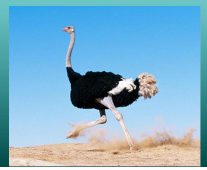
INTERNATIONAL SOCIETY OF
BIONIC ENGINEERING

Bionic mechanical foot inspired by ostrich foot for deep space exploration

From ostrich foot to bionic mechanical foot travelling on sand

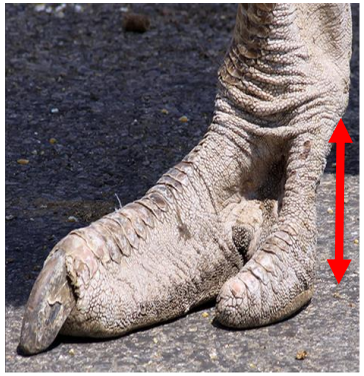
The case was provided by the Individual Member of ISBE (FM126)

1. Biological Prototype

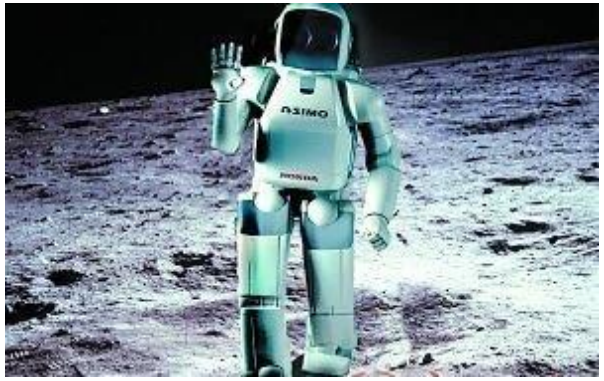


Ostrich (*Struthio camelus*), has the remarkable locomotion performance at the speed of 50-60km/h for up to 30 min, sprint speed over 70 km/h in the desert. Such high-speed running ability on sand is attributed to ostrich didactyl foot with a permanently elevated metatarsophalangeal joint.

