

A Study on SNN-Based Decision Models for Autonomous Driving

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In this paper, we examined the applicability of spiking neural networks (SNNs) to decision-making models for autonomous driving. Compared with conventional artificial neural networks (ANNs), SNNs are expected to offer lower power consumption and lower latency, although the availability of dedicated hardware remains an issue. Therefore, this paper constructed an SNN model that does not depend on dedicated hardware and evaluated it using a small mobile robot.

In the experiment, we defined a simplified fox-hunting task and addressed the problem of enabling the robot to reach a target point while avoiding obstacles based on distance sensor information and distance information to the goal. The SNN model was implemented using SpikingJelly, and preliminary experiments confirmed that increasing the timestep improved accuracy but also increased processing time. In addition, reinforcement learning using PPO was conducted in the Genesis 3D simulator to train SNN and ANN action-decision models. As a result, both models were able to reach the goal, but the acquired rewards tended to be slightly higher for the ANN.

Furthermore, the trained SNN model was implemented on a small mobile robot, and its operation on the actual machine was verified. In addition, memory bit flips in the neural network weights were simulated, and fault tolerance was compared with that of the ANN. The results showed that the SNN tended to exhibit less degradation in goal-reaching rate and fewer occurrences of computational failure than the ANN. One possible reason is that the neuron outputs of the SNN are binary, making the influence of abnormal values more likely to remain localized.

Based on the above, under the conditions of this paper, the SNN did not demonstrate a significant performance advantage over the ANN, and its computation time tended to increase. On the other hand, the effectiveness of the SNN was suggested in terms of fault tolerance against bit flips. In future work, different SNN implementation methods and utilization approaches will be evaluated to further investigate its potential as a decision-making model for autonomous driving.

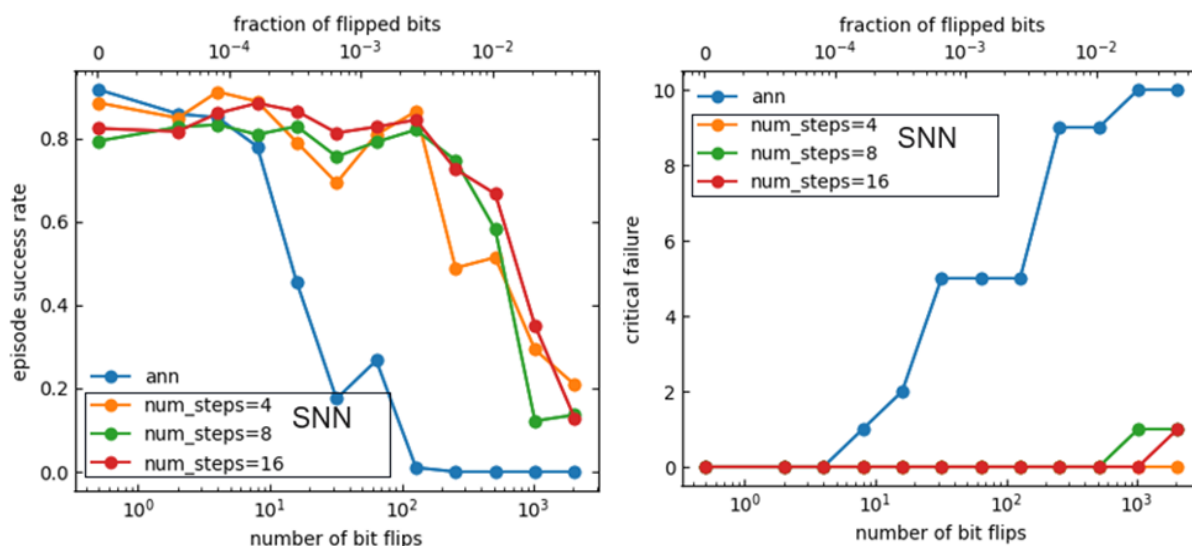


Fig. 1 Goal reach rate and Critical failure rate of RL agent models vs. flipped bits