# Making a STM32H750-based Camera

## Introduction

Digital imaging is a cornerstone of modern embedded systems, enabling applications from robotics to surveillance. This report details the design and implementation of a basic digital camera system using the STM32H750VBTb microcontroller, the OV7670 camera module, and a laptop for image display or storage. The project demonstrates how embedded hardware, and software can be integrated to capture, process, and transmit images in real time.

## Component Selection and Rationale

### STM32H750VBTb Microcontroller

The STM32H750VBTb is a high-performance 32-bit Arm Cortex-M7 microcontroller operating up to 480 MHz, with 1 MB of RAM and 128 KB flash memory. It features a dedicated Digital Camera Interface (DCMI), multiple DMA controllers, and a wide array of communication peripherals (UART, USB, I2C), making it ideal for real-time image capture and processing tasks required in digital camera systems.

How it will be used in this project:

- DCMI for direct camera interfacing.
- High-speed DMA for efficient data transfer.
- Sufficient RAM for frame buffering.
- USB and UART support for communication with a laptop.

### OV7670 Camera Module

The OV7670 is a low-cost, widely used CMOS camera module capable of capturing VGA (640x480) images at up to 30 frames per second. It outputs data in standard formats (RGB565, YUV, etc.) and communicates configuration via the SCCB (I2C-compatible) interface.

How it will be used in this project:

- Direct compatibility with microcontroller camera interfaces.
- Adjustable image parameters (exposure, white balance, etc.).
- Simple hardware interface and low power consumption.

### Laptop

The laptop serves as the user interface, storage, and display platform. It receives image data from the STM32 system via UART (serial-over-USB) or USB, enabling visualization and further processing.

How it will be used in this project:

- Flexible software environment for receiving and displaying images.
- USB/UART interface for easy data transfer from the microcontroller.

## Hardware integration

### Camera to Microcontroller Integration

- The OV7670's 8-bit parallel data lines (D0–D7), synchronization signals (PCLK, VSYNC, HREF), and SCCB lines (SIOC, SIOD) are connected to the STM32H750VBTb's DCMI, I2C, and GPIO pins, respectively.
- The STM32 generates a clock signal (XCLK) for the camera using a timer or MCO output.
- Both modules are powered at 3.3V and share a common ground.

### Microcontroller to Laptop

1. Image data is transmitted using either:
   - UART (via a USB-to-UART converter or virtual COM port).
   - USB CDC (if implemented on STM32).
2. The laptop receives the data using a serial terminal or custom application.

## Software Integration

### Camera Configuration

The STM32 configures the OV7670 via the SCCB/I2C interface, setting resolution, output format (e.g., RGB565), and frame rate.

Registers are programmed to optimize image quality for the application.

References used:

https://community.element14.com/challenges-projects/design-challenges/summer-of-fpga/b/blog/posts/security-camera-3-interfacing-with-ov7670-camera

https://www.openhacks.com/uploadsproductos/ov7670_cmos_camera_module_revc_ds.pdf

### Microcontroller Configuration

The DCMI peripheral captures image frames, with DMA moving data into internal SRAM for buffering.

Optionally, the STM32 can compress images (e.g., JPEG encoding using hardware or software libraries), or transmit raw RGB data.

References:

https://www.st.com/en/microcontrollers-microprocessors/stm32h750vb.html

https://github.com/PHANzgz/STM32-H7-camera-interface-and-display

https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000007CS/P001072/M023192/ET/1505901569e-text-Mod401.pdf

Buffered image data is serialized and sent to the laptop using UART or USB.

Data is split into bytes and transmitted in blocks, with appropriate synchronization to allow the laptop to reconstruct the image.

References:

https://controllerstech.com/stm32-uart-1-configure-uart-transmit-data/

https://community.st.com/t5/stm32-mcus-products/getting-ov7670-camera-data-in-stm32f7-sram-memory-to-computer/td-p/426574

### Laptop Reception and Display

A serial terminal or a custom program (e.g., Python script) receives the data, reconstructs the image, and displays or saves it.

References:

https://github.com/PHANzgz/STM32-H7-camera-interface-and-display

## Conclusion

This project demonstrates a practical approach to building a digital camera system using the STM32H750VBTb microcontroller and OV7670 camera module, with a laptop as the display and storage interface. The STM32H750VBTb's high performance and built-in DCMI peripheral make it well-suited for real-time image capture and processing. The OV7670 offers a cost-effective and easily interfaced imaging solution for embedded applications. By leveraging standard communication protocols, the system efficiently transfers captured images to a laptop for visualization or further processing. This architecture is extensible for advanced imaging, machine vision, or IoT camera applications.