Wildcat Rocketry Universal Flight Computer

LOGO GOES HERE

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Executive Summary

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Discussion

**Project Description**

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*Background and Motivation*

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*Project Requirements*

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*Validation and Acceptance Tests*

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*Verification and Validation Matrix*

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*Data Needed to Support Analysis*

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**Technical Design**

*Conceptual Design Descriptions*

We had two alternative designs in mind for the flight computer. Our first alternative was to use a microcontroller to gather and process the sensor data, while our second was to use a Field Programmable Gate Array (FPGA). These options will now be explored:

*Design Alternative 1: Microcontroller*

Microcontrollers are powerful small computers used on a single integrated circuit. There is a wide variety of microcontrollers, differing with regards to processing power, I/O capabilities, and data storage. These are relatively easy to program because of the simplicity of serial execution and team experience in languages such as C/C++. Power consumption can be low, especially for a model optimized for a low power environment. Some disadvantages are the serial execution nature of microcontrollers which limits capabilities when multi-tasking, such as gathering data from multiple processors simultaneously and processing that data. The choice of microcontroller must consider the internal peripherals of the specific model such as General-Purpose Input/Output (GPIO) count.

*Design Alternative 2: Field Programmable Gate Array (FPGA)*

FPGAs are a configurable integrated circuit that can be repeatedly programmed after manufacturing. FPGAs contain logic blocks and allow a programmer to connect these blocks and configure them. The main advantage of using an FPGA is the logic level programming allows for design of a specialized multi-tasking circuit. This would mean that intake and processing of sensor data would be simultaneous and potentially increase the number of data points. It can also be reprogrammed to allow for quick iterating and bug fixing. There are two main disadvantages of an FPGA: The complexity of coding and the increase of power consumption. Programming at a logic level is less familiar to the team members as well as the Wildcat Rocketry members which decreases the ability for future iteration. The other disadvantage is that to utilize the increased speed of parallel processing, more power is consumed.

*Selection Process for Preliminary Design Solution*

We used an evaluation matrix to decide between implementing the flight computer with a microcontroller or an FPGA. Compactness and reliability were our two most weighted requirements because those are especially applicable for the size of the rocket and for consistent data. Concept 1 represents the microcontroller while concept 2 represents the FPGA.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Need** | **Engineering Requirement** | **Weight (1-10)** | **Base line** | **Concept 1** | **Concept 2** |
| Lightweight | Weight < 100 grams | 3 | 5 | 5 | 5 |
| Lower Power Consumption | Minimum 2 hours battery life | 5 | 5 | 7 | 3 |
| Data storage | Can store multiple flights worth of data | 7 | 5 | 7 | 5 |
| Ease of use | Easy to use interface | 7 | 5 | 9 | 3 |
| Affordability | Unit production cost < $200 | 3 | 5 | 7 | 3 |
| Connectivity | Be able to output data via serial | 5 | 5 | 5 | 5 |
| Reliability | Produces data consistently | 10 | 5 | 4 | 6 |
| Compact | 3 inches width, 4 inches length | 10 | 5 | 7 | 5 |
| Accuracy | Produces accurate data | 7 | 5 | 4 | 7 |
| Total |  |  | 285 | 346 | 279 |

Table 3 Decision Matrix

Our final choice was the microcontroller. Some major factors over the FPGA were ease of use and power consumption.

**Preliminary Design/Solution Description**

*Global Issues*

This is to be used for K-State Rocketry Club so global issues do not pertain.

*System-Level Overview*

The flight computer will gather data from the flight and store that data for later analysis. It is meant to be easily expandable.

A diagram of a computer

Description automatically generated

**Figure 1 System Block Diagram**

*Applicable Standards*

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*Module-Level Descriptions*

Sensors:

The sensors consist of a high-G accelerometer, barometer, and a Inertial Measurement Unit which itself consists of a low-G accelerometer, gyroscope, and magnetometer. These sensors are typical and required in a flight computer and will be used to gather data on pressure, acceleration, heading, and tilt.

Flight Computer PCB:

The Flight Computer PCB module will consist of a microprocessor on a custom-made PCB.

External Memory:

Multiple flights worth of data necessitates the use of external memory in the form of an SD card.

Output Data:

Data from each flight can be output via USB-C on the PCB, or by Wi-Fi access by the wireless chip on the board.

*Detailed Design/Solution Descriptions*

THIS IS SEMESTER TWO ONLY

*Validation and Acceptance Test Results*

THIS IS SEMESTER TWO ONLY

*Assessment of Test Results*

THIS IS SEMESTER TWO ONLY

**Work Plan**

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*Work Breakdown Structure & RACI Chart*

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*Schedule Gantt Chart*

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*Prototyping and Testing Protocol*

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**Financial Plan**

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*Proposed Budget*

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*Comparison of Final Expenditures to Budget*

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**Feasibility Assessment**

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**Lessons Learned**

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**Conclusions**

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**REFRENCES**

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**APPENDEICIES**

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