MECHANICAL ENGINEERING SEMINAR

Monday, March 17, 2025 at 14:30, Dan-Kahn Building, Room 217, and ZOOM LINK

Limb Coupling and Decoupling in a Quadrupedal Walker: Can We Decipher It from a Trackway?

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Deriving a gait from a trackway is a non-trivial task: Formally identical trackways are produced by different gaits of short-bodied and long-bodied animals. If the trackmaker is unknown, the gait cannot be, generally, derived from the trackway alone. I try to solve this task on an example of a fossil trackway, which is said to belong to a few-meter-long pareiasaur reptile which lived in northern Europe and became extinct more than 250 million years ago. Reptiles are distinguished from mammals by the sprawling leg posture, which restricts their gaits to the trot and trot-like walking and running characterized by diagonal legs coupling, which ensures the least deviations from the static equilibrium. However, statistical analysis of linear dimensions of the longest pareiasaurian trackway (15.5 locomotor cycles) and also their known body proportions suggest that their gait was close to pace characterized by ipsilateral legs coupling. With the sprawling limb posture, the pace can only be performed with body rocking from side to side, according to the principles of passive-dynamic walking. This principle was implemented in the traditional Russian toy named 'the walking-rocking bull-calf' and is well known in robotics. A natural-sized model of pareiasaur was built to teach children paleontology. It performed the passive-dynamic rocking pace, being driven manually by pulling it forward with the rope and simultaneously pushing it from side to side. In real animals, the hindfeet were used for propulsion, while the inward-turned forefeet generated the transverse forces required to pump the rocking motion. It is hypothesized that this walking mechanism was associated with an archaic deficiency of nervous and muscular supply of the limbs. Today, a similar gait is only employed by echidnas, the egg-laying mammals retaining archaic leg posture. However, their gait is not the perfect pace, the ipsilateral legs being somewhat decoupled. Remodeling the bull-calf toy shows that a stable gait like this is achieved due to an additional degree of freedom, which is the axial rotation in the backbone.

Short bio: Alexander Kuznetsov graduated from the Biological Faculty of the Moscow Lomonosov State University in 1983 as a master in zoology and botany. Throughout his scientific career, his main topic of research was biomechanics of locomotor apparatus of mammals and other vertebrate animals, their walking and running on land. He started his research as a member of the Laboratory of Bionics working on biological prototyping of legged robots with a powerful team of the Institute of Mechanics of the Moscow University under the leadership of Professor Yevgenii Devyanin. His dissertations were devoted to the general structural features of the legs of mammals and birds from the point of view of their optimality in terms of energy expenditures for muscular work during locomotion on land. In March 2023 he has repatriated in Israel, and since 2024 he is a research associate in immigrating scientists program, conducting research on bio-inspired legged robots at Technion, hosted by Assoc. Prof. Yizhar Or.

Seminars Coordinator: Assoc. Prof. Gal Shmuel .