Combination of infrared thermal imaging camera and ESP32 microcontroller

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ABSTRACT
This article presents a research analysis of the effect of the CuP_2 element as a modifier on the wear resistance of the gray cast iron low – alloyed liquid cast iron alloy. Based on the obtained results, the increase in the number of crystallization centers of the cast alloy and the formation of a fine granular structure led to a significant increase in the wear resistance property of the cast product.

Keywords: *ESP32 microcontroller, mlx90640 Infrared Thermal Imaging Camera, TFT SPI 240x320 LCD,*

Introduction.

In the last decade with the development of new sensors and sensor networks the attention of many researches is focused on providing personalized services for users in their daily life, human localization or occupancy detection, activities recognition, and security issues. Vision-based human localization and actions recognition is under intensive research in the field of Ambient Assisted Leaving (AAL) and assistive technologies as the ageing population rapidly growing in a worldwide scale [5].

However, at present, remote temperature measurement is used in many fields. Due to Covid-19, the demand for this has increased to the maximum. For this reason, various methods of remote temperature measurement have been developed. But the invention of mlx90640 Infrared Thermal Imaging Camera was a big news. Because, if you use this sensor, you can see the temperature of the object in different colors according to its shape.

Besides humans, computers and many other objects indoors emit infrared radiation and hence can be captured by the infrared thermopile array sensor at the same time. The background of the infrared image of sensor is complex and dynamically changing, and we should remove the dynamic background, i.e. to remove non-human thermal disturbances first. Thermopile array sensor MLX90640, with an array output of 24 × 32 pixels [6].

Discussion

Esp32 and mlx90640 infrared thermal imaging camera.

Here is a brief description of our main controller, the ESP32 microcontroller:

ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios [3].

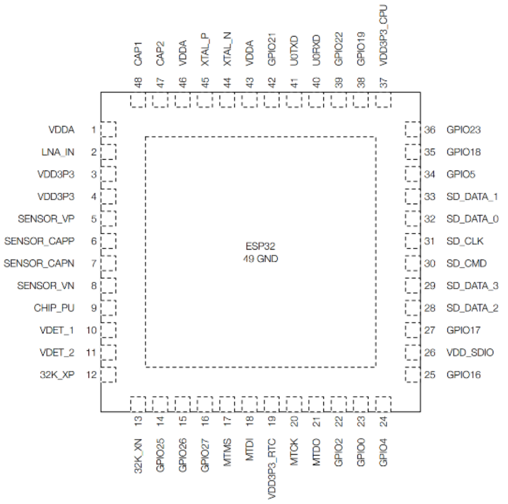

Figure 1. ESP32 Pin Layout (QFN 6*6, Top View)

Describes the functions integrated in ESP32. ESP32 contains one or two low-power 32-bit LX6 microprocessor(s) with the following features:

- 7-stage pipeline to support the clock frequency of up to 240 MHz (160 MHz for ESP32-S0WD)
- 16/24-bit Instruction Set provides high code-density
- Support for Floating Point Unit
- Support for DSP instructions, such as a 32-bit multiplier, a 32-bit divider, and a 40-bit MAC
- Support for 32 interrupt vectors from about 70 interrupt sources

The single-/dual-CPU interfaces include:

- Xtensa RAM/ROM Interface for instructions and data
- Xtensa Local Memory Interface for fast peripheral register access
- External and internal interrupt sources
- JTAG for debugging

ESP32's internal memory includes:

- 448 KB of ROM for booting and core functions
- 520 KB of on-chip SRAM for data and instructions
- 8 KB of SRAM in RTC, which is called RTC FAST Memory and can be used for data storage; it is accessed by the main CPU during RTC Boot from the Deep-sleep mode.
- 8 KB of SRAM in RTC, which is called RTC SLOW Memory and can be accessed by the ULP coprocessor during the Deep-sleep mode.
- 1 Kbit of eFuse: 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including flash-encryption and chip-ID.
- Embedded flash or PSRAM [3].

MLX90640 Description

The MLX90640 is a fully calibrated 32x24 pixels thermal IR array in an industry standard 4-lead TO39 package with digital interface.

