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CORRECTION

# Correction to: Joint failure recovery for snake robot locomotion using a shape-based approach

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## 1 Conclusion

**I.** In the above article [1], there is a typing error in equation (1), which has to be

$$w = \begin{bmatrix} x \\ y \\ \varphi \end{bmatrix} = \begin{bmatrix} L\,C_{\theta_{q-n}} + L\,C_{(\theta_{q-n}+\theta_{q-n+1})} + \cdots + LC_{\sum_{i=q-n}^{q+m}\theta_i} \\ L\,S_{\theta_{q-n}} + L\,S_{(\theta_{q-n}+\theta_{q-n+1})} + \cdots + LS_{\sum_{i=q-n}^{q+m}\theta_i} \\ \theta_{q-n} + \theta_{q-n+1} + \cdots + \theta_{q+m} \end{bmatrix}$$

where $S_a = \sin(a)$ and $C_a = \cos(a)$.

This also applies to the equation format in the Appendix A, where the following terms have to be defined as

$$J11 = -L\left\{ \sin\theta_{q-n} + \sin(\theta_{q-n} + \theta_{q-n+1}) + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J1n = -L\left\{ \sin\sum_{i=q-n}^{q-1}\theta_i + \sin\sum_{i=q-n}^{q}\theta_i + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J1(n+1) = -L\left\{ \sin\sum_{i=q-n}^{q+1}\theta_i + \sin\sum_{i=q-n}^{q+2}\theta_i + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J1(m+n) = -L\sin\sum_{i=q-n}^{q+m}\theta_i$$

and

$$J21 = L\left\{ \cos\theta_{q-n} + \cos(\theta_{q-n} + \theta_{q-n+1}) + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J2n = L\left\{ \cos\sum_{i=q-n}^{q-1}\theta_i + \cos\sum_{i=q-n}^{q}\theta_i + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J2(n+1) = L\left\{ \cos\sum_{i=q-n}^{q+1}\theta_i + \cos\sum_{i=q-n}^{q+2}\theta_i + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$J2(m+n) = L\cos\sum_{i=q-n}^{q+m}\theta_i.$$

Similarly, in Appendix B

$$\mathfrak{J}11 = -L\left\{ \sin\theta_{q-n} + \sin(\theta_{q-n} + \theta_{q-n+1}) + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}1n = -L\left\{ \sin\sum_{i=q-n}^{q-1}\theta_i + \sin\sum_{i=q-n}^{q}\theta_i + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}1(n+1) = -L\left\{ \sin\sum_{i=q-n}^{q}\theta_i + \sin\sum_{i=q-n}^{q+1}\theta_i + \cdots + \sin\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}1(m+n) = -L\sin\sum_{i=q-n}^{q+m}\theta_i$$

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and

$$\mathfrak{J}21 = L\left\{ \cos\theta_{q-n} + \cos(\theta_{q-n} + \theta_{q-n+1}) + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}2n = L\left\{ \cos\sum_{i=q-n}^{q-1}\theta_i + \cos\sum_{i=q-n}^{q}\theta_i + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}2(n+1) = L\left\{ \cos\sum_{i=q-n}^{q}\theta_i + \cos\sum_{i=q-n}^{q+1}\theta_i + \cdots + \cos\sum_{i=q-n}^{q+m}\theta_i \right\}$$

$$\mathfrak{J}2(m+n) = L\cos\sum_{i=q-n}^{q+m}\theta_i$$

**II.** Equation (11) is to be defined in the form.

$$u = J_\lambda^\dagger[\dot{\mu}_d - K(w - w_d)] + (I - J_\lambda^\dagger J)k.$$

Including $\mu$ and $\mu$ is not needed as they contradict with the definition of $\dot{\mu}_d$. Notice that the final form of equation (11) does not change where

$$u = J_\lambda^\dagger[\dot{w}_d - \bar{J}\dot{\theta}_q - K(w - w_d)] + (I - J_\lambda^\dagger J)k.$$

The above form is the finally applied control law that insures convergence of the recovery part's tip-link.

## Reference

1. Elsayed BA, Takemori T, Matsuno F (2022) Joint failure recovery for snake robot locomotion using a shape-based approach. Artif Life Robot 27(2):341–354