system will be the go-to technology which can be used in every house and the data collected can help optimization of the smart gird when they are fully realized.

2. METHODOLOGY

Our system with a microcontroller as the central unit of operation and control carries air conditioner automation by the thermal image which is captured by the thermal camera and normal image captured pi camera ,and the light automation is carried out by monitoring the ambient light using an LDR sensor , we apply machine learning model on this image for human detection which decides whether to turn on the system in case of absence of human for power saving. If a human is detected the thermal data is extracted and heat analysis is performed and based on the decision of the system an appropriate and efficient cooling system is set by the system as per individual requirements. And further continuous monitoring is performed for collection of data in real time for adjusting and acting according to the requirement in an efficient manner. The flow of operations is displayed with help of block diagram (Fig 1).

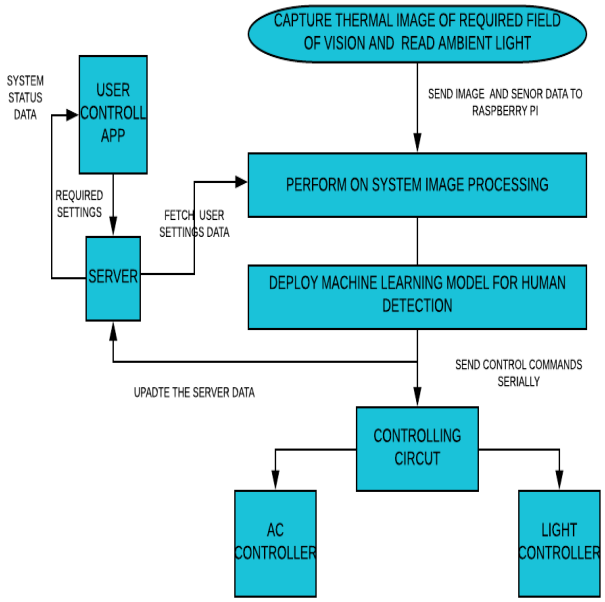

Fig 1 Block Diagram of the System

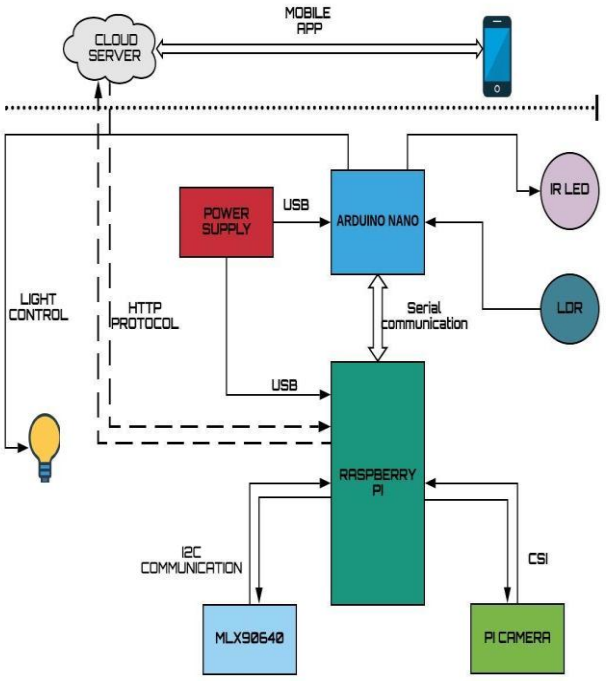

Fig 2 Hardware Schematic

3. IMPLEMENTATION

The Raspberry Pi is the central component of our system it used for capturing the image from the cameras, image processing, human detection, temperature calculations and updating information to the cloud. MLX90640 is the thermal camera used it is interfaced to the Raspberry Pi via I2C communication and Pi Camera is used to take pictures for human detection and image enhancement and it is interfaced to Raspberry Pi through CSI communication.

Arduino Nano is connected to Raspberry Pi through Serial Communication. Once the temperature is calculated by the Raspberry Pi it is sent to Arduino serially. Now the Arduino operates the IR led to control the AC (Air Conditioner).

