The paradigm of somatosensory deep immersion in Virtual Reality

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Overture

let 's give a metaphor of dream… a second-order dream …

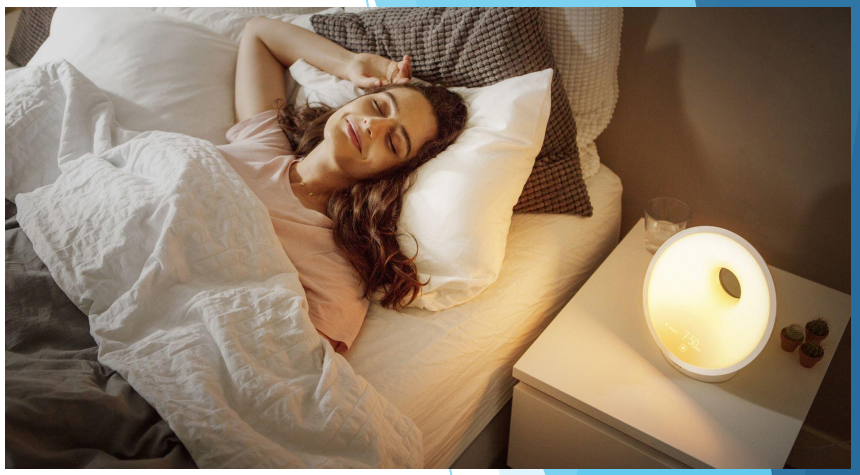
- Go to bed
  - Sleep
- Wake up

- Go to bed
  - Sleep
    - Sleep
  - Wake up
- Wake up

in reality

in a dream

?

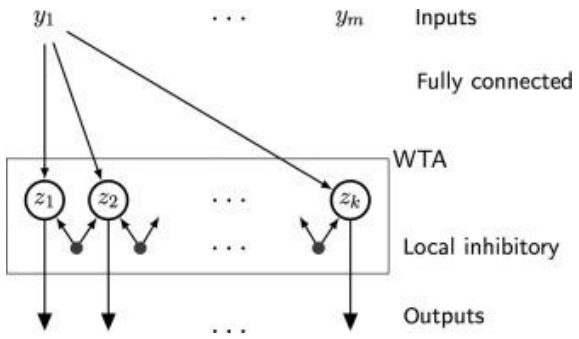


Uncertainty is the key to immersion

cognitive softmax function

future predictions

$$o_{t+1|t} = \text{softmax}(Vh_{t+1})$$
$$L = \sum_t L_t = ||o_{t+1|t} - x_{t+1}||^2$$



winner-take-all (WTA) network

PredRAE - predictive recurrent auto-encoder in the hippocampus

“CA3 makes future predictions, which are then compared at CA1 with the less delayed actual signal from the direct pathway. Such comparison is similar to the update step in the Bayes filter procedure where predictions based on previous information were compared against current observations to update the probabilistic model.”

Chen Y., Zhang H., Sejnowski T. J. Hippocampus as a generative circuit for predictive coding of future sequences //bioRxiv. – 2022.

Inference of virtuality

1. Inference of virtuality of current world it is carried out only if motivated by
2. Motivation emerges if there is a possibility of prediction
3. The feeling of predictability of transitions in the sequence of events occurs at a certain value of the minimax criterion

Peters, A., McEwen, B. S., & Friston, K. (2017). Uncertainty and stress: Why it causes diseases and how it is mastered by the brain. *Progress in Neurobiology*, *156*, 164–188. https://doi.org/10.1016/j.pneurobio.2017.05.004

It is enough to increase the total probability of alternative transitions to the probability of the most probable transition to make the subject to refuse to predict

The paradigm of deep immersion

- Infrastructure of stereotypical unpredictable transitions between parallel storylines (legends) designed to switch from input-and-output transitions to lots of nested episode-to-episode transitions.

игра2

комната

комната

комната

игра1

игра1

игра1

Transition ritual

- The ritual of entering must have pronounced features: stylized sensors, visual design, musical leitmotif, method of obtaining a task.
- Every legend includes selected sessions with full somatosensory experience:
  - an augmented reality studios with full-size decorations,
  - tube-like worlds on base of treadmills,
  - stationary capsule-like workplaces such as cabins of motor vehicles and airplanes;
  - completely real:
    - participant takes food, personal hygiene, and rest
    - equipment: a wrist communicator, a light headband to register brain activity.

