Johnny-0, A Compliant, Force-Controlled and Interactive Humanoid Autonomous Robot

Video Abstract

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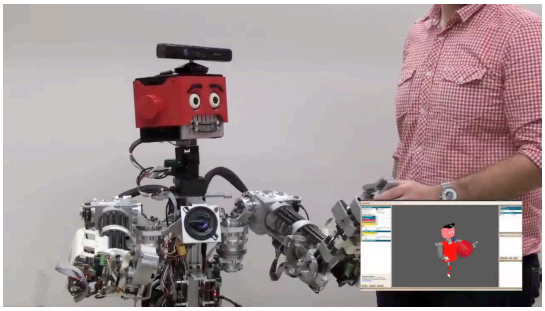

Categories and Subject Descriptors

I.2.9 [**Robotics**]: Kinematics and dynamics, Operator interfaces

General Terms

Algorithms, Experimentation

Keywords

Humanoid robot, Force-control

ABSTRACT

Johnny-0 [1] is our new humanoid robot which integrates an expressive face on an orientable head, two arms with 4 degrees of freedom (DOF) each and grippers, mounted on an omnidirectional, non-holonomic mobile platform. Our underlying goal with Johnny-0 is to design a platform capable of natural reciprocal interaction (motion, language, touch, affect) with humans, to address integration issues associated with advanced motion, interaction and cognition capabilities on the same platform, and their use in unconstrained real world conditions. To do so, compliance is a necessity to provide natural and safe interactions.

One distinctive element of Johnny-0 is that it uses force-controlled actuators (called Differential Elastic Actuators - DEA for active steering of its mobile platform, and for interactive control of its 4-DOF arms. Impedance control of each joint enables infinite combination of arm behaviors, from zero impedance for free movement with gravity compensation, to high stiffness constraining the arms to precise positions or ranges of movement. Stiffness can be configured to create virtual constraints in cartesian space, providing force feedback to the user about movement's limitations of the arms. For instance, stiffening the arms in certain poses could indicate to the user that the arms are restrained to move into a specific volume. Beyond these limits, any pushing or pulling force can be perceived by the mobile base, and can be interpreted as an intention to move the robot around.

Combining compliance to other sensors (e.g., Kinect motion sensor) and a robot head capable of facial expression allows Johnny-0 to detect incoming people and adjust the impedance of its actuators accordingly (e.g., extend its gripper to greet them), and express its state based on how people physically interact with it (e.g., displaying surprise when the user move the arms beyond specific limits).

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1. REFERENCES

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