The Arduino also continuously monitors the LDR sensor in order to operate the lights. A cloud MySQL Database is used to store all the updates remotely. An Android application is Built using the MIT App inventor which communicates to the Database via the PHP code which is stored in the backend of the database.

The Raspberry Pi also communicates with the Database using HTTP protocols in order to update the information and to read the user settings every time before operation. Dual USB output DC-DC Power Supply module is used here to provide sufficient and stable power supply to both Raspberry Pi and Arduino nano for a smooth operation. USB cables are used to connect the power module to both Raspberry Pi and Arduino.

The python program inside Raspberry Pi first reads the data from the cloud data base to fetch the user settings. The **urllib** python library is used for this operation. The Urllib module is the URL handling module for python. It is used to fetch URLs (Uniform Resource Locators). It uses the urlopen function and is able to fetch URLs using a variety of different protocols. Then the program captures images from the pi camera and thermal camera. The **picamera** python package is used to capture the image from the pi camera. But for MLX90640 camera first all the values are stored in the RAM of the camera in form of raw data this is read by the Raspberry Pi using the **adafruit_bus_device.i2c_device** further this raw data is processed using formula and procedure as specified by the manufacturer in order to obtain useful pixel values to get a thermal image. The thermal image is of low resolution hence it is processed to along with the image from the pi camera in order to make both images of same properties i.e. both the images are same size ,they have same pixel count and they are in the same color space(RGB) .This processing makes the images ready for human detection and desirable temperature extraction. Now the program performs human detection using the YOLOV3 machine learning algorithm. YOLO v3 uses a variant of Darknet, which originally has 53-layer network trained on ImageNet. For the task of detection, 53 more layers are stacked onto it, giving us a **106 layer fully convolutional underlying architecture for YOLO v3.** The program produces bounding box around a person if detected this coordinate of boxes are taken and based on this the temperature values of pixels are added within the box and averaged in order to find the temperature of human body present in the image.

Based on the temperature calculated the required ac temperature is decided by the program and this is sent to Arduino serially for further process and is updated to the cloud database via same urllib package.

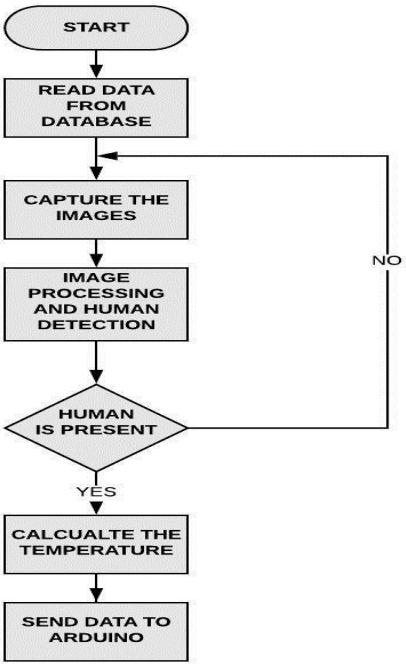

Fig 3 Flow Chart of Python Program Used in Raspberry Pi

The program uploaded into the Arduino is written is C++ language. The IRremote library is used here to handle both decoding and sending IR signals. The program consists of an array of values which are found out from the ac remote using Tsop1738 sensor each value corresponds to a particular remote operation. The program waits for a command from the raspberry pi Once the required temperature is received through the serial port the program and the command is checked on using if statement and then based on type of instruction the required value of the array is sent to ir blaster to control the Air conditioner. The program also keeps checking the sensor and operates the lights automatically in a continuous loop.

A MySQL database is used to store the information remotely for access from both app and also the raspberry pi. The Database is hosted on a website known as 000webhost.com It is free website hosting site. A table is created in phpMyAdmin which has desired number of columns as required for our system. The backend operation like insertion, update, reading the value from the table is carried out 3 programs which are written in PHP language using SQL commands within the codes to perform the CRUD operations. These PHP files are uploaded in file manager section of the website and can be accessed with help of URL corresponding to each PHP file.

