Problem Statement

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Abstract

Providing quality avionics and information technology systems for the airline industry is a task that Rockwell Collins has been capable of doing since its start. However, the research and development of these industry specific systems results in costly solutions, and our project is to recreate the video output of a complex system utilized by pilots with the use of manufactured hardware. Our solution is composed of three main pieces of hardware, and when integrated the input from multiple cameras will be fused together and displayed on an output screen at near-real-time.

1 Problem

Rockwell Collins is looking for an economic solution regarding a flight deck product that they currently offer for their clients in the aviation industry. The product is a head-up display (HUD) that is transparent, and assists pilots during low visibility conditions during the day, night, and inclement weather for all phases of flight. When lowered in the pilots forward field-of-view (FOV), the HUD displays a variety of indications, from on-board sensors and databases to real-time images taken from on-board cameras. Specifically, Rockwell Collins has requested that our project focus on duplicating the Enhanced Vision System (EVS) of their HUD, which uses input from three detection channels of the electromagnetic spectrum to display images that are beyond human vision. The output from the channels provide thermal images of the landscape and various types of lighting, for example incandescent, halogen, and LED lights, etcetera. The in-house development and custom manufacturing of this system is very costly, and therefore the company is unable to attract all customers from public and private airline industries.

2 Proposed Solution

An EVS that has system hardware composed of affordable off-the-shelf hardware, which reduces the total cost of the HUD for airline industry customers of Rockwell Collins. For multiple camera and spectral band image processing and the added size, weight, power, and cost (SWAP-C) constraint due the projects application, the EHS will need to be deployed with the use of a system on a chip (SoC) or a system on a module (SOM). These SoCs and SOMs integrate systems that typically would plug into the motherboard of a personal computer with the motherboard. For example, the motherboard and video card are combined as one. Due to our project requiring image processing our SoC or SOM must have a graphics processing unit (GPU), and the perfect example of a product would be the NVIDIA Jetson TX1 and TX2. With the latest being the TX2, internal real-time processing is one of its many capabilities that make this an attractive solution. In addition to the Camera Serial Interface (CSI) of the TX2 being capable of supporting six cameras simultaneously. The TX2 also supports High Efficiency Video Encoding (HEVC) or H.265, which is the new video compression standard capable of providing double the compression efficiency than the previous standard. To allow for future compatibility of future cameras, a camera interface board is a likely solution, and is required to be compatible with the SoC or SOM selected for the project. Another limitation that must follow the projects SWAP-C constraint is the need for the system to run independent of a development kit or external computer. The cameras selected to attach to the camera interface board simultaneously must include the desired bands of the electromagnetic spectrum to mimic the current EVS output.

3 Performance Metrics

The following is a list of metrics that must be met in order for the project to be deemed a success.

3.1 System Research

The GPU, camera interface board, and cameras must be capable of being integrated for the system to produce an output to a screen. Researching compatible components for system integration will be the first major step, and most specifically a camera interface board capable of communicating with the GPU. The is potential that the camera interface board may require minor modifications to meet full requirements of the project. These components must also meet size, weight, power, and cost (SWAP-C) requirements due to the application for the EVS. With a Jetson TX2 currently available, research and tinkering will occur during this process to gain better understanding of it.

3.2 System Integration and System Output with One Camera

Once the system components are narrowed or finalized, purchased and in-hand, system integration is required for the major components to communicate. This may be capable of being confirmed without an output display and signal input from a camera, but until more information is gathered on the hardware this metric will be confirmed by such. All desired wavelengths that provide input to the existing EVS utilize will be tested for output.

3.3 System Output with Two or More Cameras

Due to the EVS requiring input from multiple cameras, the next goal for the project will be to have two camera inputs fused together on an output display. At a minimum, the three wavelengths that provide input to the existing EVS will be tested for a fused output. Completion of this step will be verified once all cameras have been tested and that two combinations of camera outputs are capable of being fused together.

3.4 Overall and Stretch Goals

The system should be capable of being integrated for a quality video output near-real-time. Since the EVS's primary benefit during flight is low visibility conditions, different conditions will be tested with the cameras, and the recording and plotting of data will be expected. Additional camera inputs will added one at a time and fused together on an output screen. Once the fused output is tested satisfactorily this will be repeated for up to six total camera inputs.