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Navy ManTech SBIR

N242-092: GigEVision-compliant Event-based Cameras

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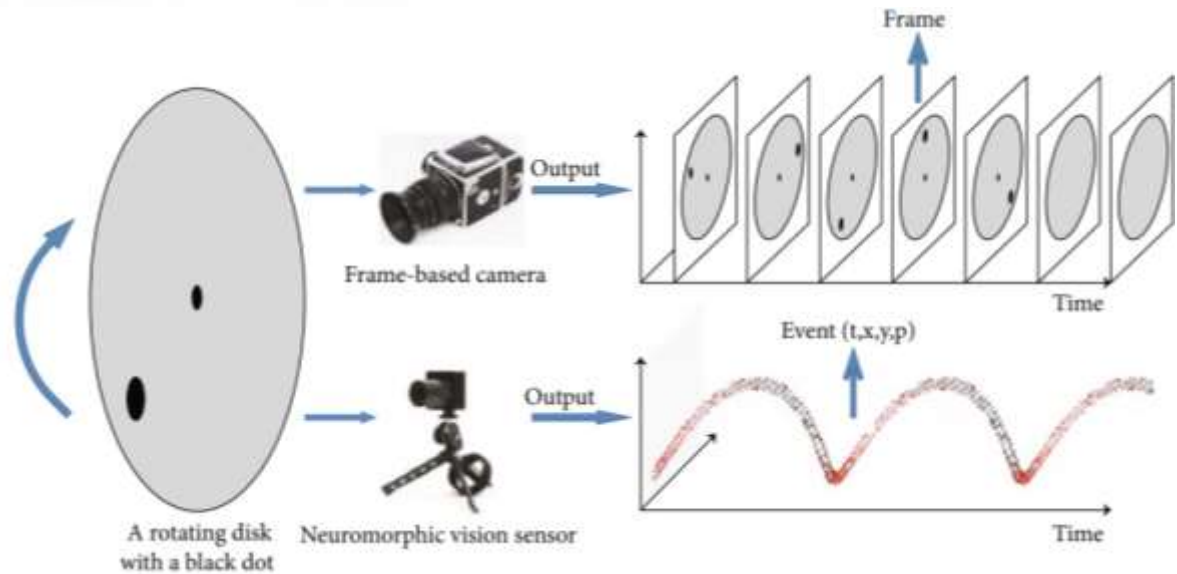
Manufacturing Technology (ManTech) Program
Code 332
Advanced Naval Materials & Systems Division
May 8 2024



Important Dates

- Last day of pre-solicitation (direct contact with TPOCS) : **May 15**
- Proposals due by **June 12**
- Expected awards 1-2 months after June 12

Event-based Cameras (EBCs)



Frame based vs event based camera

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<https://doi.org/10.1155/2022/2673191>

- fundamentally different than standard frame cameras
 - the resulting data stream is unique!
- EBC data provides temporal data as well as spatial information
- must be read out, processed, and interpreted differently than how standard imagery is done today



Problem statement

Develop camera interface hardware and software, which allows commercial off the shelf (COTS) event based sensors to utilize standard machine vision interfaces such as Ethernet hardware connections and GigEVision or GenICam/GenTL software.

Requirements (7):

- The prototype EBC is required to use COTS sensor components
 - The electronics, boards, physical connections, and software will be developed within this effort
- The software interface must comply with Motion Imagery Standards Board (MISB) requirements.
- The software interface must operate with low latency (< 2ms per payload).
- The software interface must comply with GigEVision or GenICam/GenTL software standards.
- The new EBC must be configurable via the GenICam interface.
- The hardware interface must utilize 10 Gigabit Ethernet (10GbE/10GigE) technology for transmitting data and configuring the EBC.
- The new EBC core must leverage COTS event-based sensor components.

