Motion Interpretation of Trochoid Paths with a Rotational Motion Sensitive Network and Attention Mechanism*

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Abstract

This paper present a simulation of motion interpretation of trochoid path generated by a single point on a rotating disc translating in the frontoparallel plane of the visual field. The process involves two mechanisms. First, the extraction of relative motion in a group motion and second the presence an attention mechanism. Specifically, the paper present neural simulation results for cycloidal motion extraction. We construct our neural network according to the directional and speed sensitivity profile observed in neurophysiological data available. The intermeditate interpretation of rotational motion is then constructed. We then show that without an attention mechanism the perception is insufficient to elicit a rotational perception. However, with an attention mechanism the rotating wheel is perceived readily.

1 Introduction

Dunnker's experiment. Cutting and other people have also examined the cycloidal path extraction.

An articulated object in motion may possibly produce different families of absolute motion trajectories; however, it should have simple relative motion percepts.[1] This is demonstrated in Duncker's[?] experiment. By placing lights sources on a rotation and translating wheel in the frontoparallel plane, different percepts are formed about the underlying structure although they all represent the same motion.

When only a single point is placed on the rim of the wheel, a cycloidal trajectory is observed without revealing much of the rotating wheel. However, when the center of the wheel is shown when superimposed on the cycloidal path, an impression of a rotation wheel is immediately available. When the light at the center of the wheel is moved off to some external points outside of the rotating wheel, this impression is lost.

Simple experiments like the ones shown above demonstrate that it is the invariant features with respect to orientation that will guide the interpretation.

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[1]The statement goes against the approach of motion interpretation based on measuring the absolute motion of moving objects. In biological organisms, it seems that relative motion interpretation is more important and effective than the absolute motion.

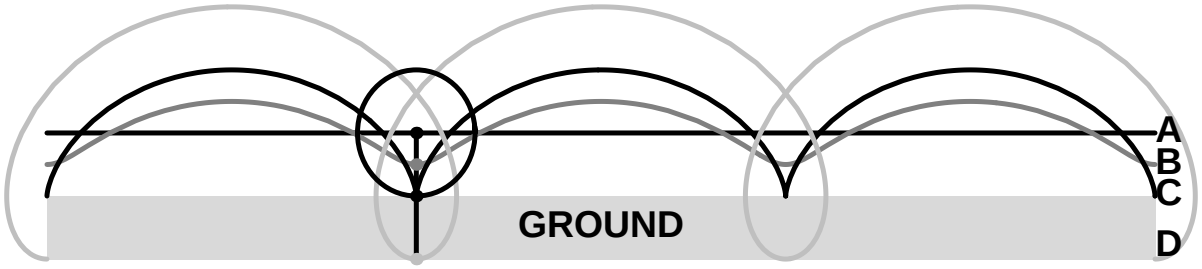


Figure 1: Trochoidal paths generated by different points on a disc which is rolling along on a straight line in the frontoparallel plane. The line A is the path traces out by the center (hub) of the rotating wheel, line B traces out a curtate cycloidal trajectory by a point between the center and the rim, line C traces out a perfectly cycloidal path, and line D etches a prolate cycloidal path by a point which lies outside of the rim of the wheel.

Show the cycloidal paths and discuss about the different perceptions that are possible.

Several scenarios are possible using this type of configuration for motion interpretation. In the absence of the center point (only the line C in Figure 1), the absolute motion generates no perception of a rotating wheel. This also lend support that absolution motion measurement may not be sufficient for the interpretation of coherent motion.

With the introduction of a center point along with the point on the rim, the perception of a rotating wheel is perceived strongly despite that fact that the point on the rim continue to trace out a cycloidal path.

This perception can be altered significantly depending on the location of the other point. When the point is within in the perimeter of the rotating wheel but not at the center, the perception of a rotating wheel is gradually decreased according to the distant away from the center. More important, when the external point is outside of the rotating disc the subject will only observe two independent motion paths with the same common motion.

The above observation conveys that the external point to the cycloidal path is important in the interpretation process. Furthermore, the placement of the point is also very crucial.

To explain the above observation, we posit that two mechanisms must be working in cooperation in order to produce the correct motion interpretation. First,

Relative motion (physiological evidence) -

It would seem that a mechanism to extract relative motion is necessary. Here is when attention mechanism is most important.

