



VALKYRIE

NASA's First Bipedal Humanoid Robot



NASA's Valkyrie was designed and built by the Johnson Space Center (JSC) Engineering Directorate to compete in the 2013 DARPA Robotics Challenge (DRC) Trials. Valkyrie, a name taken from Norse mythology, is designed to be a robust, rugged, entirely electric humanoid robot capable of operating in degraded or damaged human-engineered environments. Building on prior experience from designing Robonaut 2, the JSC Valkyrie team designed and built this robot within a 15 month period, implementing improved electronics, actuators and sensing capability from earlier generations of JSC humanoid robots.

Following the robot's appearance at the 2013 DRC Trials, the Valkyrie team modified and improved the robot - modifying the hands to increase reliability and durability, redesigning the ankle to improve performance and upgrading sensors for increase perception capability. The Valkyrie team also partnered with the Florida Institute for Human and Machine Cognition (IHMC) to implement their walking algorithms on NASA hardware in preparation for the Space Robotics Challenge, part of NASA's Game Changing Development Program and Centennial Challenges.



Specifications

Weight: 300 pounds
 Height: 6 feet 2 inches
 Battery Energy: 1.8kWh

Computers: 2 x Intel Core i7
 Degrees of Freedom: 44



Power/Battery

Valkyrie can be configured to run from a wall or from battery power. The custom dual-voltage battery is capable of running the robot for about an hour. When a battery is not in use, it can be replaced with a mass simulator and capacitor that simulates the mechanical and some of the electrical properties of the battery.

Torso/Pelvis

The robot's torso houses two series elastic rotary actuators (the first arm joint on either side), two series elastic linear actuators that work in concert to realize motion between the torso and pelvis, and various computer and power facilities. The pelvis houses three series elastic rotary actuators: the waist rotation joint, and the hip rotation joint of each leg. The pelvis is considered the robot's base frame, and includes two IMU's.

Legs

Each upper leg contains five series elastic rotary actuators. The ankle is realized using two series elastic linear actuators working in concert. The leg has a quick mechanical and electrical disconnect between the first two joints that allows for easy shipping and service.

Head/Sensor Suite

Valkyrie's head sits atop a 3 DOF neck. The main perceptual sensor is the Carnegie Robotics Multisense SL, with modifications to allow for IR structured light point cloud generation in addition to the laser and passive stereo methods already implemented. Valkyrie also features fore and aft "hazard cameras" located in the torso.

Arms

Each upper arm consists of 4 series elastic rotary actuators and when combined with the forearm has 7 joints. The arm has a quick mechanical and electrical disconnect between the first two joints that allows for easy shipping and service.

Forearms/Hands

Valkyrie features a simplified humanoid hand, with 3 fingers and a thumb. Each forearm consists of a single rotary actuator (realizing the wrist roll), a pair of linear actuators (realizing wrist pitch and yaw), and 6 finger and thumb actuators. The hands are attached to the ends of the arms with mechanical and electrical quick disconnects that allow for easy shipping and service.