Other desirable qualities:

- The new EBC should have a small form factor (~4"x4"x4") and have integrated digital-to-analog converters (DACs)/references for the on-chip event based sensor component biases.
- The new EBC should have an external general purpose input/output (GPIO) interface which can be used for synchronization and timing (can be extended to be used via RS232 or comparable serial protocol).
- The new EBC should utilize a field-programmable gate array (FPGA) or similar as the intermediary between the event based sensor components and the 10GigE interface. This device should be comparable to the specification of an Advanced Micro Devices (AMD) Kintex-7 and leverage 2GB of external memory for potential frame buffer.
- *This latter capability and the EBC should be accompanied with a Software-Hardware Development Kit (S/HDK) to allow the end user to develop FPGA/PC-based algorithms around the IP (this includes example scripts, simulation frameworks, documentation,...)*

Phase I

EXAMPLES ONLY

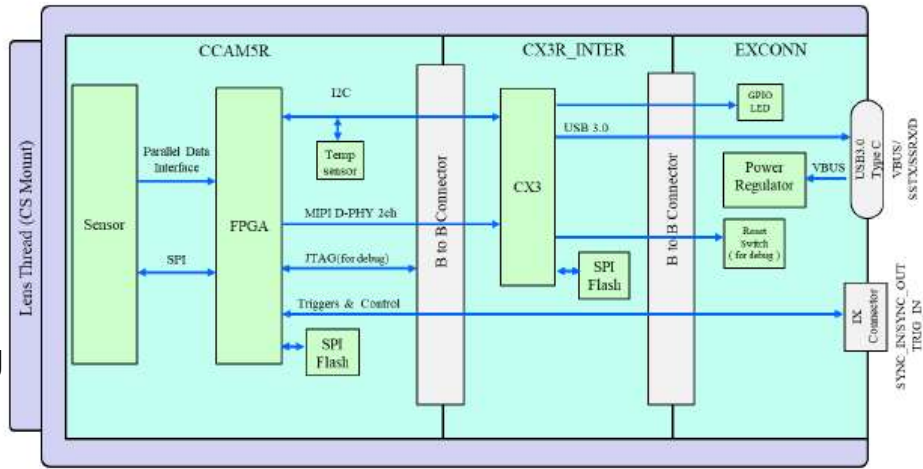
A successful proposal will develop concepts and schematics for

1. Electrical and mechanical components of a new EBC and 10GigE physical interface which is based upon COTS event based sensor components and will allow data transfer via Ethernet cables.
2. a block diagram of a software package which can read in data streams from this new EBC, configures the EBC biasing/readout modes and complies with GigEVision or GenICam/GenTL software standards.

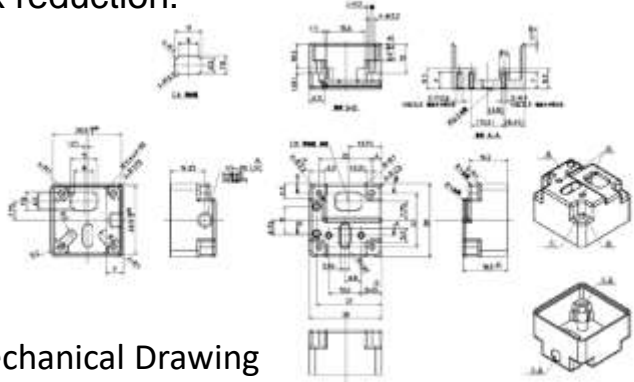
Demonstrate the feasibility of the concepts in meeting Navy and Naval Enterprise needs and establish the concepts for development into a useful product.

3. Devise a mechanism to demonstrate the software/hardware approach, either in material testing, analytical modeling, simulation, emulation, or via evaluation-board hardware (budget permitting).
4. Provide a Phase II development plan with performance goals and key technical milestones and that addresses technical risk reduction.