The MLX90640 contains 768 FIR pixels. An ambient sensor is integrated to measure the ambient temperature of the chip and supply sensor to measure the VDD. The outputs of all sensors IR, Ta and VDD are stored in internal RAM and are accessible through I2C. [2]

Connection of infrared thermal imaging camera mlx90640 and esp32.

Let's calculate a small circuit for connecting the MLX90640 sensor to the ESP32 controller. First of all, we need to connect the power source correctly. We connect VIN input voltage to VIN on ESP32 and GND to GND. Connect the SDA and SCL outputs to the 2 digital pins you want. We connect to pins D2 and D4.

After connecting the infrared thermal imaging cameras to the microcontroller, we connect the TFT SPI 240x320 display to control it. We will not need the TOUCH PINS of the LCD display. We will be able to connect the rest of the display pins to the auxiliary digital pin other than D2 and D4 on the ESP32. Of course, we must connect the power supply to 3.3V and GND. We connect CS to D13, RESET to D12, DC to D14, SDI(MOSI) to D27, SCK to D26, LED to D25 and SDO(MISO) to D33. After that, we will write the Arduino codes.

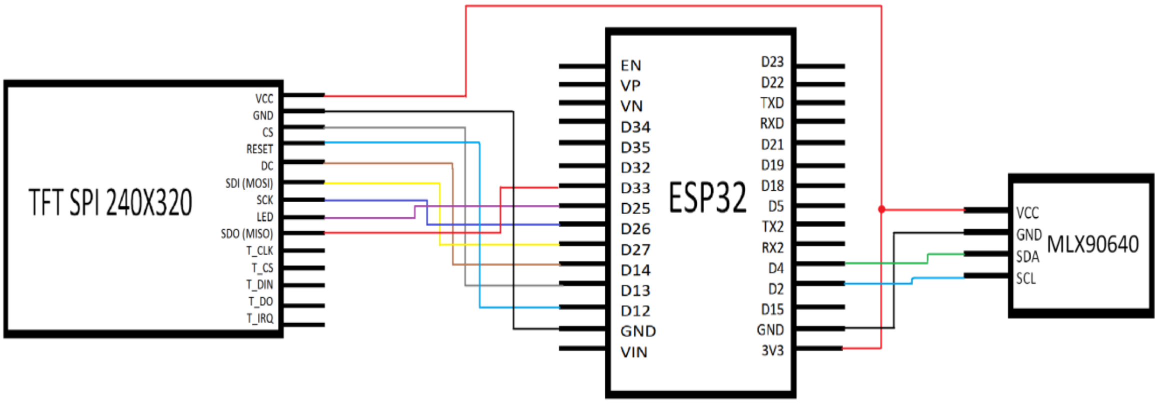

Figure 2. Circuit Diagram of Thermal Camera Project

After writing the necessary files for Include, we write down the contacts of the TFT SPI 240x320 display connected to the controller. We implement it with define.

A 2-byte "int" is written to display the corresponding temperature in red, yellow, and blue along the x and y axes, and we write the code in the SetUp section.

Select Board port 115200. Enter serial print on a new line. Next, we enter status in the int command. We associate the status with MLX90640 DumpEE. If the status is 0, the command to print "Failed to load system parameters" on a new line is written.

We specify the input and output with the "pinMode" command to input TFT_LED to output OUTPUT. We set TFT_LED and HIGH to the "digitalWrite" command. Then we enter commands for lcd display on tft.begin. In turn, we select the colors corresponding to the temperature. Then we set the maximum, average and minimum values of the temperature according to the void loop commands. Then, he chooses colors accordingly.

And by void getColour, we specify the color result corresponding to the temperature

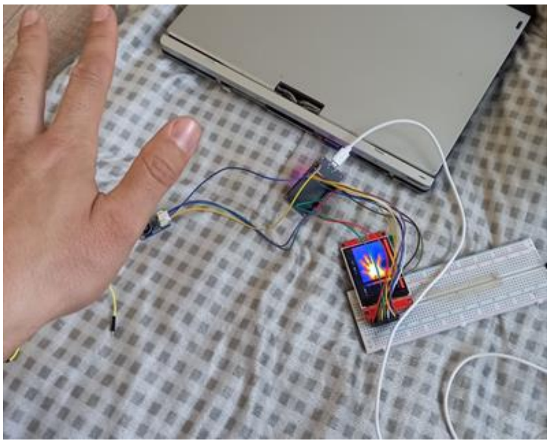

Figure 3. The research result.

