Design - Part 2

Sddec24-01

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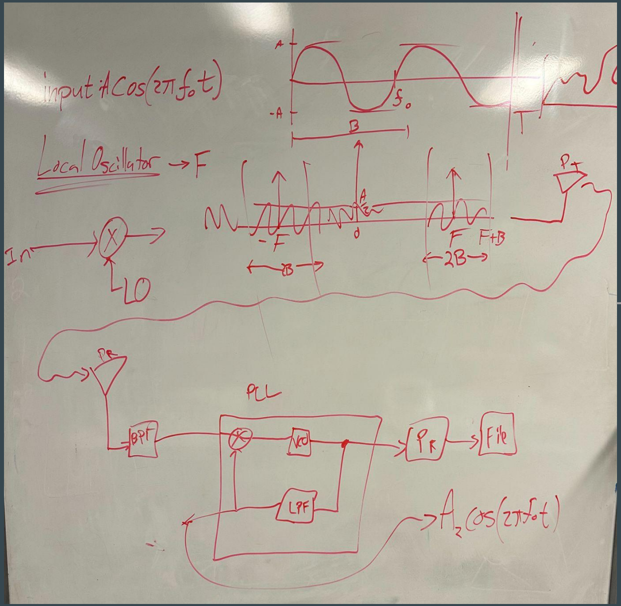
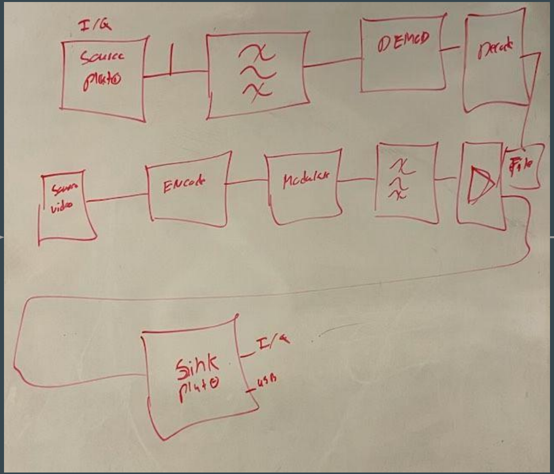
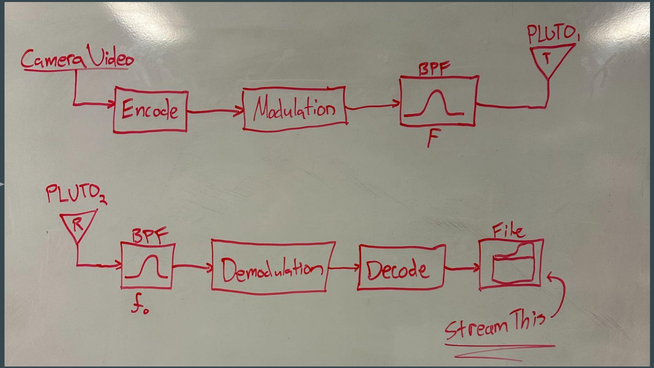
Project Overview:

- Create a project with a balloon that flies high up to collect data and record videos from near space.
- Work together with H.A.B.E.T. and other groups.
- Our aim is to get clear videos from up to 30,000 meters using software defined radios.
- We need to keep an eye on power use and how heavy the payload is.

Design and Visuals







Functionality

- User Scenario
  - Preparation Phase:
    - The user prepares the payload, ensuring all components are securely attached and powered. They set up the ground station equipment for receiving the video data.
  - Launch Phase:
    - The weather balloon, carrying the payload, is launched to an altitude of 30,000 meters. Once at altitude, the payload begins its operation.
  - Operation Phase:
    - The Pluto Board initiates data collection from sensors and activates the camera module to capture images and video. As the payload ascends, it continuously transmits video data over a 5.8GHz radio signal to the ground station. The ground station receives and displays the live video feed, allowing the user to monitor the surroundings in real-time.
  - Data Analysis Phase:
    - Simultaneously, the collected sensor data and recorded video footage are stored for further analysis post-flight. The user can observe environmental conditions such as temperature, pressure, humidity, and altitude throughout the flight.
  - Recovery Phase:
    - Once the weather balloon reaches its maximum altitude or bursts, the payload begins its descent. The user tracks the payload descent using GPS or radio tracking systems. Upon landing, the user retrieves the payload and collects the stored data for analysis.

