ECCE ROBOT

Embodied Cognition in a Compliantly Engineered ROBOT

University of Sussex

GPU-Powered Control of a Compliant Humanoid Robot

Alan Diamond & Owen Holland (University of Sussex), Richard Newcombe (Imperial College London), Rob Knight (The Robot Studio), Steffen Wittmeier & Michael Jaentsch (Technische Universität München)

The ECCEROBOT Project

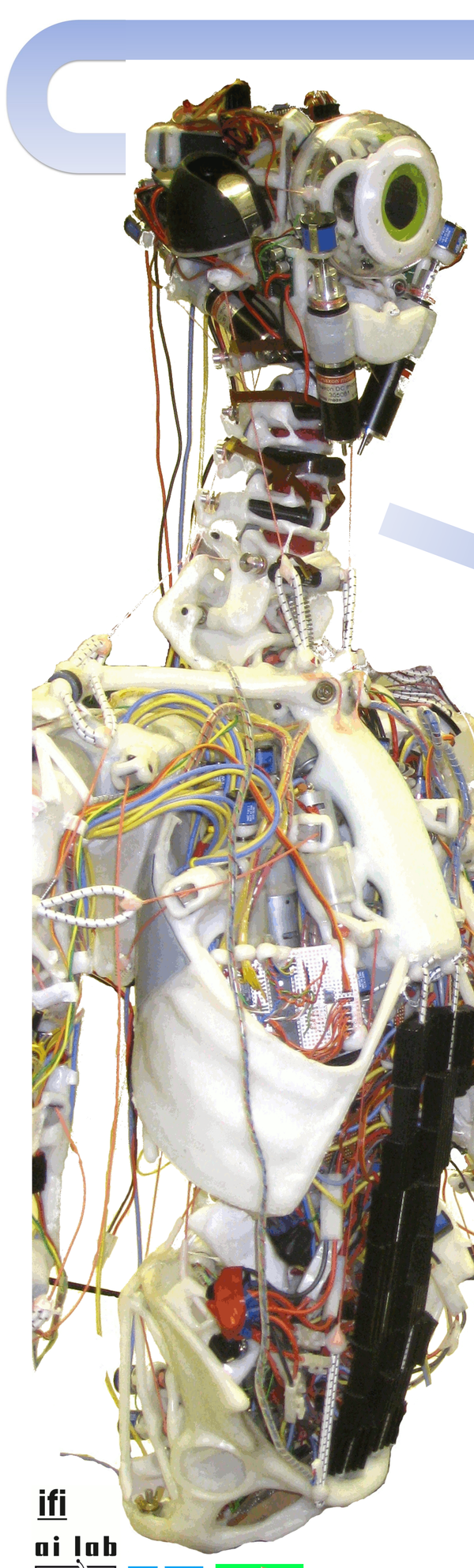
The ECCEROBOT project deals with the construction and control of a robot with a humanoid skeleton and muscle-like elastic actuators. We describe this robot as being *anthropomimetic* [1].

In such a system, the nonlinear passive and active coupling between the skeletal elements, combined with the effect of environmental interaction, present too complex a problem for conventional control techniques to deal with in a task-achieving context.

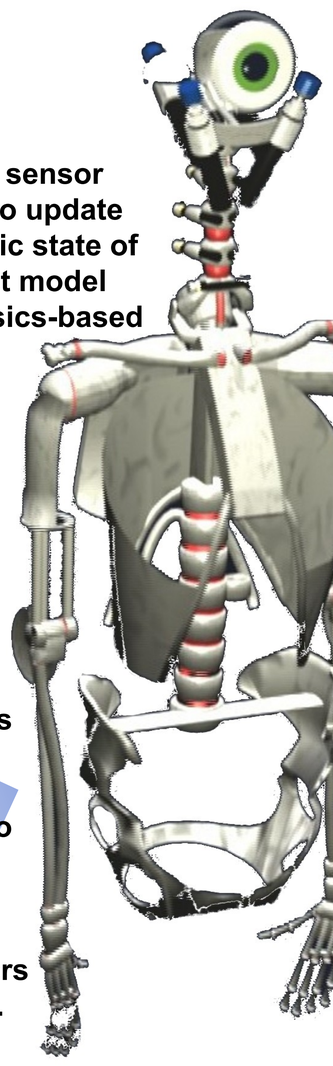
Instead, suitable motor programs are found by using, in parallel, physics-based simulations of both the robot and its environment to search the space of candidate movements and test their effects.

