Whole-body motion of a Humanoid robot for passing through a door
- Opening a door by impulsive force -

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Motivation/ Objectives

- Opening a swing door, a door with restoring force, by humanoid robot using impulsive force
Technical Approach:

Why Impulsive force:
Restoring force of Swing Doors

Creating Impulsive force:
• Robot sway along the Coronal plane
• Impacts door using the elbow

Motion Generation for creating Impulse:
1. Robot moves away from door, to create momentum
2. Robot moves towards door, moves left leg closer to door – to avoid ZMP from reaching boundaries when colliding with door

Velocity at the impact point on Door

\[ v_{RB} = \frac{(I_{rob} + a_r^2 \cdot m_{rob}) \cdot I_B}{I_{rob} \cdot m_{rob} \cdot I_B} \cdot w'_{B} + v'_{rB} \]

\[ \text{The Velocity curve, } T - \text{ point of contact} \]

Fig.6. Modified constant velocity cam curve
Results

- Red line in plot shows position of ZMP
- Gitter at 12.5 seconds - due to impact with the door, but ZMP always lies within support polygon

Simulation on the HRP-2 Robotic platform

Experimentation on the HRP-2 Robotic platform

Fig. 7: Snapshot of the motion of HRP-2 opening a door

Fig. 12: Impact manipulation for opening a swing door
Conclusions

- Impact force method is successful in opening of a swing door, and keeping robot balance.
- Simulated and experimental results on the HRP-2 platform show the working of the concept.
Contribution to the field

- The impact method can be used in other Humanoid robots to open sway doors that are usually tough to open with arm trajectory.
- This method can also be used when the robot arms are occupied/constrained.

[1] Whole-body motion of a Humanoid robot for passing through a door - Opening a door by impulsive force -