IoT Surveillance

Draft 1, Track 4, Computer Architecture and Organisation (AV312)

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***Abstract*—The Internet of Things (IoT) is transforming a wide range of industries and sectors by bringing automation, intelligence, and connectivity at unprecedented performance levels and has potential for much more. There is undeniable need for surveillance for purposes such as security, automation etc. Surveillance can be achieved using Facial Recognition and Object Detection & Classification through IoT implementation. Here we aim to achieve this using MAX7800 SoC for Facial Recognition and Object Detection & Classification related processing and ESP32-CAM WiFi-Bluetooth module coupled with OV2640 camera module for video & image capturing.**

***Index Terms*—IoT, Surveillance, MAX 78000, ESP32-CAM, OV2640**

I. Introduction

A. What is IoT?

The Internet of Things (IoT) portrays the organization of Physical objects (”things”) that are installed with sensors, software, and different advancements to interface and trade information with different gadgets and frameworks over the web or other correspondence organizations. These gadgets range from ordinary household objects to refined modern devices.

B. Surveillance and IoT

There is undeniable need for surveillance for purposes such as security, automation etc. Surveillance can be achieved using Facial Recognition and Object Detection & Classification through IoT implementation. Here we aim to achieve this using MAX7800 SoC for Facial Recognition and Object Detection & Classification related processing and ESP32-CAM WiFi-Bluetooth module coupled with OVM7692 camera module for video & image capturing.

Currently, there exist multiple security systems, which make use of various motion sensors to detect any motion and notify the owner about the intrusion. However, most of these systems do not provide the features of zone barriers, facial recognition, remote camera surveillance and power failure detection, combined with ease of use, economic viability and power efficiency.Through our implementations we aim to achieve these.

II. Components selected

A. MAX78000

The MAX78000 is an advanced system-on-chip featuring an Arm Cortex-M4 with FPU CPU for efficient system control. The AI microcontroller is built such as to enable neural networks to execute at ultra-low power. Its hardware-based convolutional neural network (CNN) accelerator enables battery-powered applications to execute AI inferences while spending only microjoules of energy.

The applications include Audio Processing, Facial Recognition, Object Detection & Classification, and Time-Series Data Processing.

The parametic specs for the microcontroller are as follows,

- Internal Flash (KBytes): 512
- Core Clock Speed (MHz) (max): 100
- Internal SRAM (KBytes): 128
- Package/Pins: CTBGA-CU/81

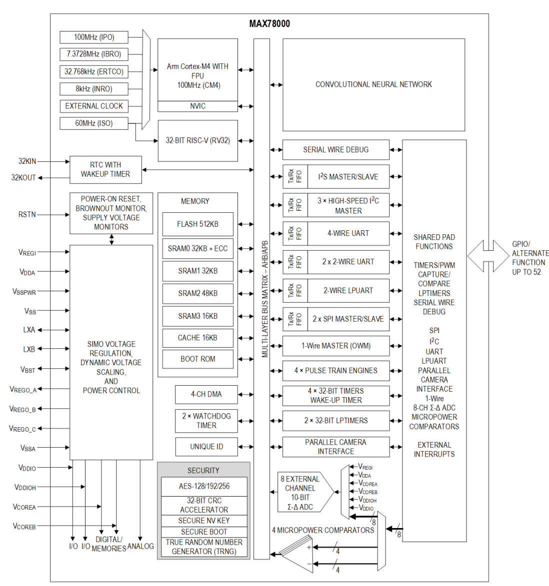

Fig. 1. MAX78000 Architecture

B. ESP32-CAM WiFi-Bluetooth Module

It is suitable for home smart devices, industrial wireless control, wireless monitoring, and other IoT applications.It based on the ESP32 chip with the additional facility of using a camera. ESP integrates WiFi, traditional Bluetooth, and BLE Beacon, with 2 high-performance 32-bit LX6 CPUs, 7-stage pipeline architecture. It has the main frequency adjustment range of 80MHz to 240MHz, on-chip sensor, Hall sensor, temperature sensor, etc. It has the following features,

- Ultra-small 802.11b/g/n Wi-Fi + BT/BLE SoC module
- Low-power dual-core 32-bit CPU for application processors
- Up to 240MHz, up to 600 DMIPS
- Built-in 520 KB SRAM, external 4M PSRAM
- Embedded Lwip and FreeRTOS

It supports/has support for:

- Interfaces such as UART/SPI/I2C/PWM/ADC/DAC
- Images WiFi upload
- TF card
- multiple sleep modes
- STA/AP/STA+AP working mode
- Smart Config/AirKiss One-click distribution network
- Serial local upgrade and remote firmware upgrade (FOTA)

Fig. 2. ESP32 WiFi Module

C. OVM7692

The OVM7692 CameraCubeChip™ consists of a low voltage CMOS image sensor that provides, in a small footprint package, the full functionality of a single-chip VGA camera & image processor. The OVM7692 provides full-frame, subsampled or windowed 8-bit images in a wide range of formats, controlled through the Serial Camera Control Bus (SCCB) interface.