Technology Considerations

- LynxOS
  - Real-time operating system for embedded systems, providing deterministic performance and POSIX compliance.
- Software Defined Radio (SDR)
  - Radio systems where hardware components are replaced with software, enabling flexibility and reconfigurability in communication systems.
- GNU Radio
  - Open-source toolkit for building software-defined radio systems, offering modular signal processing blocks and libraries.

LynxOS

- Strengths:
  - Real-time capabilities: LynxOS is known for its deterministic and predictable performance, making it suitable for real-time embedded systems that require precise timing and responsiveness.
- Weaknesses:
  - Resource constraints: LynxOS may have limitations in terms of available memory, processing power, and storage capacity, particularly on embedded hardware platforms, constraining the capabilities of applications and services running on the system.
- Trade-Offs:
  - Performance vs. resource utilization: Optimizing system performance while minimizing resource utilization involves trade-offs in terms of task scheduling, memory management, and I/O operations.
- Possible Solutions and Design Alternatives:
  - Optimization: Optimize system configuration, task scheduling policies, and memory management strategies to maximize performance and minimize resource overhead.

Software Defined Radio (SDR)

- Strengths:
  - Flexibility: SDR allows for programmable and reconfigurable radio systems, enabling customization and adaptation to various communication protocols and standards.
- Weaknesses:
  - Sensitivity to interference: SDR systems may be more susceptible to interference due to their reliance on software-based signal processing, requiring robust interference mitigation techniques.
- Trade-Offs:
  - Performance vs. complexity: Balancing performance requirements with the complexity of SDR implementation involves trade-offs between computational resources, power consumption, and system flexibility.
- Possible Solutions and Design Alternatives:
  - Optimization: Employ optimization techniques such as parallelization, algorithmic optimization, and hardware acceleration to improve the efficiency of signal processing algorithms and reduce computational overhead.

GNU Radio

- Strengths:
  - Open-source ecosystem: GNU Radio provides a vast collection of signal processing blocks, libraries, and frameworks, fostering collaboration, innovation, and community-driven development.
- Weaknesses:
  - Learning curve: GNU Radio may have a steep learning curve for users unfamiliar with digital signal processing concepts and software development, requiring time and effort to acquire proficiency.
- Trade-Offs:
  - Ease of use vs. customization: Choosing between pre-built signal processing blocks and custom implementations involves trade-offs in terms of development time, complexity, and system requirements.
- Possible Solutions and Design Alternatives:
  - Performance optimization: Optimize signal processing chains by minimizing computational overhead, reducing data dependencies, and leveraging hardware acceleration where possible.

Areas of Concern and Development

- Robust signal transmission:
  - Implement advanced error correction algorithms and signal processing techniques to ensure reliable video communication over a 5.8GHz radio signal, minimizing interruptions and ensuring smooth.
- Seamless connectivity:
  - Design the system to automatically adapt to changing environmental conditions and interference levels, maintaining a stable connection for uninterrupted video communication using the 5.8GHz radio signal.
- Interference mitigation:
  - Address potential interference issues from other wireless devices operating on the same frequency band, such as Wi-Fi routers or other communication systems, to maintain signal integrity and reliability for video communication over the 5.8GHz radio signal.

Conclusion

- Design and Visuals:
  - Detailed visualizations include block diagrams, circuit diagrams, and sketches for comprehensive technical description.
- Functionality:
  - Users engage with intuitive interfaces triggering system responses depicted through timelines or storyboards.
- Technology Considerations:
  - Integration of LynxOS, GNU Radio, and SDR offers unique strengths with trade-offs in resource constraints and performance. Solutions include optimization techniques and hybrid approaches for functionality and efficiency.
- Areas of Concern and Development:
  - Addressing reliability, scalability, and compatibility. Mitigating challenges such as resource constraints and optimizing user experience.