MORF - Modular Robot Framework

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ABSTRACT

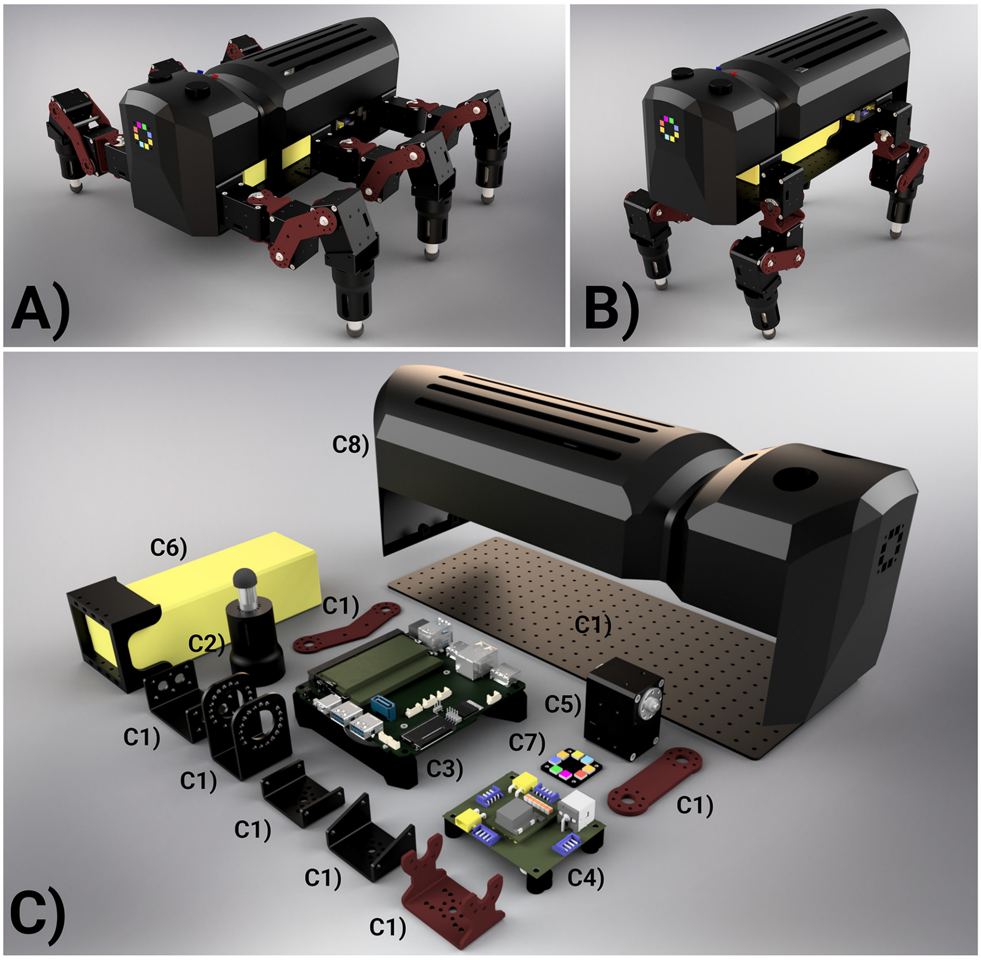
Every mobile robot needs some mechanisms to make them able to move. The most frequently used one is wheels, as their simplicity and low power consumption is appealing. However, wheeled robots are limited to predominantly flat surfaces with few obstacles and in need of additional mechanisms if manipulative tasks are to be performed.

An alternative solution is legs. A legged robot needs legs with at least two degrees of freedom to move - one for lifting and one for swinging - but it is usually equipped with legs that have three to allow additional maneuvering. This increases power consumption and requires a more complex controller due to the complex body structure (Kajita and Espiau (2008); Todd (1985)). So why use legged robots at all? Legged robots are first of all able to interact with generic physical environments that are either designed for legged locomotion (humans) or rough terrain filled with obstacles by nature (Todd (1985)).

Current solutions to adaptive locomotion for legged robots are promising, but often looks miserable and are far from able to compete with the behaviors of real animals. This is presumably due to fact that the benefits of using legs most often are overshadowed by their high design complexity. We, therefore, present MORF, a MOdular Robot Framework that can be used in a wide range of studies. The primary aim of MORF is for it to be easy and convenient to use, such that researchers can focus more on the actual controller of the robot and not the hardware. Its design makes use of state-of-the-art components for high performance as well as kinematics inspired by nature. This enables some of the complexity to be moved from the controller to the mechanics of the system. MORF is modular as it defines standards that can be used for re-configuring, extending, and/or replacing parts of the robot, e.g. body shape. MORF furthermore includes a software suite with a full simulation of MORF and hardware interface methods based on the Robot Operating System (ROS). This makes it easy for the user to quickly test his code and to interface with the physical system using any language compatible with ROS.

MORF is shown in Fig. 1, which lists the different parts of MORF and illustrates its modularity when only using its default components. Compared to other modular robots like (Ansari et al. (2017); Kim et al. (2017)), MORF is advantageous in areas like processing power, mobility (no external wires), controllability, completeness (includes a software suite), sensory feedback, and expandability, but lacks their ease of attaching parts together (e.g, using magnets or threaded collars). Future work thus includes finding a simpler while still robust attachment mechanism

for the different parts of MORF. The above described advantages together with the fact that the system is open-source will result in many extensions developed by the community and thus an ever growing and improving framework.



MORF when configured as A) an insect and B) a mammal. C) Shows C1) the mechanical aluminum parts, C2) the 3D printed foot module with an aluminum tube, a spring, and a 3D force sensor, C3) an Intel NUC i7 used as main controller, C4) a power stabilizing and distribution board, and C5) the dynamixel XM-430-350 smart servos from where the position, velocity, current, input voltage, and temperature can be read, C6) A six-celled Li-Po battery with a 3D printed holder, C7) an LED array from BlinkStick for debugging and visuals, and C8) a 3D printed shell with magnetic connection for easy access to the underlying electronics.

Figure 1.

Keywords: Legged-Robot, Modular, Locomotion, Research framework, Bio-inspired

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