It has an image array capable of operating at up to 30 frames per second (fps) in VGA with complete user control over image quality, formatting and output data transfer. All required image processing functions, including exposure control, gamma, white balance, colour saturation, hue control, white pixel cancelling, noise-canceling, and more, are also programmable through the SCCB interface.

In addition, OmniVision Camera chip sensors use proprietary sensor technology to improve image quality by reducing or eliminating common lighting/electrical sources of image contamination, such as fixed pattern noise, smearing, etc., to produce a clean, fully stable colour image.

Fig. 3. Camera Module

D. TPS62060DSGR (Power IC)

The TPS62060DSGR is a highly efficient synchronous step-down DC to DC converter with 3-MHz Switching Frequency, input voltage range of 2.7V to 6V and provides up to 1.6 A output current with up to 97% efficiency.

E. FT230XS-R (USB to UART)

The FT230X is a USB to serial UART single chip asynchronous serial data transfer interface which is used for smaller PCB designs.It requires no specific firmware programming, and its entire USB protocol is handled on the single chip. It has integrated +3.3V level converter for USB I/O and integrated power-on-reset circuit.

III. Working Algorithm

The workflow of the presented IoT solution is centred around MAX78000, which is connected to ESP32 Wifi Module and OV2640 Camera Module. Here after initiation the camera module constantly sends data (video) to Wifi module which is connected to the SoC. The SoC runs a neural network in it to identify humans in the received data. The identification will continue till the objective is achieved, and when achieved the IoT solution with the help of Wifi module will send a notification to the main node, which can be a smartphone or a PC or any others similar device, which will informs about the presence of someone to the required person and then again start the identification process, i.e. a complete loop. The recipient can further ask for continuous video feed to his local device which can again be done by using ESP32 module, i.e. the data from the camera is directly uploaded to main node by ESP32, without sending it to SoC and will continue this till the user requests for the data, after the end of request, the data is again routed to SoC for processing and the recipient is again pinged when another target is identified.

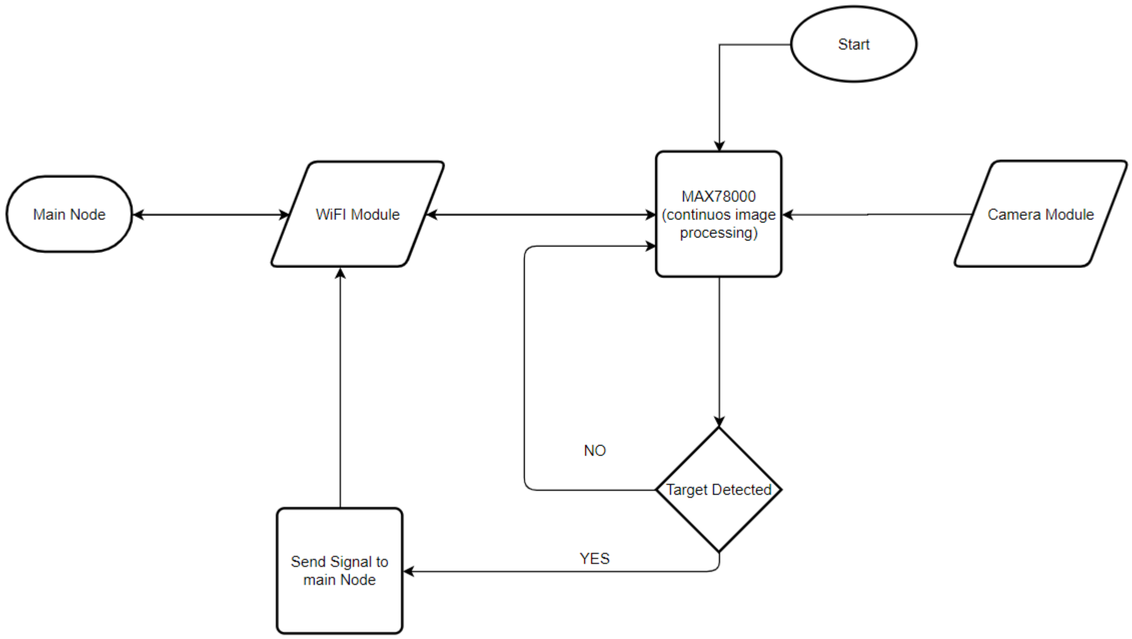

Fig. 4. Flow Chart Representation of Working Algorithm

IV. Implementation

A Board (Neural Network IoT Board) is designed using the above components. The Board is in 2:1 (11cm*5.5cm) form factor, which makes easier to realize hand-held systems or encapsulate it to make outdoor solution.

