6.374 Final Project Proposal

Title:

A low power down-conversion and correlation engine for GPS receivers

Team:

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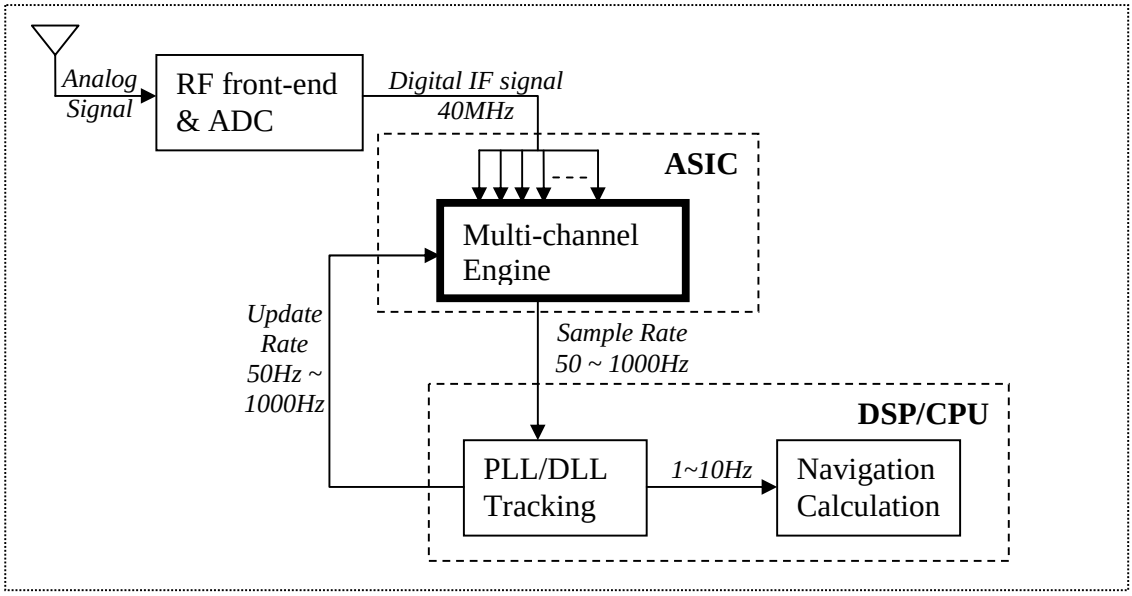
Motivation:

Handheld GPS devices or cell phones with integrated GPS functions are gaining more popularity in consumer industry. Low power consumption is always one of the top requirements of mobile devices. A generic diagram of GPS receivers is shown below.



As illustrated in the diagram, the multi-channel engine works on the digital IF signal with a sampling rate of 40MHz as an example. The rate of Pseudo-random (PN) codes embedded in satellite signals is around 1MHz. Thus the over-sampling rate is 40. The multi-channel engine is supposed to handle signals from at least 12 satellites. In our project, we consider one satellite only.

The main function of the engine is to,

1. Remove the IF carrier and Doppler frequencies by multiplying with local sine wave
2. Remove the Pseudo-random code by correlating it with locally generated code

The engine is the major source of power dissipation because of its high-rate processing. The goal of our project is to explore techniques to achieve ultra low power solution for the engine.

The main task:

Although traditional GPS solutions apply parallelism by tracking 12 satellites simultaneously, they process each satellite signal sequentially. We'll explore a different parallelism based on the oversampled signal. For example, we will have 40 correlators working on different sampling locations of one satellite signal in parallel. Since all correlators share the same data generated locally, aka, the sine wave and PN code, the clock rate of those components can be reduced down to 1MHz, resulting in power saving. However, the major power-saving technique of this project should be the sub-threshold design of circuits for down-conversion and correlation operations. This is our top priority task.

Optional task 1:

If time allows, we'll explore the design of a "smart de-multiplexer". The de-multiplexer is used to distribute high rate input data to each correlator. The design shouldn't be difficult for the fixed oversampling rate such as 40. However, in real GPS signal processing, due to Doppler and clock errors, the sampling rate must be adjusted to achieve accurate locking to satellite signals. The de-multiplexer must be configurable by the DSP/CPU processor.

Optional task 2:

A digital sine wave generator. In the main task, we assume that the sine wave required for down-conversion operation is available already. In real system, the sine wave must be generated in real time. More importantly, the wave frequency must also be configurable in order to lock to the Doppler shift.

Optional task 3:

PN code generator. It's unlikely that we have time for this part, but it should be noted that because of our new architecture, the implementation of this component is much easier than conventional approaches.