Vision-based Simultaneous Localization and Mapping (SLAM) algorithms draw the most power in a drone system, requiring CPUs/GPUs. SLAM power comparison for insect-scale UAV (100 mg)

<table>
<thead>
<tr>
<th>Lifting</th>
<th>Sensing</th>
<th>GPUS, CPUs</th>
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<tbody>
<tr>
<td>100 mW</td>
<td>100 mW</td>
<td>100 W</td>
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</table>

Within SLAM, the feature extraction process, which identifies image corners in order to track them, is one of the bottlenecks given its complexity and real-time requirements.

**Implementation Results**
- C programable ASIP, implemented with Synopsys ASIP Designer, supporting real-time ORB feature extraction
- 4-slot VLIW processor. Scalar core consists of a GP RISC-V, extended with register move and control operations. Vector slots 1-3 implements intrinsics related to FAST & NMS, Harris and Orientation, and RBRIEF respectively
- Reconfigurable multi-pattern vector memory allows single-cycle access to recurrent loads ORB, except RBRIEF which takes 8 cycles
- Synthesized in 22-nm, with an area of 0.566 mm²
- 1k keypoints can be extracted for VGA images at 140 FPS, for a single-scale (ASIP at 430 MHz) 90 mW
- Sequential and overlapping memory accesses oppose real-time processing and energy efficiency

**References**
- Reconfigurable Multi-Access Pattern Vector Memory for Real-Time ORB Feature Extraction, ISCAS 2021
- Energy-Efficient Application-Specific Instruction-Set Processor for Feature Extraction in Smart Vision Systems, ASILOMAR 2021