We can see that the resulting temperature is expressed in different colors according to the shape and temperature of the object being measured (Figure 3). As an object, I measured the temperature of my hand. The parts of my hand that have been cooled down by the outside air also look bright (Figure 4).

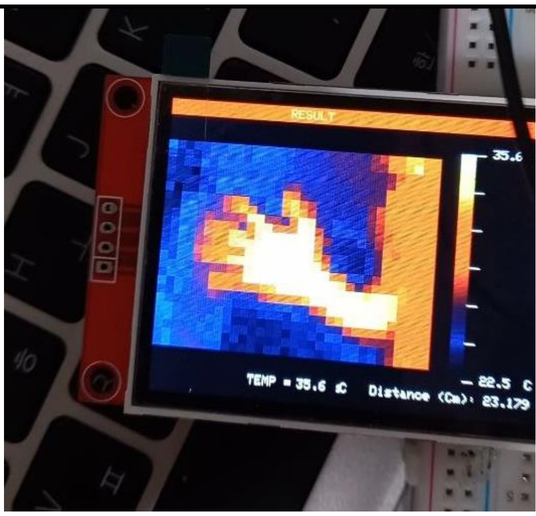

Figure 4. The research result.

The highest temperature is represented in yellow, the average in red and the lowest temperature in blue. We can see where the object's maximum temperature is. Here we measure the temperature of the iced coffee, which is below room temperature (Figure 5)

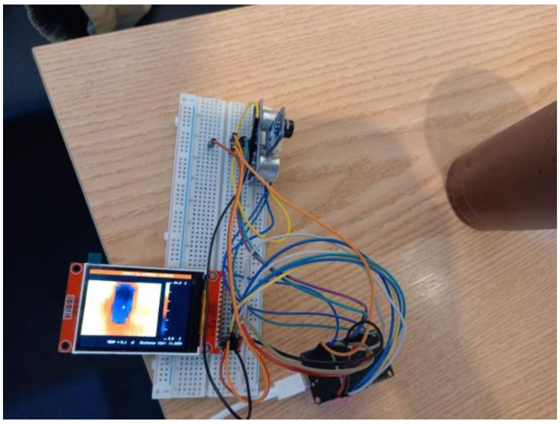

Figure 5. The research result.

And determine its maximum and minimum temperature (Figure 6).

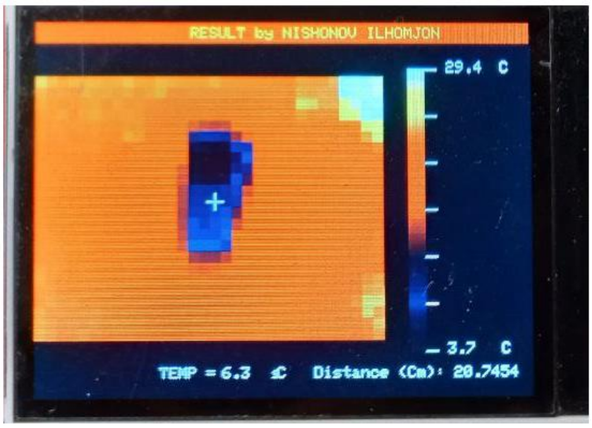

Figure 6. The research result.

Since iced coffee is at a temperature below room temperature, its image is displayed in blue. Therefore, this system is very convenient for measuring the temperature of an object at any temperature, which the MLX90640 thermal imaging camera can measure.

The obtained research results show that the temperature of the object we need to measure is expressed in different colors. We will be able to remotely measure the temperature of all objects that have infrared light. At the same time, we will be able to determine the effect of external temperature on the object. This system is also very useful for finding out where the problem is most common in the heating and cooling system of the room.

Conclusion

In short, the object temperature measurement system was developed using the MLX90640 infrared thermal imaging camera sensor. The MLX90640 thermal camera determines the maximum and minimum values of the object's temperature and shows us its image in infrared form. As a result, it allows you to see the temperature of the object in a combination of different colors. With this device, we will be able to accurately measure the temperature of any object from a distance.

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