Online Prediction for Vision-Based Active Pursuit Using a Domain Agnostic Offline Motion Model

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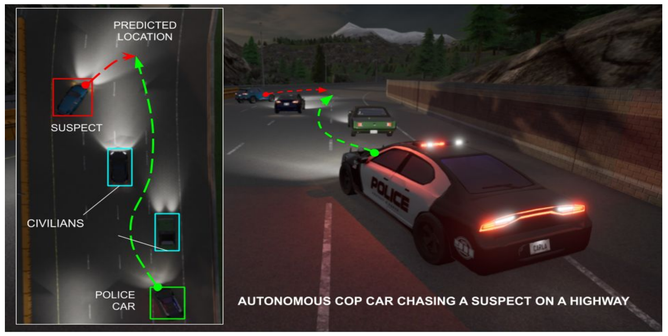
Can a visibility-based pursuer that uses a prediction LSTM do a better job of capturing an evader compared to conventional methods?

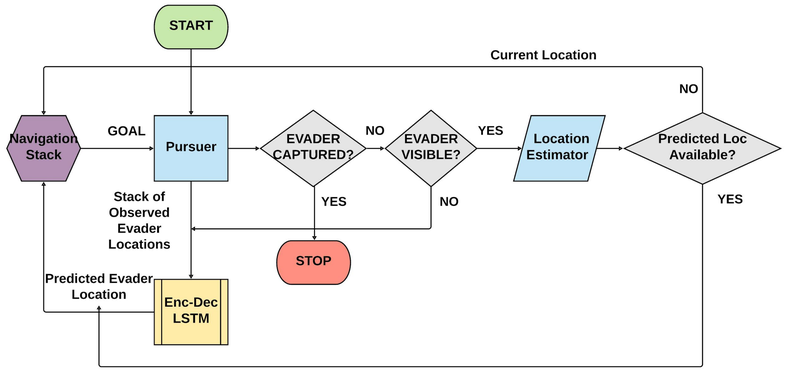
Abstract: The use of a Long Short-Term Memory Network-based domain-agnostic predictive pursuit agent is proposed as an alternative to conventional methods such as Kalman Filtering. The empirical results from the pursuit-evasion game establish the superiority of the proposed framework as attested to by lower capture times. This active pursuit framework enhances the ability of autonomous vehicles to navigate rapidly changing environments and situations. Future work involves enhancing the perception capabilities of the pursuing agent and the deployment and coordination of multiple pursuers.

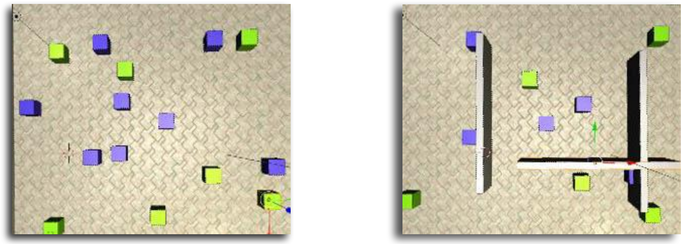


A futuristic chase scenario; police AV uses a predictive model

Neural Basis to Predictive Pursuit:

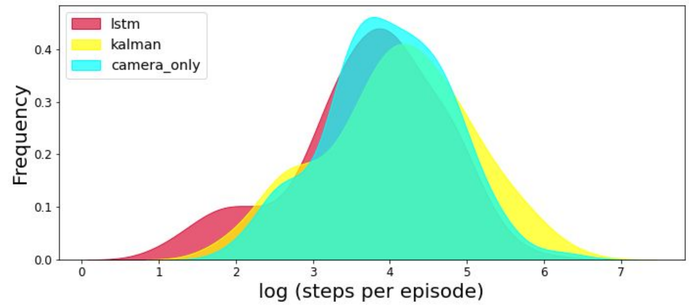
- neurological structures permit animals to predict the positions of prey during pursuit
- primates in a visual pursuit task reliably aimed towards their prey's estimated future positions
- they have the ability to generate mental predictions and use them to guide their behavior
- neurons in the brains of the brain's **dorsal Anterior Cingulate Cortex (dACC)** are responsible for storing an explicit representation of the prey's future position





Test Environment Variants inside the MORSE Simulator

Results: LSTM-based Pursuer has the lowest mean capture times



Conclusion: We build a visibility-based Pursuer which can function without requiring a map of the environment. We successfully validate our hypothesis that this pursuer does a better job of capturing the evader using an encoder-decoder LSTM, as opposed to pre-existing estimations techniques such as linear dynamic estimation with Kalman filter, by estimating its future location . We also show that we can adopt the prediction model across domains without the need to retrain using any information from the new domain. This formulation of a pursuer-evader game under an autonomous vehicle setting and its validation environments facilitate future avenues of research.

Future Work:

- enhancing the pursuer's perception capabilities using short-term mapping techniques
- incorporating evader's orientation to the prediction schematic
- studying the effectiveness of prediction models in multi-agent settings

Code Available at : https://github.com/varunjammula/morse_pursuit_evasion

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Video Demo:

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