A Cradle of Future Leaders in Robotics



Design for Dynamic Stability of a Humanoid Mechanism

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There have been many attempts to design humanoid robots- the biped robot that can walk and behave like human. The human movement mechanism. however. is verv complex and, hence. difficult to fully understand. The past attempts show tremendous progress in humanoid technology but the perfect humanoid is yet to come.

The design of a dynamically stable humanoid does not stop at mechanical design. It involves the whole system. The problem is in the name of the concurrent design- how can we obtain the best humanoid configuration and, at the same time, easy for dynamic stabilization

In this research, we focus on the walking mechanism of the humanoid. We design a 12 degrees-of -freedom (DOF's) direct drive humanoid with all revolute joints. There are two DOF's at the ankle joint, one DOF's at the knee joint, and three DOF's at the hip joints. Our research and development steps are as follow.

1.We use the real human walking information to help designing the direct drive mechanism. The suit is tailored for the human subject such that the walking data can be retrieved directly.



2.We construct the direct kinematics model using the geometrical method. We also construct the inverse kinematics model using the combination of numerical analysis and direct solution of geometrical equations. This is a bit complicated due to the design requirement of the hip. Three axes of the hip joint do not intersect and led to difficult kinematics equations. However, this design is needed so that the robot is able to walk in the circular path. We utilize the Manipulability Ellipsoid to



illustrate the maneuvering capability of the

3.We analyze the stability of the humanoid walking using the Zero Moment Point (ZMP) theory. This analysis leads further to the newer stability criteria- the Single Moment Point (SMP) theory.(Single Moment Point, SMP)



4.We design and build the six-axes force sensor. The force sensor is a part of the humanoid foot. Clever sensors orientation helps simplify the calculation of forces and moments.



F=Force Cell Sensor

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