Ostrich running in the desert



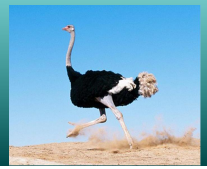
Ostrich didactyl foot

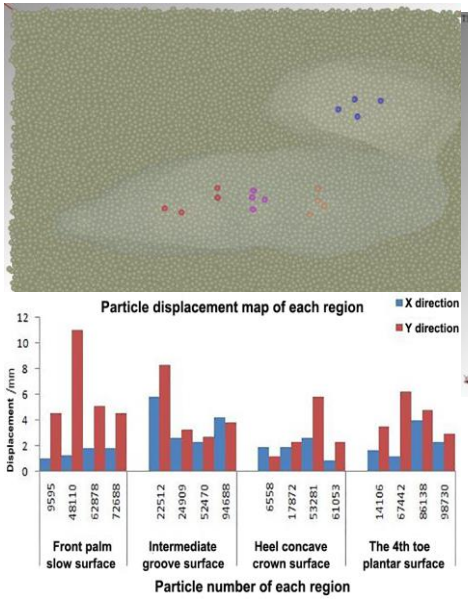


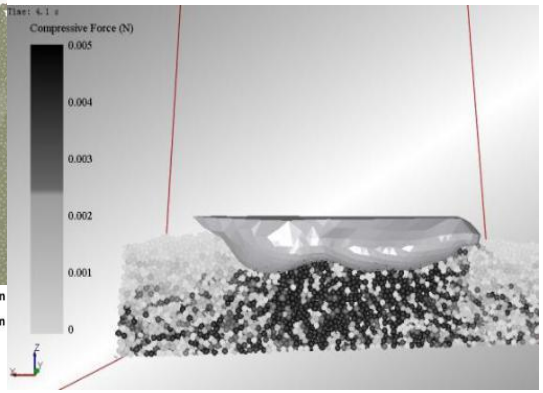
Lunar robot inspired by human beings

Lunar robot inspired by chimpanzee

2. Bionic Study





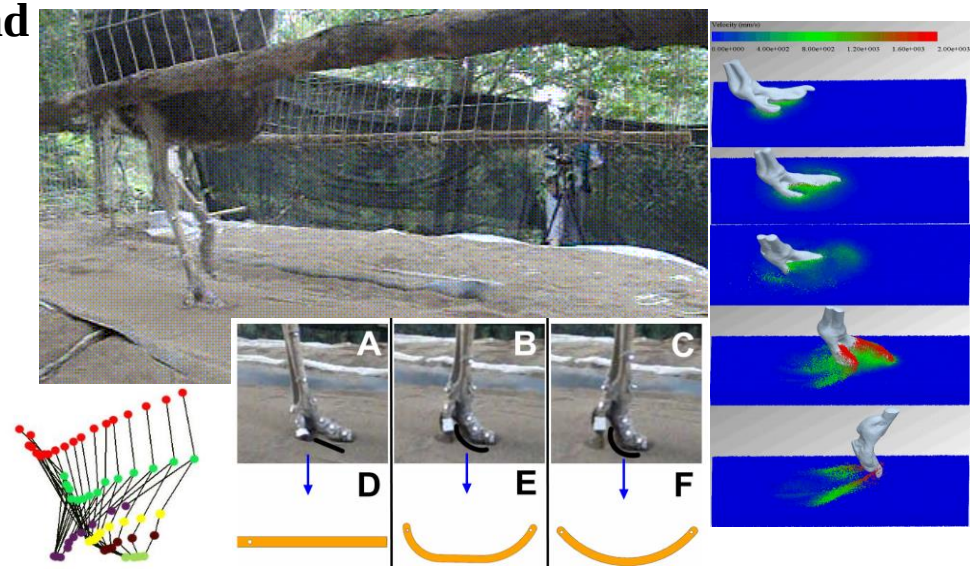


Simulation in ostrich plantar surface traveling on sand

Ostrich plantar surface can preferably retard the slippage during ostrich foot moving ahead on sand.

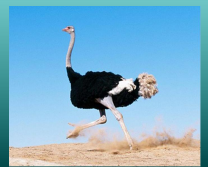
The 3rd toe plantar surface, composed of several curved surfaces, has the obvious effects of sand fixation and flow limitation.

Locomotion morphology during touchdown period changes from line to arc while ostrich running on sand, and the postures contribute to resisting sinkage and slippage of foot.

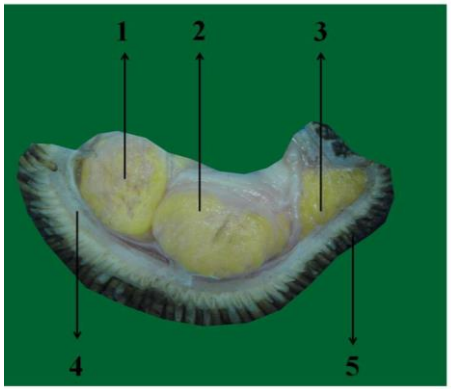


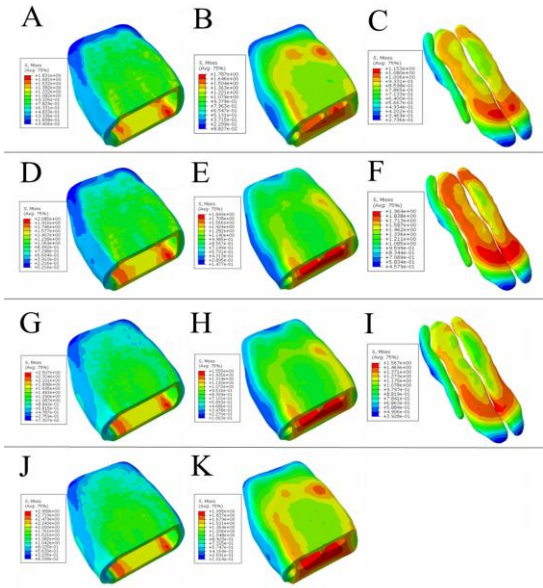
Test and simulation in posture of ostrich foot running on sand

2. Bionic Study

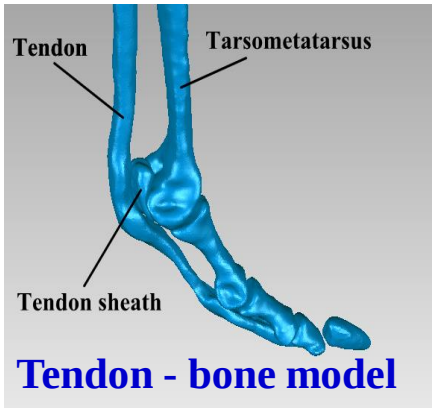


The muti-layer structure of the pads make the stress and strain decay from outside to inside.
The composite material model has the best performance in decreasing the negative acceleration peak value.

