FPGA-Based Evaluation and Implementation of an Automotive RADAR Signal Processing System using High-Level Synthesis [1]

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Context

FMCW RADAR

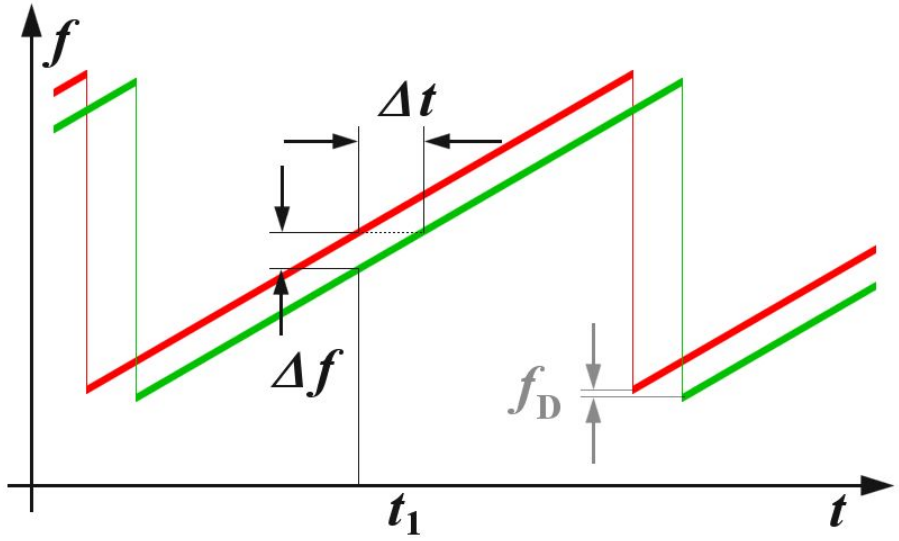
Frequency Modulated Continuous Wave Radio Detection and Ranging

Transmit wave of linearly increasing frequency

Reflected wave delayed in time

Leads to frequency offset

Frequency difference -> time delay -> range



[2]

Non-Reconfigurable Radar Hardware

Voltage Controlled Oscillator

Beamforming - steering

Signal reflects - measure time

Mix with transmitted signal

Analog to Digital Conversion

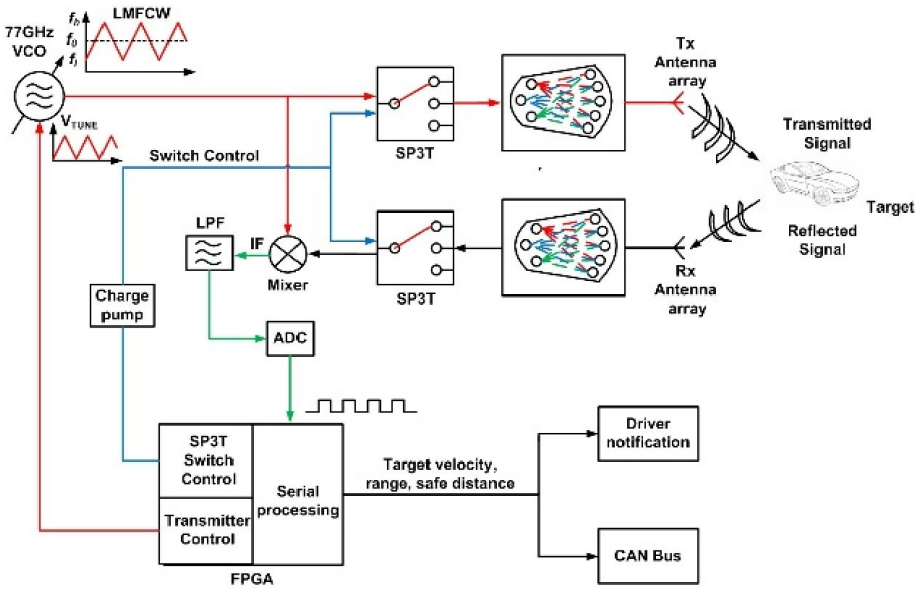


Fig. 1 Conceptual diagram of the RADAR system [12].

Motivation

HLS vs HDL

High Level Synthesis (C/C++)	Hardware Design Language
Higher level abstractions	Register Transfer Level
Less direct control over hardware	Large semantic gap
Faster development time?	**Higher performance?**