To complete searches fast enough to control the robot in real time will require multiple copies of the simulation to be run faster than real time, necessitating the use of GPU acceleration.

Further, in order to capture the environment within which the task must be executed in sufficient detail, it is also necessary to use GPU-accelerated dense reconstruction [2] via an eye-like camera system.

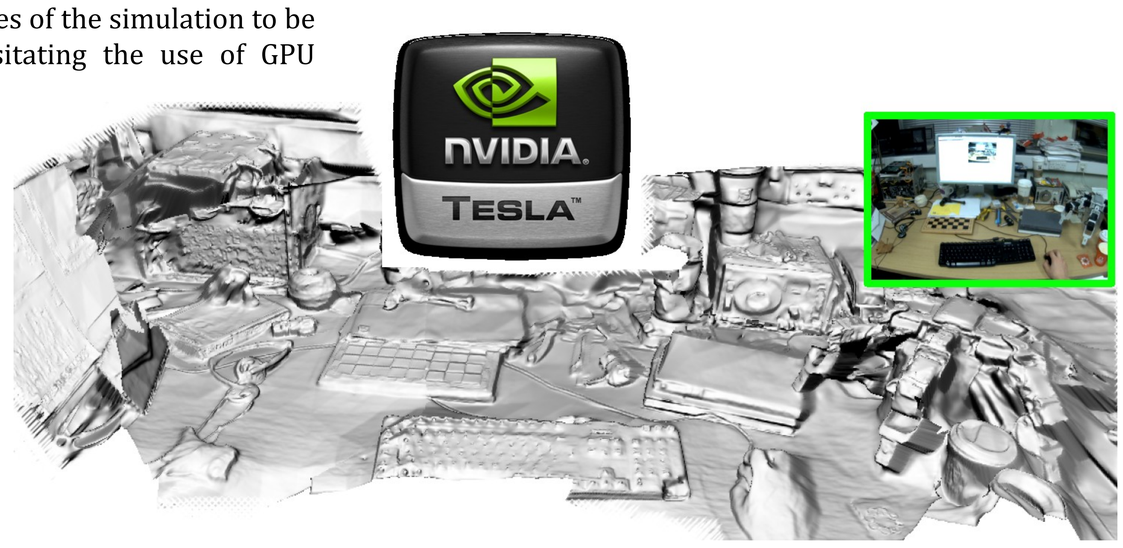


Proprioceptive sensor data are used to update the kinodynamic state of a detailed robot model within the physics-based simulation.

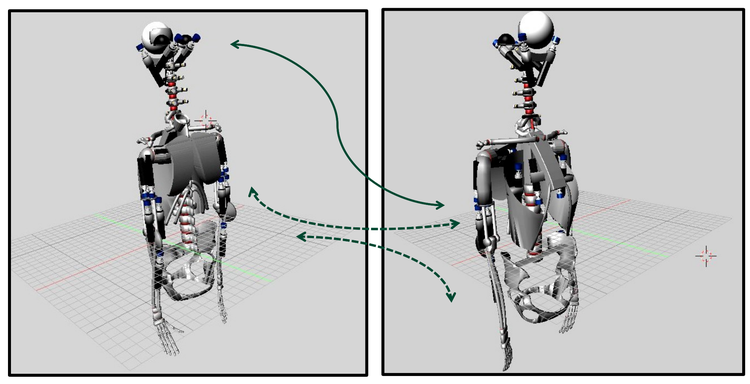


The model incorporates numerous custom contraints to model the elastic muscles, joints, motors and pulleys.

GPU-accelerated dense reconstruction (nVidia Tesla) captures high resolution depth maps and inserts them in real time into the physics-based simulation "world" as texture mapped surfaces.



Environment and robot are combined in a single "world" ready for motion planning. The physics engine is accelerated by an nVidia GTX295 GPU so that it can be run faster than real time.



Using multiple copies of the accelerated physics world, candidate motor programs are tested in simulation for their ability to control the compliant robot structure to perform the designated task, such as reaching for a target object.

Finally, the best motor program is downloaded to the "muscles" of the real robot.

References and background

[1] O. Holland and R. Knight. The anthropomimetic principle. In Jeremy Burn and Myra Wilson, editors, Proceedings of the AISB06 Symposium on Biologically Inspired Robotics (2006)
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Contact info: Alan Diamond <A.Diamond@sussex.ac.uk>