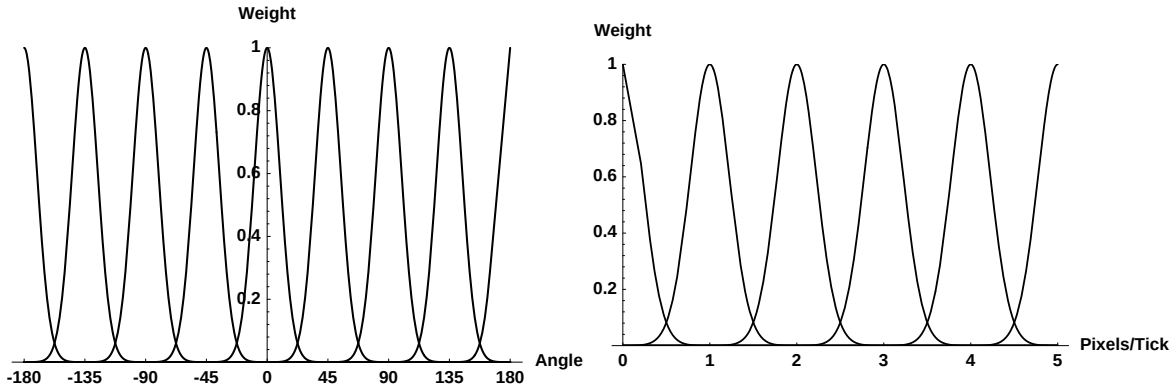
2 Model Defined

To mimic plausible biological circuitries, our model is constructed in the bottom up fashion. The first layers of neural networks are composed of motion detection cells. The information from the motion detection layer is then segregated and fed into the next layer which are directional and speed sensitive.

The author has presented a plausible neural network for rotational motion extraction [**?**]. Moreover, neural networks for visual reversal and invariant motion perception is also dealt in [**?**].

After the preceding layer, the intermediate motion interpretation layer gives rise to intermediate motion interpretation of rotational motion. These perception are found in neurophysiological findings suggested by [?, ?, ?]

Pseudo attention mechanism.



(a) (b)

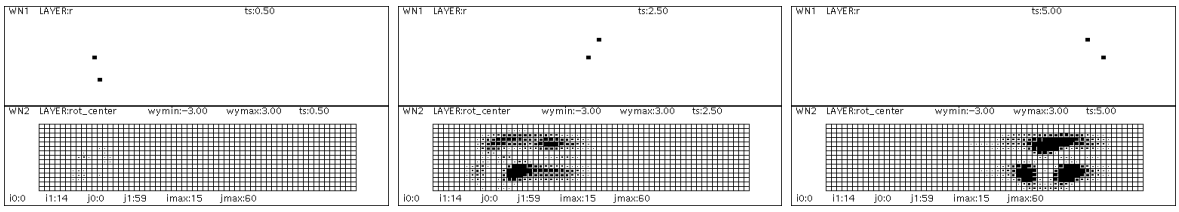
Figure 2: Angle and Speed profile of the neural network

3 Simulation Results

The simulation was done on Unix workstations using the Neural Simulation Language (NSL)[?].

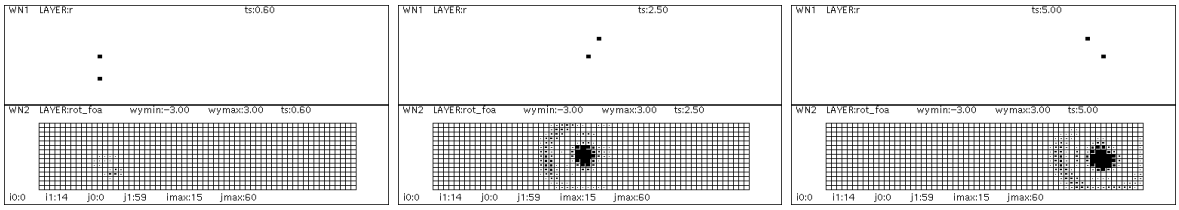
4 Discussions

Our simulation suggests that two items are needed for the perception of the cycloidal motion. First, a neural connection mask capable of extracting rotational (or symmetrical) motion path is needed. Second, an attentional mechanism must also be present to integrate the motion path into a consistent perception.



(a) (b) (c)

Figure 3: Simulation results for a rotational sensitive layer without the attention mechanism. The layer shows difficulties in integrating a consistent interpretation with different regions of the network activated in an incoherent manner.



(a) (b) (c)

Figure 4: Simulation results for a rotational sensitive layer with the attention mechanism. The result shows that the rotational network with the attention mechanism proffers a coherent integration which renders a consistent motion interpretation of the rotational motion.

5 Conclusion

From the simulation result, we conclude that two mechanisms must cooperate to elicit the percept of a rotating wheel. Although we have simulated a rotational sensitive neural network, the network does not render a . The only correct interpretation of the rotating wheel is achieved when the attentional mechanism is focusing on or near the center of the disc. The grouping of the center point and the cycloidal motion eventually give rise to the perception of the coherent motion.

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