Paper tests this

Design

Reconfigurable Radar Hardware

Digitize

Fast Fourier Transform

Target Detection

Post Processing

Output

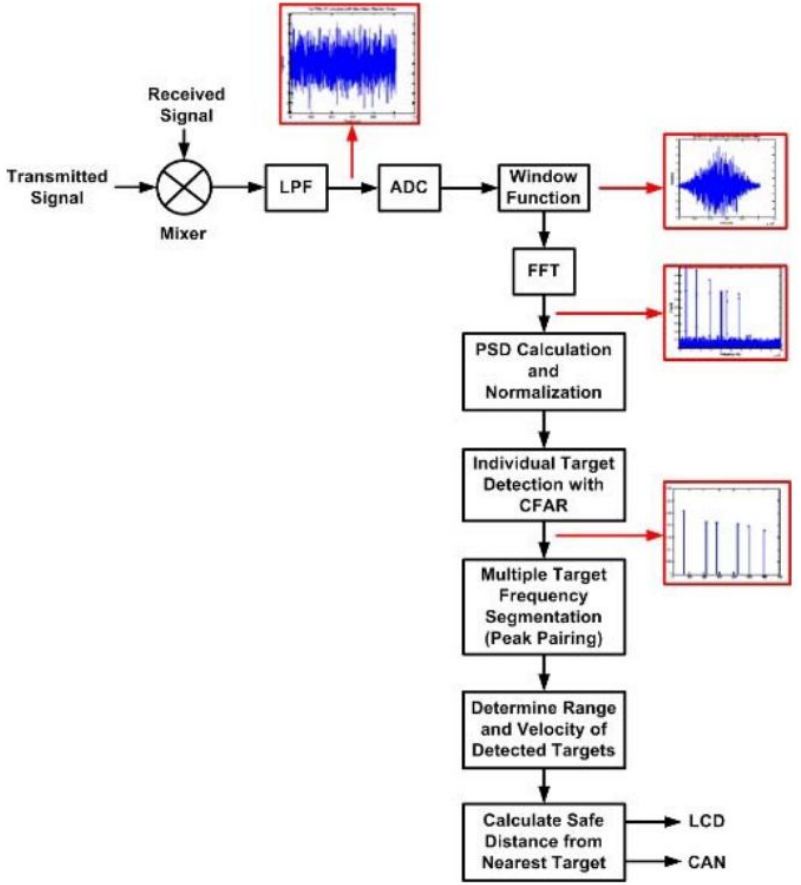


Fig. 3 Flowchart of Radar Receiver flow control and Signal Processing [12].

Results

Comparison

Faster development time

Estimate?

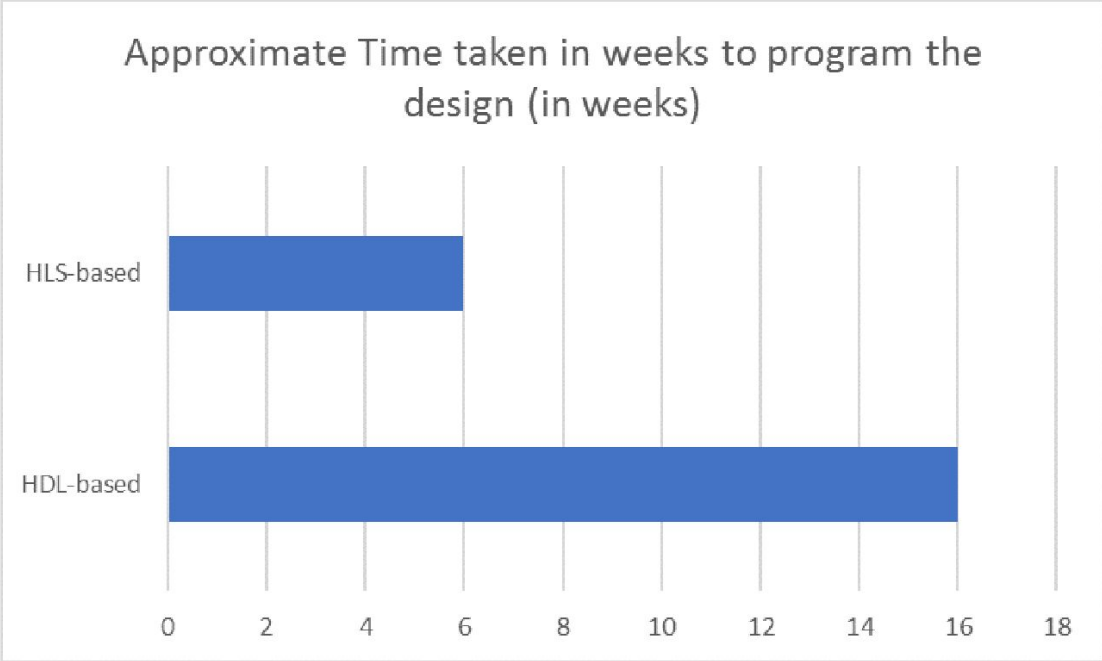


Fig. 4 Approximate design time (in weeks)

Resource Usage

Significantly higher for HLS

Particularly Block-RAM (BRAM)