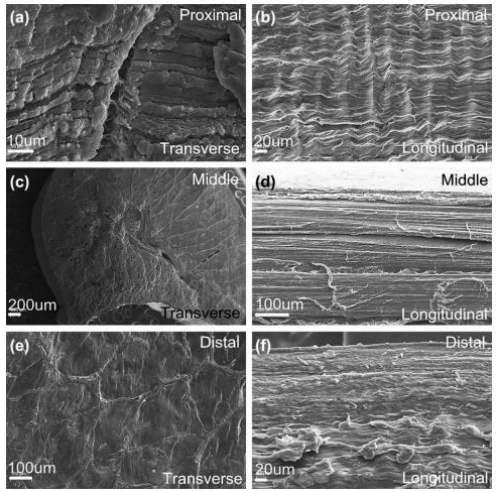




Simulation in toe pad of ostrich foot



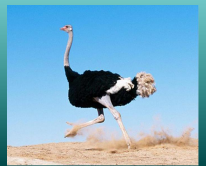
Tendon - bone model

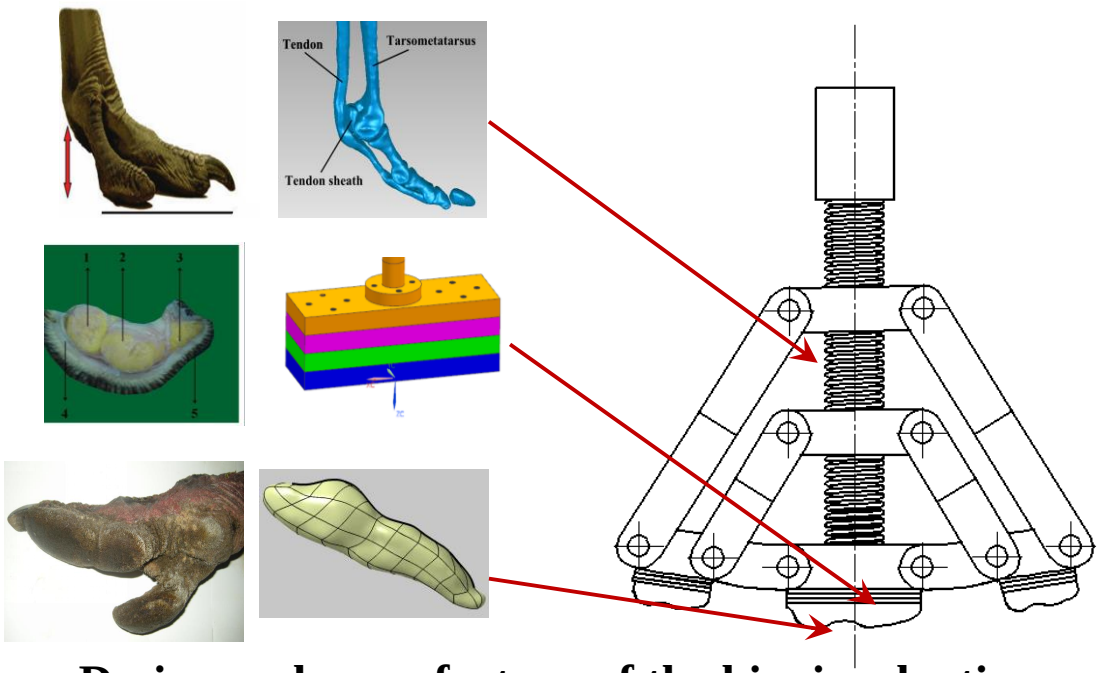


SEM micrographs of the tendon

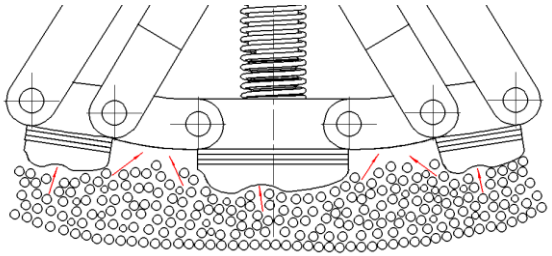
Collagen fiber bundles in the proximal and distal TMTPJ are mainly wavy-type, and likely play a role of energy storage and shock absorption.

