**Supplementary materials of reconfigurable tri-prism mobile robot with eight modes**

**A. DOF analysis of the mobile robot**

The twist system of limb 1 is obtained as:

 (A1)

where {*x*13, *y*13, *z*13}T is the position of the center of joint *r*5 in limb 1, {*x*12, 0, *z*12}T is the position of center of joint *r*3, *L*13, *N*13,*L*14,*M*14, *N*14,*L*15,*M*15 and *N*15 are arbitrary constants that cannot be simultaneously equal to zero. The wrench of limb 1 can be derived as:

 (A2)

where,

****** (A3)

****** (A4)

****** (A5)

 ******is a wrench with finite pitch.

 The twist system of limb 2 is calculated as:

 (A6)

 The wrench of limb 2 can be yielded as:

 (A7)

where,

 (A8)

 (A9)

 (A10)

 (A11)

 (A12)



The twist system and the wrench system of limb 3 are in the same format as limb 2. The three limbs exert three independent constraint wrenches in total on Foot 2. There are no common constraints and the mechanism is not over-constrained, the DOF of the mobile robot is calculated as three.

**B. Positions and accelerations of the links of the mobile robot in the sphere rolling mode**

The positions of the links and feet of the robot (represented by *F*1, *F*2, *L*1, *L*2, *L*3, *L*4, *L*5 and *L*6) can be obtained as

 (B1)

  (B2)

 (B3)

 (B4)

 (B5)

  (B6)

 (B7)

  (B8)

The accelerations of the links of the mobile robot in the sphere rolling mode are:

  (B9)  (B10)

 (B11)

 (B12)

 (B13)

 (B14)

 (B15)

 (B16)

**C. Positions and accelerations of the links of the mobile robot in the wheeled rolling mode**

The position of each foot and link of the robot in the first step of motion can be obtained as

 (C1)

  (C2)

  (C3)

  (C4)

 (C5)

 (C6)

 (C7)

 (C8)

The accelerations of the links of the mobile robot in the wheeled rolling mode can be derived as:

 (C9)

 (C10)

 (C11)

 (C12)

 (C13)

 (C14)

  (C15)

 (C16)

**D. Positions and accelerations of the links of the mobile robot in the somersaulting mode**

 Let ∠*EFA* = *λ* and ∠*FEC* = *β.* We have

 (D1)

 (D2)

 (D3)

 (D4)

 The position of each foot and link can be obtained as

 (D5)

  (D6)

 (D7)

 (D8)

 (D9)

 (D10)

 (D11)

 (D12)

The accelerations of links of the mobile robot in the somersaulting mode is got as

 (D13)

(D14)

 (D15)

 (D16)

 (D17)

 (D18)

 (D19)

 (D20)

where,

 (D21)

 (D22)

  (D23)

 (D24)

 (D25)

 (D26)

**E. Positions and accelerations of the links of the mobile robot in the turning mode**

The position of each link and foot is obtained as

 (E1)

 (E2)

 (E3)

 (E4)

 (E5)

 (E6)

  (E7)

 (E8)

The accelerations of the links of the mobile robot in the turning mode are

 (E9)

  (E10)

 (E11)

 (E12)

 (E13)

 (E14)

 (E15)  (E16)