CenturyArks SilkyEvCamVGA Block Diagram



PSEE Gen3.1 Block Diagram



CA SilkyEvCamVGA Mechanical Drawing

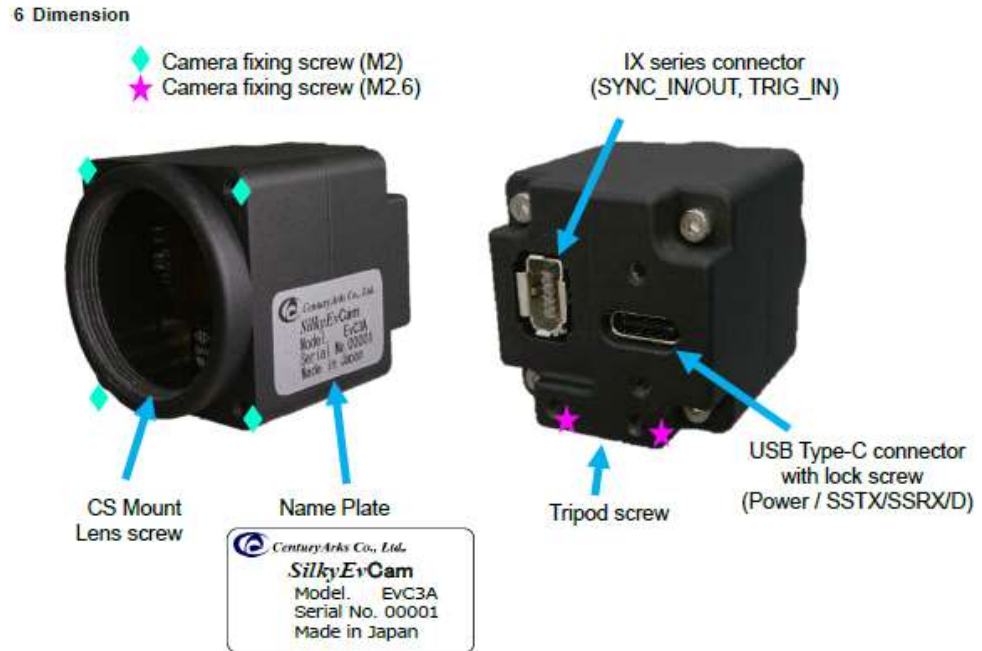
Phase II

EXAMPLES ONLY

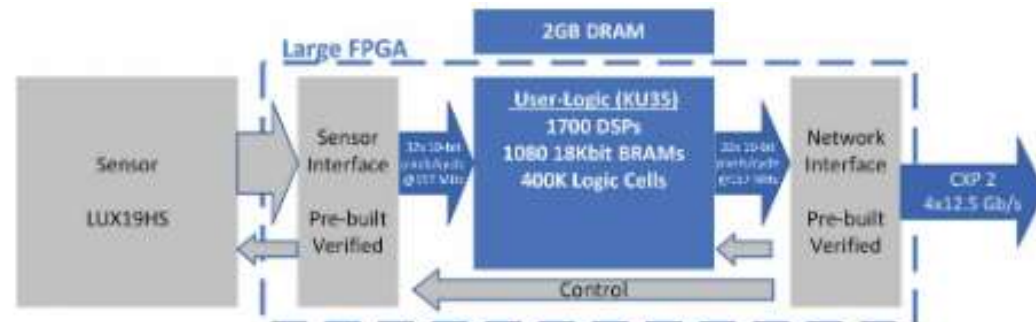
A successful proposal will:

1. Develop a prototype for evaluation.
2. Evaluate, demonstrate, and disseminate the S/HDK.
3. Evaluate the prototype to determine its capability in meeting the performance goals defined in the Phase II development plan and the Navy requirements for the hardware and software interfaces.
4. Support Navy requirements for any testing, such as submittal of Navy Cybersecurity Waiver Board interaction, submissions and approvals and development of a system security plan.
5. Demonstrate system performance through prototype evaluation and modeling, or analytical methods, over the required range of parameters.
6. Use evaluation results to refine the prototype into an initial design that will meet the Naval Enterprise requirements.
7. Prepare a Phase III development plan to transition the technology to Navy enterprise use.

CA SilkyEvCamVGA Camera



Concurrent EDA HDK for LUX19HS





Phase III

- **PHASE III DUAL USE APPLICATIONS:**
- Support the Navy with putting this product into useful service in government facilities. This product could be leveraged by commercial camera producers who develop, manufacture, and sell EBCs. Possible transition to Tech candidate or Future Naval Capabilities (FNC) or Innovative Naval Prototype (INP) for a Program of Record.



Q&A

Questions we will not be answering

- What are the Navy's perceived applications of this EBC?
- With all the specific requirements in the solicitation, it appears that there are specific use cases. Could you please elaborate on them?
- Other than the common GigE interface, what performance improvements are sought over other COTS event based cameras?
- What potential targets/objects are to be observed?
- Is this an operational requirement?
- How will the EBC support the Navy and other parts of DoD? Who is the end user?
- What technical challenges exist?
- What obstacles make it hard to achieve the end state?
- What would an ideal solution look like?
- Are there any prime contractors with which we may need to partner?
- To help determine sensor options, what are the operating environments in which the Navy wishes to use this EBC? Any special lighting conditions? Any high speed events (and what does the Navy consider high speed). Resolution?
- What is the anticipated operation environment?
- The FRAMOS EBS development kit is integrated with an NVDIA Jetson. Is that the target platform, or would another processing platform be responsive?
- Can you elaborate on application software requirements other than the interface and configuring the system?