VR is based on visual and auditory images

- In experiments, the illusion of possession of a virtual body arising due to synchronous visual-tactile stimulation led to the predominance of visual signals over vestibular ones when they mismatch

  Preuss, N., Brynjarsdóttir, B. L., & Ehrsson, H. H. (2018). Body ownership shapes self-orientation perception. *Scientific Reports*, *8*(1), 16062. https://doi.org/10.1038/s41598-018-34260-7

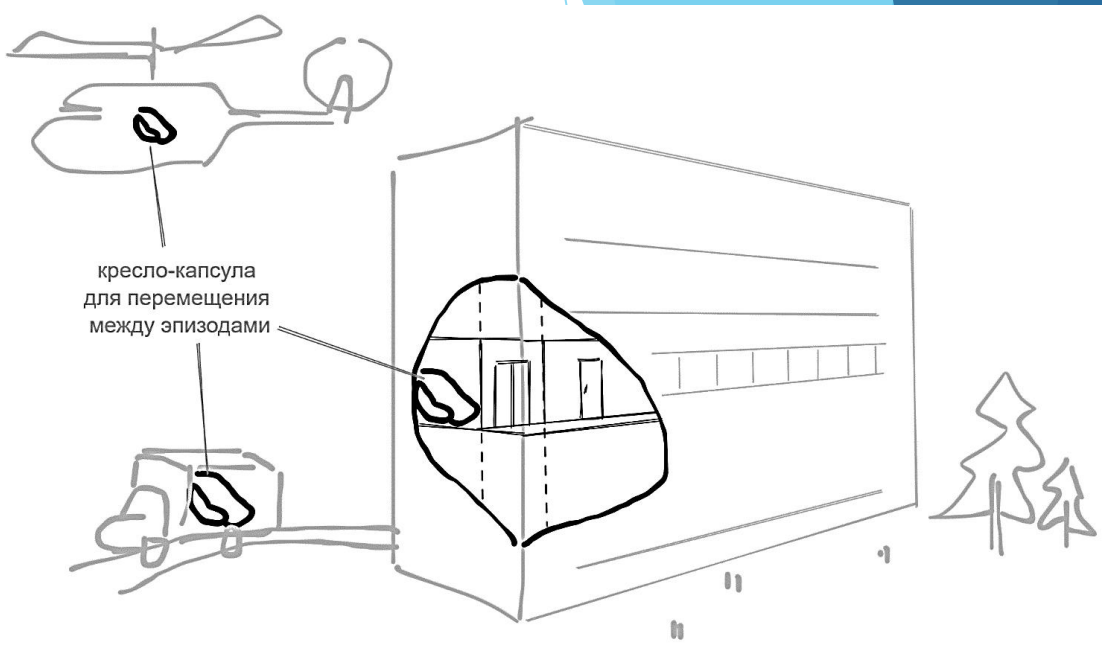
- Illusion that arises in a real episode is able to compensate for the technical imperfections of virtual episodes for some time due to the thought inertia
- EEG monitoring during sleep can be used to assess involvement in episodes by revealing traces of musical leitmotifs and characteristic heat maps of eye movements that are recorded in the VR helmet

  Wang, B., Antony, J. W., Lurie, S., Brooks, P. P., Paller, K. A., & Norman, K. A. (2019). Targeted memory reactivation during sleep elicits neural signals related to learning content. *Journal of Neuroscience*, *39*(34), 6728-6736. https://doi.org/10.1523/JNEUROSCI.2798-18.201

  Hong, C. C.-H., Fallon, J. H., Friston, K. J., & Harris, J. C. (2018). Rapid Eye Movements in Sleep Furnish a Unique Probe Into Consciousness. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02087

More info

- The requirements for a standardized transition scheme between episodes are described in the paper.
- Suggestions on development such network for Russian Military services



1. Щербина Д.Н. Парадигма непрерывных учений в виртуальных средах. Предпосылки создания // Научная мысль, 2021, Т. 18, N 4, С. 83-90.

2. Щербина Д.Н. Парадигма непрерывных учений в виртуальных средах. Техника реализации // Научная мысль, 2022, Т. 19, N 1, С. 13-24.

Thank you for attention!