TPS62060DSGR IC, from ti is used to realize 6 LDO circuits, that will power all the components of the board. The outputs derived from LDOs are 3V3 (2 circuit for redundancy), 1V1, 1V2, 1V8 and 2V8. These LDOs derive there input power through the USB input, i.e., common for both power and data. Further FT230XS is used to convert the USB data input to UART format that is feed to SoC. JTAG input is provided so that we can flash the system and additional IS25LP128-JBLE is used to realize the flash memory (QSPI based) for the system. Also the Board is developed to support external clock, which is achieved using MAX13202EALT+T.

For input from real world we used Camera Cube OVM7692 for image/ video input. Also SPH0645LM4H i.e., a digital mic is added in the schematic which can be used for future improvement.B3S-1000P switch is used to realize power and reset button.

Further it is recommended to use tensor flow based neural network for facial recognition.

V. Future Improvement

The major addition to the realized board is the addition ESP32 wifi-module which is yet to be done. Other than that Voltage and Current sensors can be added to the board that can help in debugging of the board. Also the camera module is not attached to the board, headers are provided for connection, this provide more flexibility for adjusting the vision of camera, yet a more robust solution can be achieved for the same.

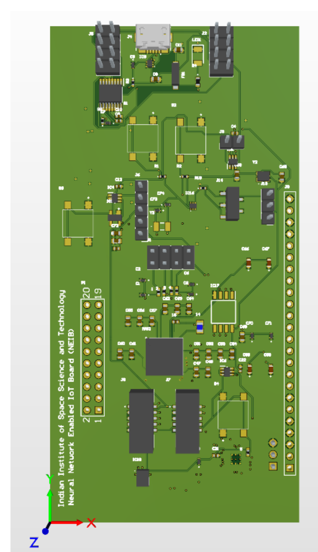

Fig. 5. Designed Board

Acknowledgment

I would like to express my special thanks of gratitude to Dr. B.S.Manoj who gave me the opportunity to do this project, we will also like to thanks Dhruva Ananta Datta for his help in PCB layout and designing.