Q&A

Hardware

- The solicitation describes the GigEVision interface as being used with COTS EBS components. From what we know of the EBC industry as it is right now, there are few companies manufacturing the sensors themselves (e.g., Sony, Samsung) and others creating and selling packaged modules using these sensors (e.g., Prophesee). Is the intention to design and build an interface around a camera module, or to build the camera in its entirety around the sensor?
 - To build the camera in its entirety around the COTS sensor (discrete chip)
- If using a sensor instead of a camera module, are there any defined requirements for the optical or electrical characteristics of the EBC?
 - No requirements other than those listed in the topic announcement (justify your choices)



Q&A

Hardware

- Sensors do vary in geometry and peripheral interface circuitry; is this call asking for a readout board with a modular interface to different/multiple sensors?
 - Preferably readout would be agnostic and meets all requirements in the topic announcement
- Are all event based sensing modalities sought or is the DVS type pixel preferred?
 - No preferred sensing modality



Q&A

Hardware

- Are there any image format/chip size requirements?
 - no
- Are there any environmental requirements that the camera needs to meet?
 - no
- Are there any power requirements for the camera?
 - <1W
- Should we be concerned about vibration? Is image stabilization required?
 - no



Q&A

Hardware

- Do you have a list of recommended sensors or the minimum parameters?
 - no
- Is there a requirement that COTS sensors be US made?
 - no
- Regarding the EBC itself, can you provide more information about the GPIO requirements related to pin quantity and functionality?
 - **“The new EBC should have an external general purpose input/output (GPIO) interface which can be used for synchronization and timing (can be extended to be used via RS232 or comparable serial protocol).”**
- Can a data transfer interface in addition to 10GigE be proposed?
 - No requirement however the minimum requirement is 10GigE
- What kind of processing is expected from the FPGA component?
 - Processing that can be achieved using below:
“The new EBC should utilize a field-programmable gate array (FPGA) or similar as the intermediary between the event based sensor components and the 10GigE interface. This device should be comparable to the specification of an Advanced Micro Devices (AMD) Kintex-7 and leverage 2GB of external memory for potential frame buffer.”



Q&A

Software

- Would you clarify the latency requirements of 2ms per payload including payload size expectations?
 - Full system latency: from the moment we get the data from the sensor to the moment we measure it in the software. Maximum payload size: 1MP at 16-bit - 2MB
- What is the anticipated maximum event rate?
 - Bound by the physical interface specified in the requirements
- Is there a predefined minimum or maximum number of GigE Vision Stream Channels that the EBC will need to support?
 - No, to be determined by the performer. Must meet requirements in the topic announcement



Q&A

Software

- Based on projected use case and event statistics, will there be a scenario where all the pixels must be read in certain operational environments?
 - No requirements, depends on sensor chosen
- Will there be interest in reading out triggered pixels and their neighbors?
 - No requirements, depends on sensor chosen.
- On what kind of computer does the Navy hope to run the software package that reads in the data stream?
 - Operating system requirements?
 - Is a GUI expected and a display representation of the data?
 - Specific NIC we should be using?
- No requirements, proposals should abide by the requirements of the topic announcement



Q&A

Software

- The solicitation states the EBC should be manufactured from COTS components that are compliant with GigE Vision or GenICam/GenTL (software) and 10GigE (software). Are there any additional desired interfaces?
 - GPIO, otherwise no requirements
- The GigE Vision protocol standard and the MISB standard for GigE Vision lay out a groundwork for how the protocol should be implemented for motion imagery like what we expect from the EBS. However, there are some implementation decisions that affect the overall design of the solution. Is it always to be assumed we'd be sending class 0 (raw) image data over the GigE Vision Streaming Protocol or will the camera also be expected to send compressed image data (class 2)?
 - Safe to assume class 0
- Regarding Phase II, have all the Navy testing requirements been determined, or is that still in-work?
 - To be determined