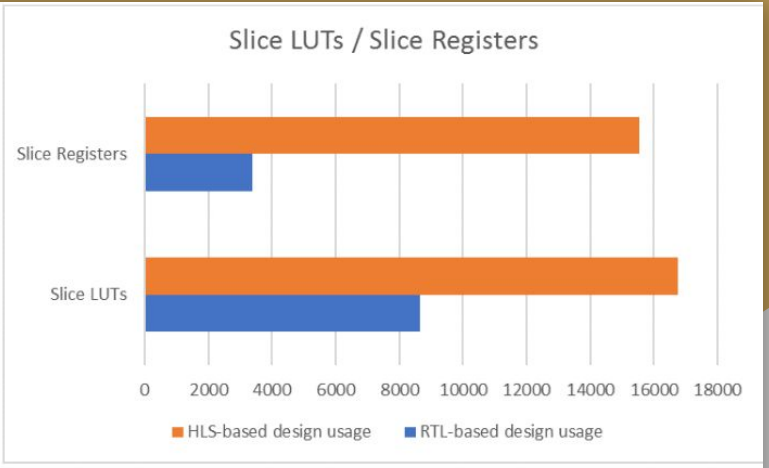


Fig. 6. Slice LUTS/Registers utilization comparison graph.

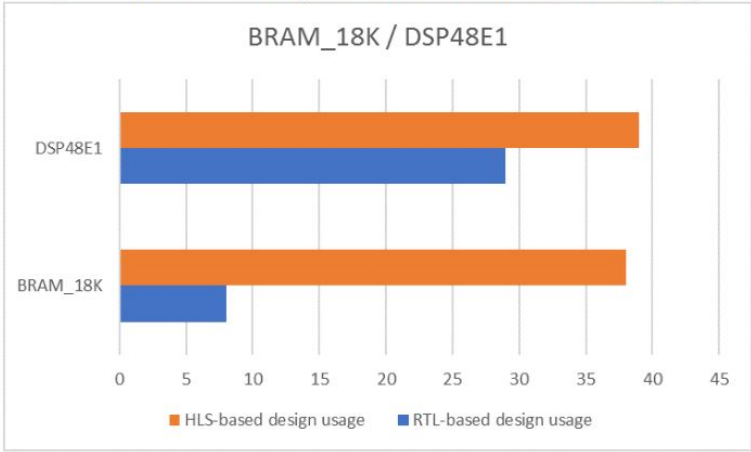


Fig. 7 BRAM and DSP blocks utilization comparison graph.

Performance

Lower latency - better performance

But higher resource usage

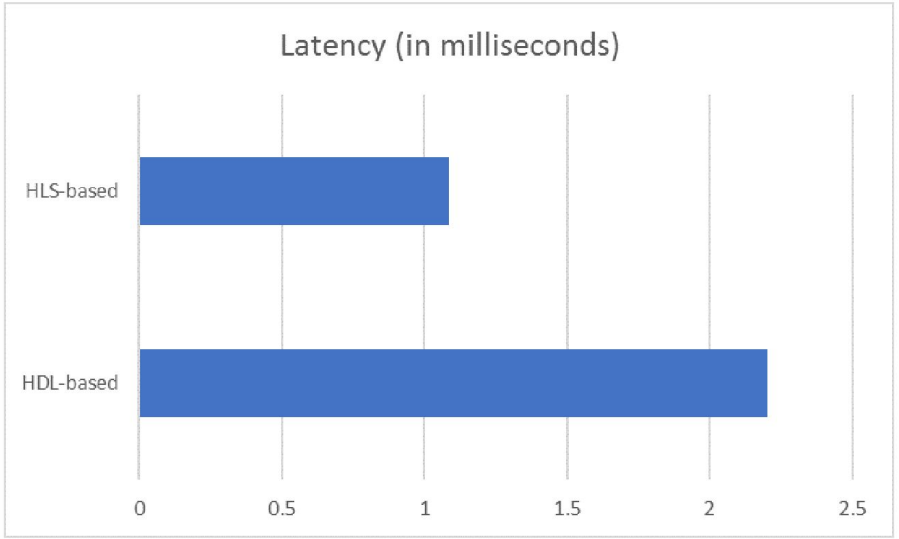


Fig.8. Latency comparison graph.

Conclusion

Conclusion

Contribution

- Comparison of HLS and HDL in DSP RADAR application

Strengths

- Interesting, concrete, real world application
- Clear, helpful diagrams, good explanation of background

Weaknesses

- Uneven comparison - Higher resource usage and better performance

Sources

Sources

1. S. Luthra, M. A. S. Khalid and M. A. Moin Oninda, "FPGA-Based Evaluation and Implementation of an Automotive RADAR Signal Processing System using High-Level Synthesis," 2020 IEEE Canadian Conference on Electrical and Computer Engineering (CCECE), London, ON, Canada, 2020, pp. 1-6, doi: 10.1109/CCECE47787.2020.9255725.
2. https://www.radartutorial.eu/02.basics/Frequency%20Modulated%20Continuous%20Wave%20Radar.en.html