

Scale Invariant Feature Transform on the Blackfin Processor

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Motivation: Is local image processing more efficient than raw transmission?

Proposed Scenario

- Wireless Camera Network**
Battery operated camera sensors are connected via a wireless link over a variety of terrain
- Digital Signal Processing (DSP) Processor**
Advances in DSP processor design allows for complex math operations on a single low cost, low power chip
- Scale Invariant Feature Transform**
Robust object detection algorithm that is accurate regardless of any combination of scale, rotation, varying illumination, or occlusion

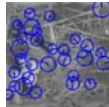
Local Processing Advantages

- Minimal Number of Transmissions**
Images can be processed and only the data of interest is sent rather than every image
- Minimal Transmission Time**
When transmission is necessary only relevant results are sent and none of the transmission time and energy is wasted
- Maximum Time Spent In Hibernation**
Processing takes less time then transmission resulting in savings
- Maximum Power Savings**
More time spent in hibernation means more power savings

Platform: Scale-Invariant Feature Transform (SIFT) on the Blackfin Processor

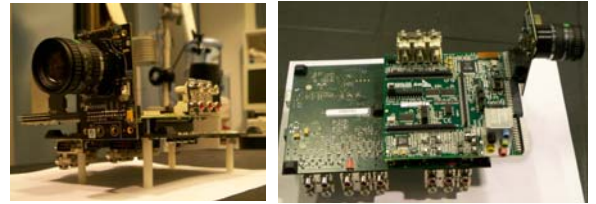
SIFT Algorithm Outline

- Scale-Space Extrema Detection**
Step over all scales to find keypoints of interest
- Keypoint Localization**
The keypoints of interest are given a location and a scale at which it is most prominent
- Orientation Assignment**
Each keypoint is given an orientation that is used as a reference when it is transformed
- Keypoint Description**
An image neutral representation is given to the keypoint so that it can be compared with in other images



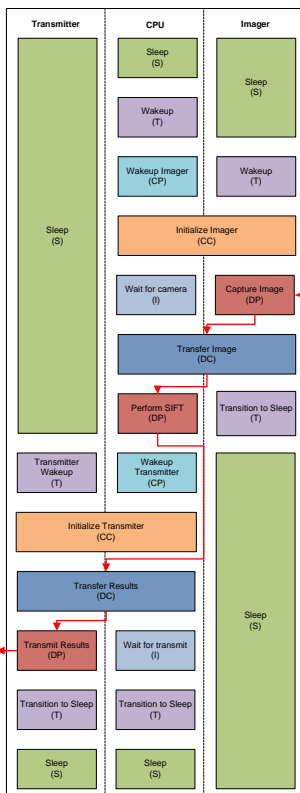
Hardware

- Blackfin 533
- ADSP-BF533 EZ-Kit Lite
- A-V EZ-Extender
- Micron MT9V022



System Profiling: Classifications & Results

Component Operation & Data Flow



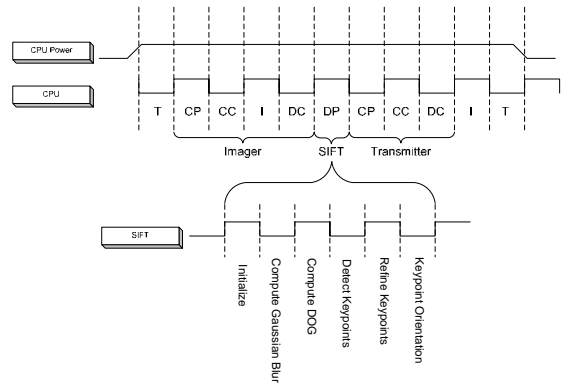
Sensor Functionality

- Wakeup from hibernation
- Capture image
- Process image with SIFT
- Send results via transmitter
- Return to hibernation

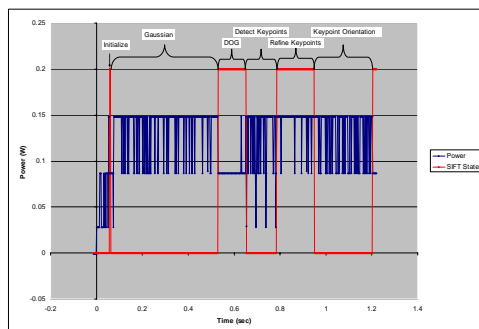
Peripheral Interfaces

- Transmitter – UART
- Imager – I²C/TWI

CPU & SIFT Transitions



SIFT Power Consumption



SIFT Timing & Energy Consumption

Phase	Total Time (sec)	Average Power (W)	Total Energy (J)
Initialization	0.004	0.087	0.0005
Gaussian Blur	0.465	0.136	0.0637
DOG	0.121	0.089	0.0110
Detect Keypoints	0.132	0.126	0.0168
Refine Keypoints	0.162	0.867	0.0236
Keypoint Orientation	0.252	0.129	0.0327
Total	1.136	1.434	0.148