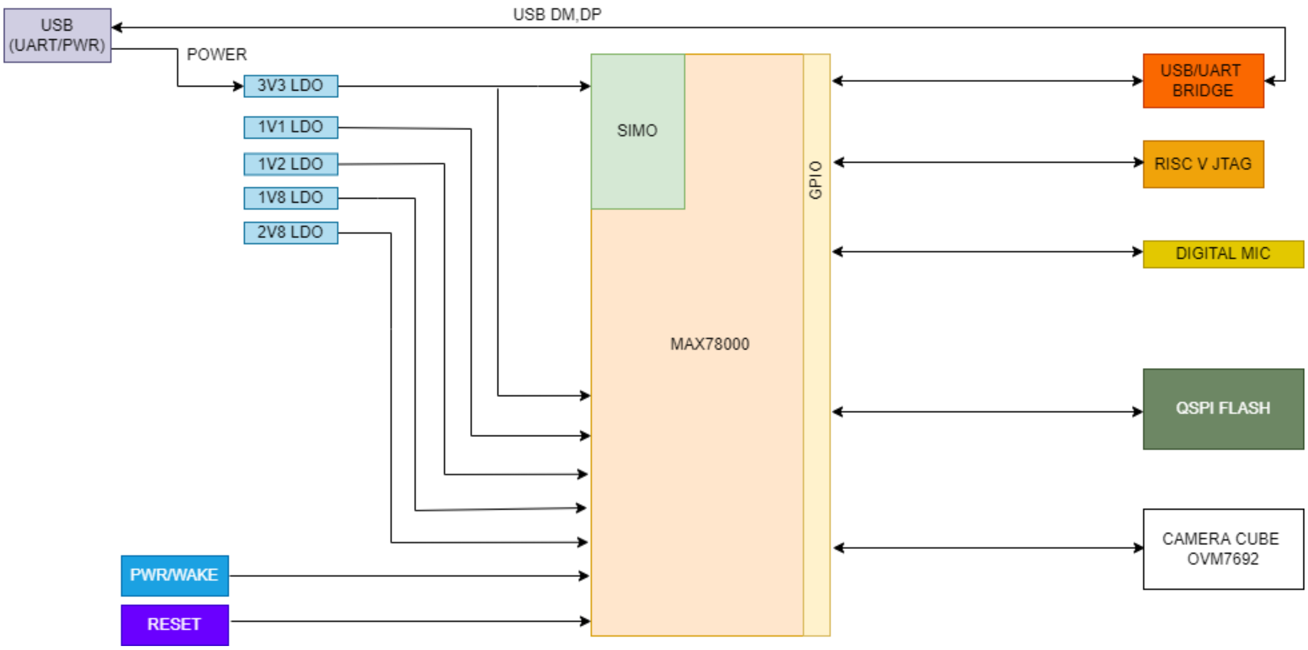

Fig. 6. Basic Design Idea of PCB

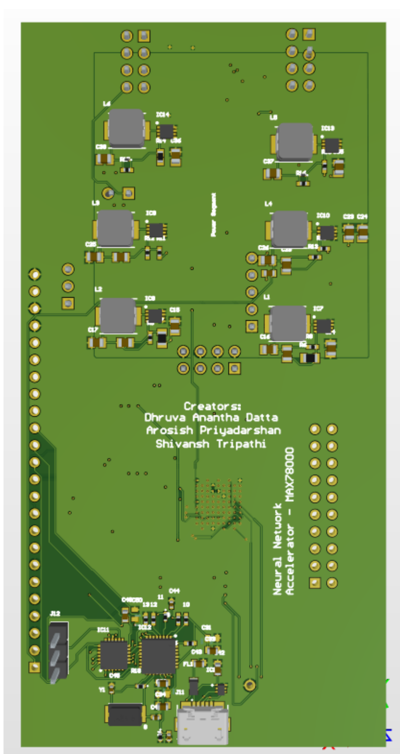

Fig. 7. Bottom view of PCB

REFERENCES

[1] https://www.maximintegrated.com/en/products/microcontrollers/MAX78000.html

[2] https://www.maximintegrated.com/en/products/microcontrollers/MAX78000EVKIT.html

[3] https://www.digikey.in/catalog/en/partgroup/ovm7692/28408#:~:text=AR0130CS-,OVM7692,in\%20a\%20small\%20footprint\%20package.