The mobile app is developed using is MIT APPINVENTER which is opensource software to build custom mobile applications are various uses. The MIT APPINVENTER has two parts first part is designing section where the frontend i.e. the user interface of the app is designed it consists of drag and drop feature to construct the UI and all need components like buttons textbox etc. are readily available. The next part is the backend control sections which consists of code blocks which can be used for each component used in the design section. Using these code blocks the task which is to performed when the user performs an operation in the User Interface is designed programmatically and once everything is finished an emulator is available to check is everything is working fine before uploading it to the mobile phone.

4. RESULTS

The python program is uploaded to the Raspberry Pi and is tested successfully. The program successfully read data from thermal camera and converted into useful pixel values. Then with the help matplotlib and OpenCV programming tools a useful thermal image was constructed.

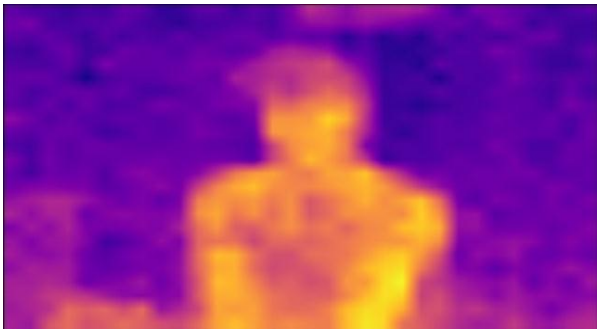

Fig 4 Thermal Image from MLX90640

The YOLOV3 program efficiently detected whether humans are present in the image within a time of around 0.8-0.9 seconds and it output the coordinates of the bounding box which are drawn around the human detected.

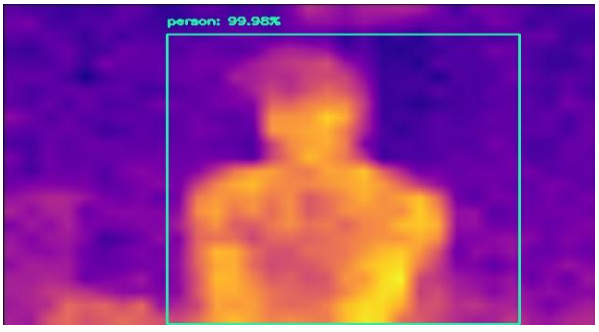

Fig 5 Output of Yolov3 Human Detection

The temperature within the bounding box is calculated and sent serially to Arduino for AC control. The temperature and human presence were successfully updated to the cloud database and was checked the same using the android application which works perfectly.

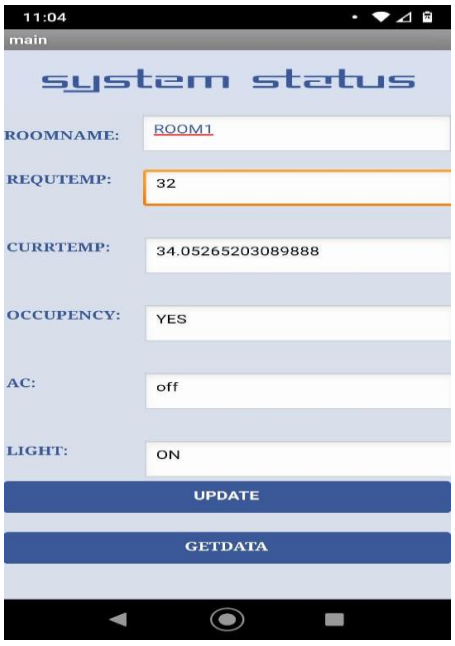

Fig 6 Information Updated on App

All the components were assembled in a 3D printed box custom designed by us for this project. The final device is shown in the Fig 7

Fig 7 Final Picture of the Device

5. CONCLUSIONS

Our system since operates by calculating the temperature of human body in real time rather than calculating atmospheric temperature is first of its kind.

Since the system monitors the human body it adjusts the cooling system accordingly which provides a better user experience. The system adopts to any sudden change in body temperature caused by various factors and keeps the body from sweating without any human intervention .The system also detects the absence of human and turns off automatically and it also recognizes need for adjusting the AC temperature when the body is in normal condition to a efficient setting there by helps in saving energy. Currently thermal cameras are costly and thereby we have used pi camera for increasing image quality and for human detection. In future when thermal cameras are affordable only thermal camera with high resolution can be used for both human detection and temperature calculations

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