3. Design and Processing

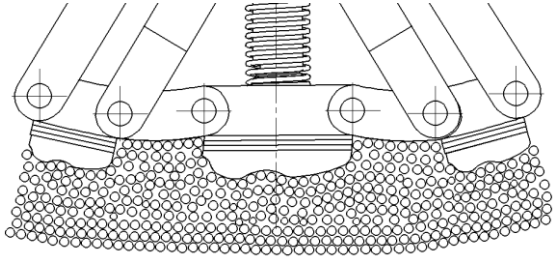




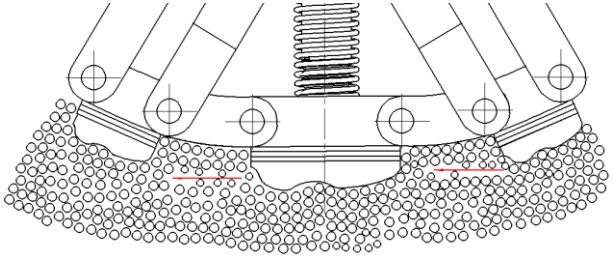
Design and manufacture of the bionic adaptive mechiancal foot travelling on sand



Initial touchdown periond



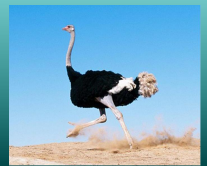
Middle touchdown period



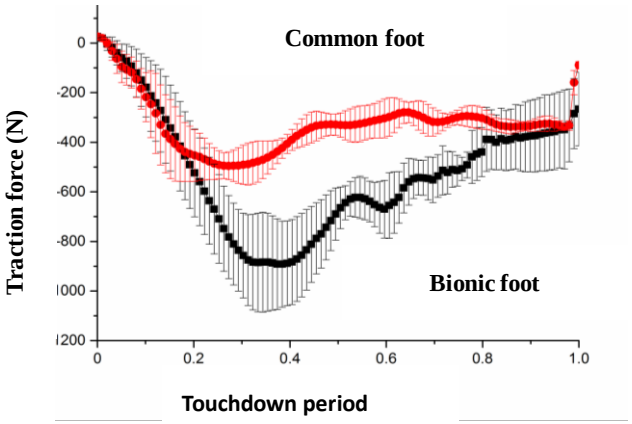
Terminal touchdown period

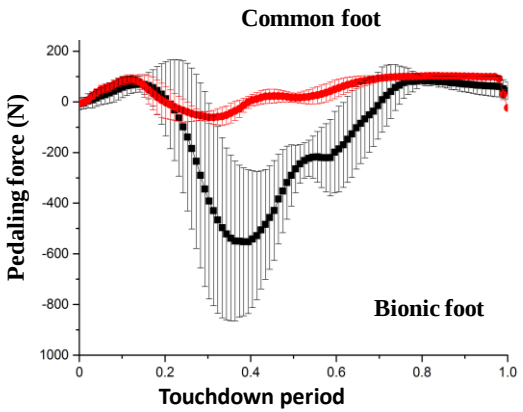
Analysis in the bionic adaptive mechianical foot travelling on sand

4. Achievements and Application



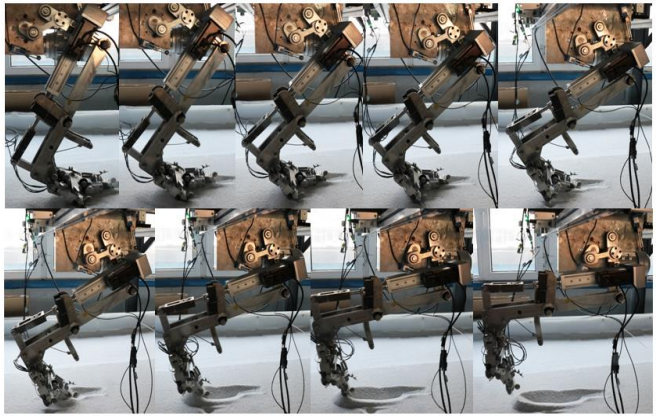
Test for bionic foot travelling on sand



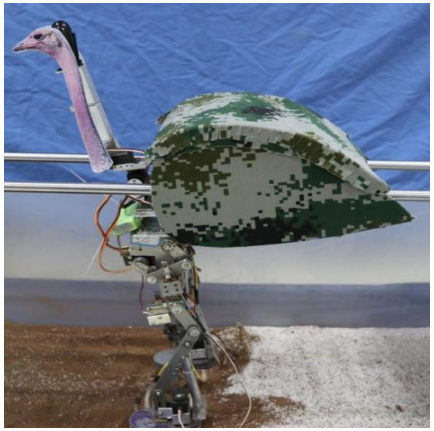


Forces for common and bionic feet

The bionic adaptive foot has superior trafficability travelling on sand under faster walking, which is suitable for deep space exploration robot in th future.



New bionic leg on sand



Ostrich robot on sand

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The ostrich-inspired foot has the potential to be used for deep space exploration