[4] https://www.ti.com/store/ti/en/p/product/?p=TPS62060DSGR

[5] https://www.mouser.in/datasheet/2/163/DS_FT230X-5395.pdf

[6] https://www.mouser.in/datasheet/2/198/IS25LP032-064-128-463542.pdf

APPENDIX

Different layers of PCB

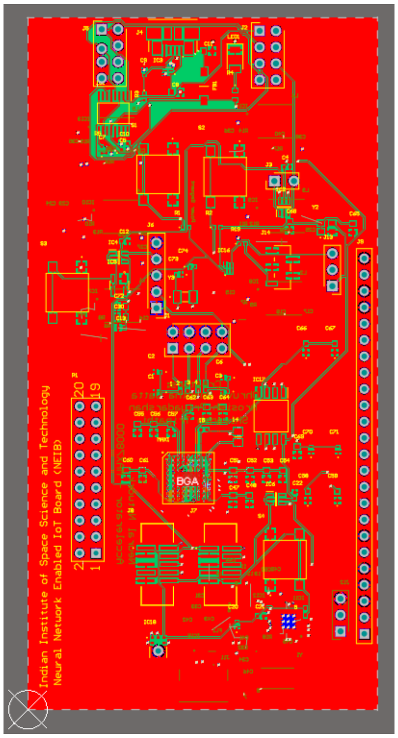

Fig. 8. Layer 1

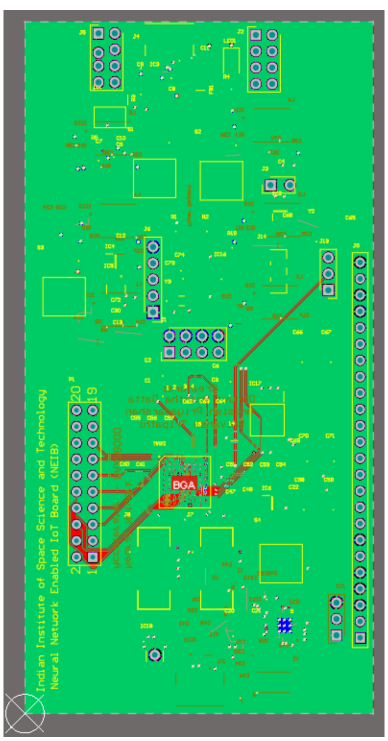

Fig. 9. Layer 2

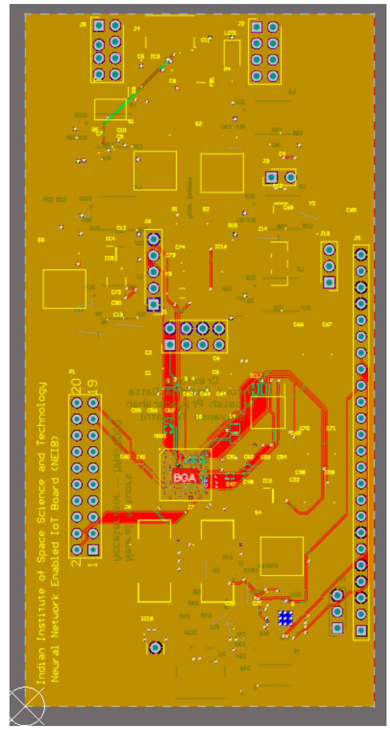

Fig. 10. Layer 3

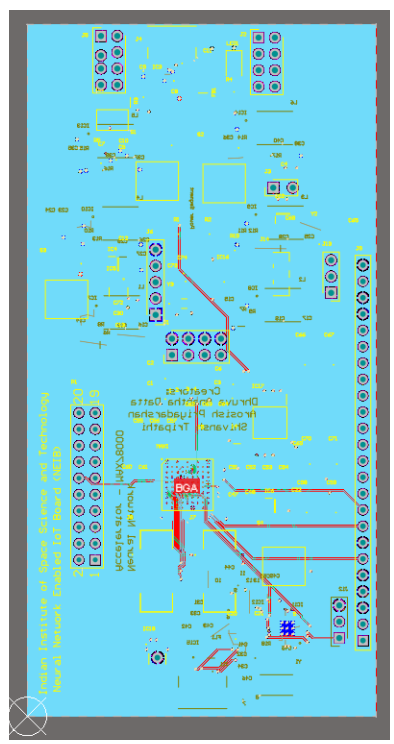

Fig. 11. Layer 4

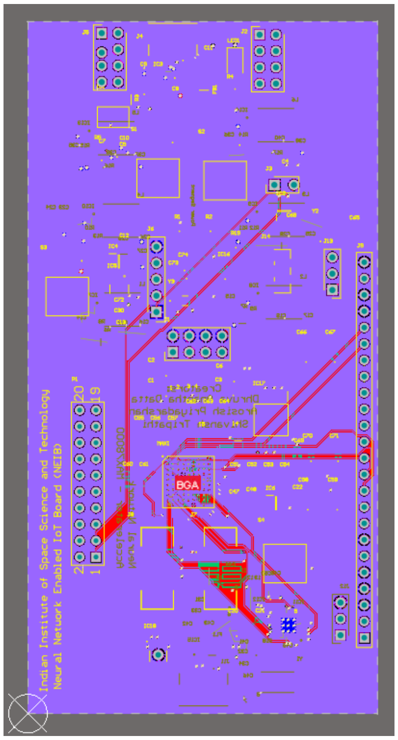

Fig. 12. Layer 5

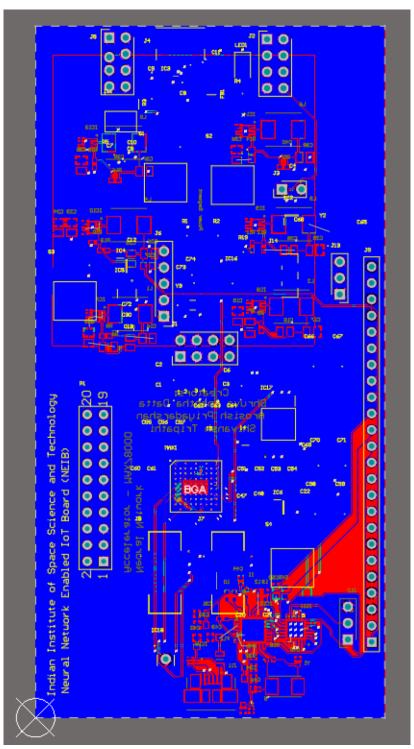

Fig. 13. Layer 6