Proposal Evaluation Form

Factor 1. Scientific/Technical Merit and Feasibility

Reviewer: 1

Strengths:

The proposal provides a thorough approach to using deep learning algorithms to recognize spatial relationships using earth-based GPS metrics. The follow-on efforts may be applied to planetary bodies and stars for deep-space navigation capabilities. The concept, in itself, is relevant to NASA's goals.

Weaknesses:

The proposal often mentions the use of neuromorphic algorithms and hardware as part of the approach, but the specific algorithms described (e.g., traditional deep learning using convolutional neural networks via CuDNN, or hidden Markov models) are not spike-based in nature as would be required for implementation of machine learning algorithms on neuromorphic hardware, and the specific hardware platforms described (e.g., NVIDIA or ARM processors) also do not appear to be neuromorphic in design. Neuromorphic computing architectures (such as the Intel Loihi or IBM TrueNorth processors) are those that consist of neuron and synapse circuits arranged in a massively parallel fashion, similar to the constructs of the biological nervous system, and spiking neural network models are the preferred computational approach for implementation of machine learning algorithms on neuromorphic hardware. These constructs appear to be missing from the proposal.

Since the proposed effort does not appear to use neuromorphic constructs, there is risk in that the algorithms and hardware still require transition from conventional to neuromorphic in order for the proposed capability to be infused into resource-constrained space platforms such as CubeSats.

Reviewer: 2

Strengths:

1. The proposal has promise for extending cartographic knowledge to new terrestrial areas where little is known.

Weaknesses:

1. What are the innovations that AI will provide for NASA and what is the path to get there?
2. The proposal makes claims to aid mapping of viable space travel routes but these cannot be mapped statically since everything is in motion in space. It is unclear how this might be accomplished.

Factor 2. Experience, Qualifications and Facilities

Reviewer: 1

Strengths:

The proposal describes a vast pool of personnel with a skillset that appears adequate to complete the Phase 1 efforts as described. The availability of resources required for the described Phase 1 efforts also appears to be adequate.

Weaknesses:

For this SBIR topic area, I would expect strong experience and expertise in the specific areas of neuromorphic computing, spiking neural network algorithms, and possibly computational neuroscience. Some of the key personnel mentioned in the proposal possess some experience and qualifications in related areas of machine learning, mathematics, and hardware development.

The hardware mentioned in the proposal (e.g., Boeing Chiplet, NVIDIA and ARM processors) may exhibit a potential for enhanced energy efficiency, but are not, in themselves, neuromorphic in design.

Reviewer: 2

Strengths:

1. The technical capabilities, experience, and accomplishments of the PI and his team are well suited for the proposed work.
2. The team has demonstrated a breadth of knowledge across a range of a variety of related areas necessary for the proposed work.

Weaknesses:

1. The proposal identified teams, but the proposal lacked a clear discussion on how the teams would interact and how results are exchanged, checked, and reconciled.

Factor 3. Effectiveness of the Proposed Work Plan

Reviewer: 1

Strengths:

The methods provided in the proposed work plan are described in detail and appear to be aligned with accomplishing the desired goals. Also, there appears to be an effective distribution of resources across the available pool of personnel, and the schedule seems reasonable to achieve what is proposed for Phase 1.

Weaknesses:

The proposal specifies the intent of implementing deep learning algorithms to recognize spatial relationships of planetary bodies and stars for deep-space navigation using CubeSats, which is highly relevant to NASA's goals. However, the specifics of the work plan seem to focus on a deep learning approach for processing of earth-based GPS data using traditional deep learning approaches and traditional computing architectures (as opposed to neuromorphic processors). The relationship between how the proposed work product transitions to the desired end-goal of achieving spatial recognition using neuromorphic algorithms/hardware for deep-space navigation capabilities for CubeSats is unclear.

Additional personnel and facilities for efforts beyond Phase 1 may be required, if funded.

Reviewer: 2

Strengths:

1. There appears to be effective use of available resources and labor.

Weaknesses:

1. There are no clear deliverables in terms of intermediate and final reports as well as software.

Factor 4. Commercial Potential and Feasibility (Adjectival)

Reviewer: 1

Comments:

The proposed innovation may be applied to NASA applications in areas such as swarm-based platforms deployed in orbit around planetary bodies. The work may also apply to swarms of CubeSats or other small, space-based platforms for colonization or resource extraction.

The proposed innovation has non-NASA applications in the mapping of viable space travel routes and launch windows in an open-source capacity. Mapping services (APIs and SDKs) may be offered to private and public groups; this could be applied to transportation, logistics, resource access via use of tools to accurately map and plot terrain.

The proposer has not submitted any previous proposals or sought any other SBIR/STTR awards.

The proposal does not include a detailed commercialization plan.

Reviewer: 2

Comments:

This idea appear to have more terrestrial commercial value than directly for NASA until phase II. It is not clear how the proposal maps into NASA's studying terrestrial changes regarding global warming or helping to drive around the Moon.