HEAD-UP DISPLAY AUTO-ALIGNMENT SYSTEM

The cost of an airplane may be reduced in the future!

WHAT IS A HEAD-UP DISPLAY (HUD)?

A transparent display that is installed in a number of aircraft today. Located in the pilot's forward field of view, a HUD presents flight information by using graphical, numerical and symbolical data. This device eliminates the need for pilots to continually transition from head-down instruments to head-up, out-the-window view during critical phases of flight.

Pilot's forward field of view

CURRENT HUD ALIGNMENT SYSTEM

Currently, a HUD obtains data from an aircraft's Inertial Measurement Unit (IMU). To display precise and accurate information, the HUD must be carefully aligned to the IRU during installation. However, the current HUD installation process requires specialized equipment and epoxy which is time consuming, costly, and interrupts production line progress for the manufacturer.

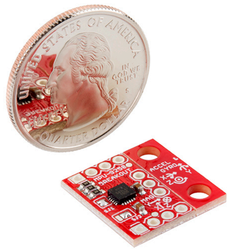
Head-Up Display during flight

NEW ALIGNMENT METHODOLOGY

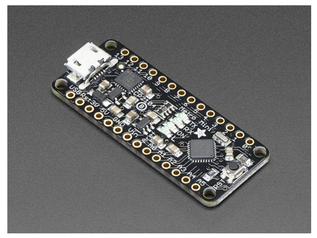
The goal of this project is to improve the current HUD alignment systems by reducing the installation cost and time required to precisely align flight information to the HUD. Our client, Rockwell Collins, seeks a new alignment methodology that utilizes HUD mounted inertial measurement units.

WHAT IS AN INERTIAL MEASUREMENT UNIT (IMU)?

An IMU contains a set of sensors that typically include an accelerometer, gyroscopes and/or magnetometer (compass). In this project, we used an IMU of model MPU-9250 from *Sparkfun Electronics*. *An MPU-9250 IMU* is as tiny as a quarter, yet it contains all three of the sensors mentioned above. A diverse set of sensors increases the degrees of freedom which improves data accuracy. In addition, in order to retrieve sensor data, we also used a microcontroller of model Metro-Mini 328 from *Adafruit Industry* to communicate with the IMU.



IMU - *Sparkfun MPU-9250*

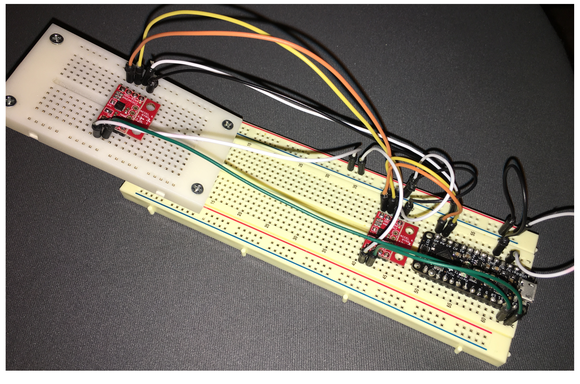


Microcontroller - *Metro-Mini 328*

PROJECT OVERVIEW

Our project serves as a proof of concept for a new alignment methodology. This project is separated into three parts.

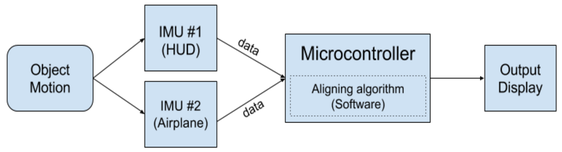
- The configuration of hardware and communication between devices.
- The development of an program that can find the HUD's alignment offset in relation to the aircraft.
- The design and implementation of a demonstration interface that visually presents the alignment results.



Microcontroller wired to two IMUs

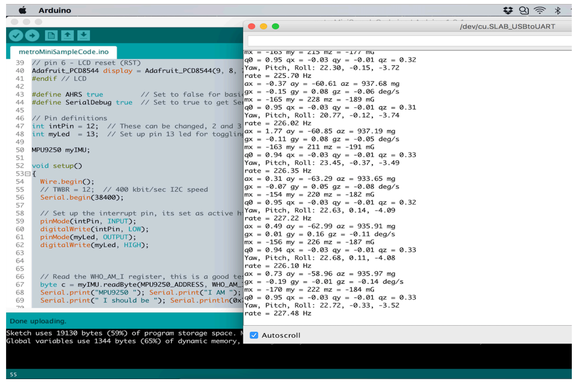
HOW DID WE SOLVE THE PROBLEM?

Our demonstration system made use of two separate IMUs to generate the data that represents the individual points of origin for both the HUD and aircraft. Along with the IMUs, we used a microcontroller to process data and a PC to display the results.



Data flow between hardware components

By using a communication protocol we were able to access each IMU from the microcontroller. We used the Arduino development environment to program the microcontroller as well to debug data output. Data then was retrieved from each sensor and used to determine the alignment offset through statistical analysis. The results were then sent to the PC to be displayed.

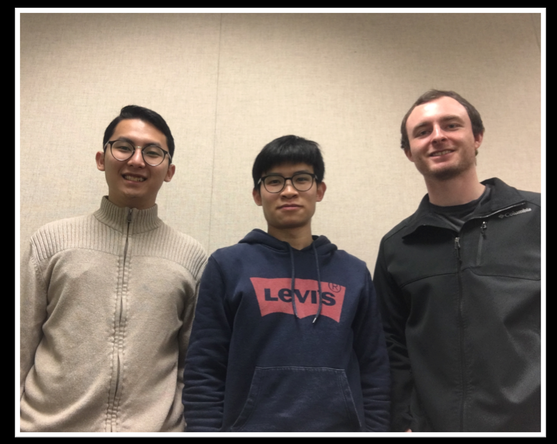


Reading IMU data in Arduino Development Environment

CALIBRATION PROCESS & RESULT

Our project required a two part calibration process. First, each IMU was configured to output its individual sensor data. During IMU configuration, an initial calibration was performed to discover each sensors individual bias. Once the biases were known, we removed them from future readings. Next, the alignment offset discovery required a calibration process to produce a result within an acceptable range. We found the offset between two IMUs (airplane and HUD) after taking a number of samples from each device, the difference between each pair of samples and the average of those differences. Multiple data readings were required in each part of calibration to remove inaccuracies.

Meet the Engineers



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Sponsors - *Rockwell Collins, Inc.*

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Rockwell Collins

HYPOTHETICAL OUTCOME

Although we were not able to test the system using a real HUD on an aircraft, our project demonstrates how an inexpensive IMU can be used to accurately find an offset in alignment. This new alignment methodology points to a departure from the current HUD installation process by utilizing HUD mounted IMUs. Overall, this system proves that there is an opportunity to substantially cut HUD installation costs in the future.

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