

Biased Electropermanent Magnetic Docking Design for Neutral Buoyancy UAV Deployment

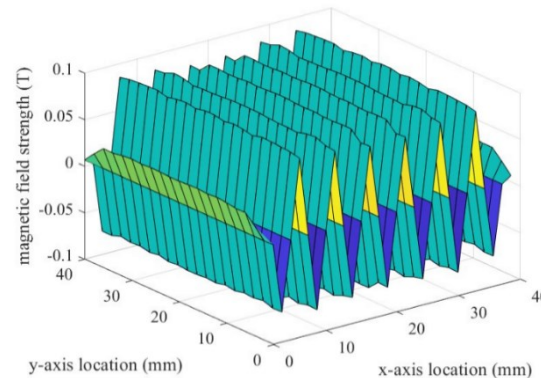
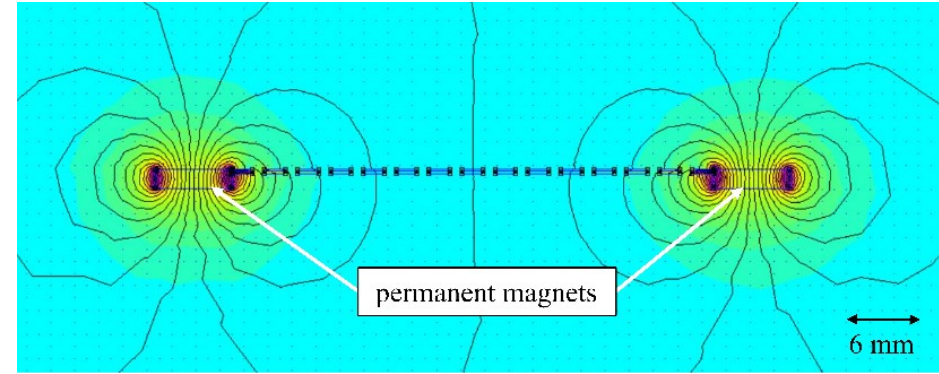
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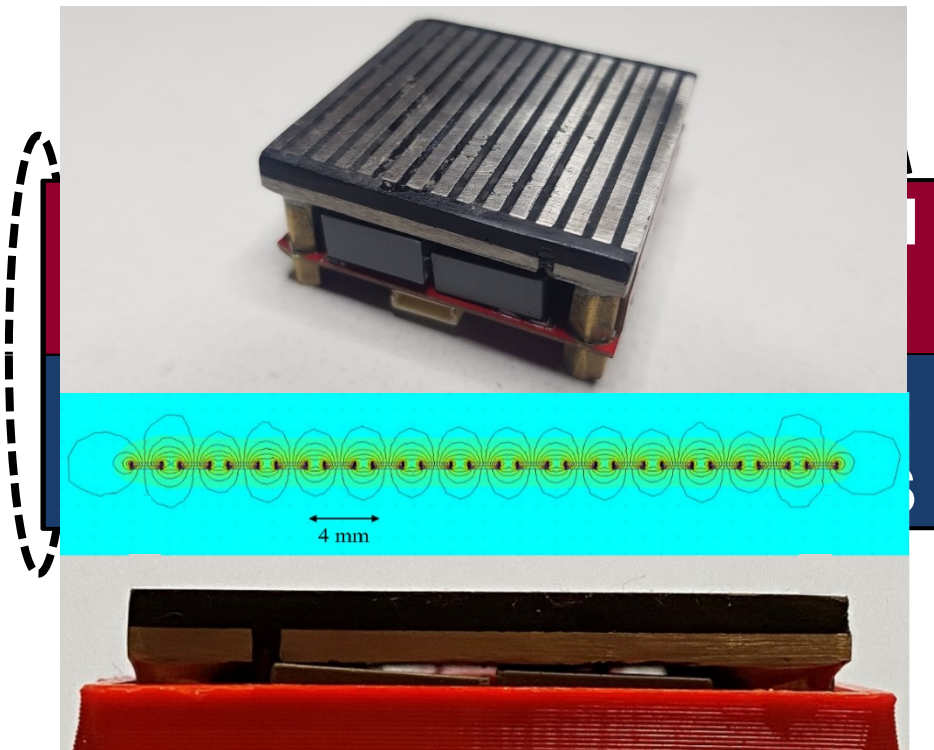
Outline:

- Methodology:
 - EPM technology
 - EPM-aided sensor deployment
- Experimentation:
 - surface field strength scanning
 - magnetic pull strength
 - proposed magnet design
- Results and Discussion:
 - FEMM simulation
 - force vs distance curves
- Future work:
 - UAV field deployment with modified magnet design



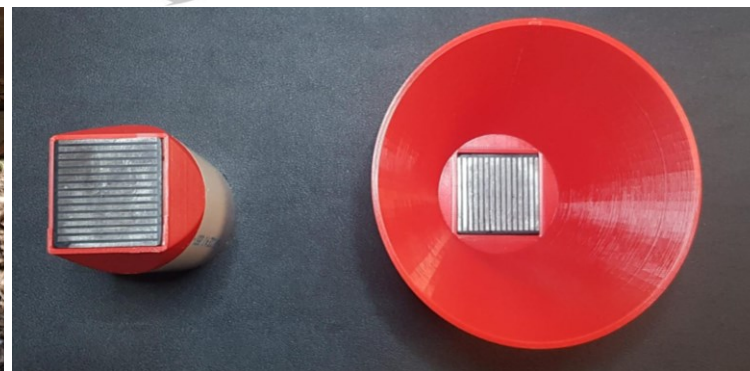
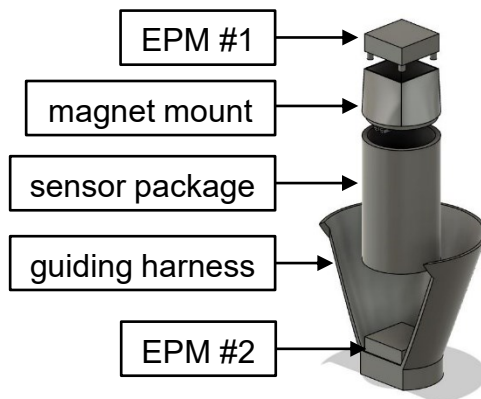
EPM technology:

- single magnetic field
- two magnet fields
 - South-South
 - South-North
- magnet array field
- magnetic field is manipulated through doping metal alloy



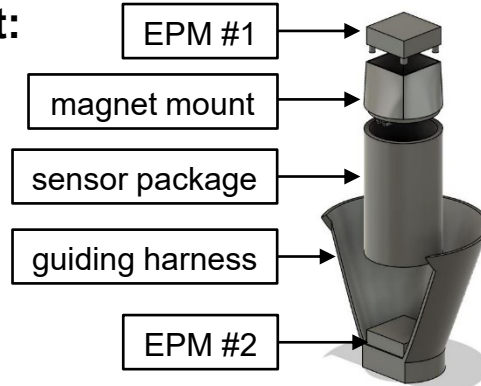
EPM-aided sensor deployment:

- pros:
 - desirable low power operation
 - compact footprint
 - minimal vibration transmissibility loss
- cons:
 - magnetic force is not enough to hold UAV
 - most magnetic field strength is close to surface
 - difficult to guide to ferromagnetic objects



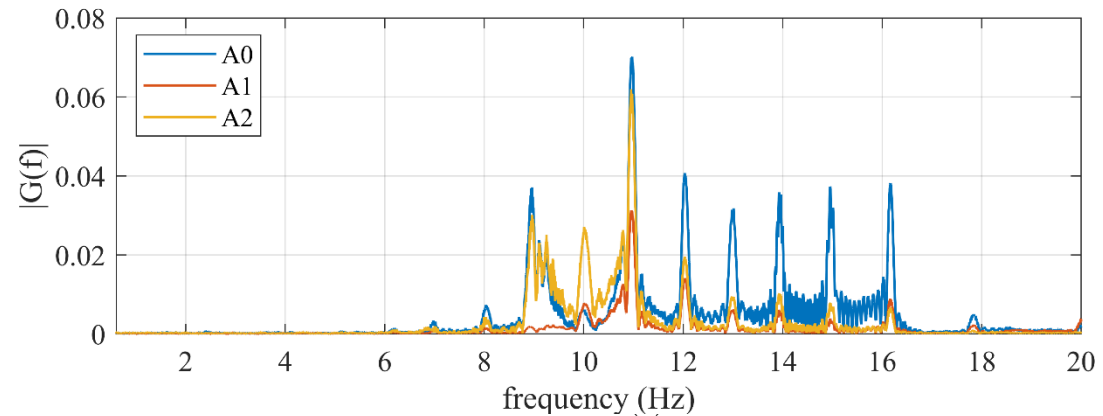
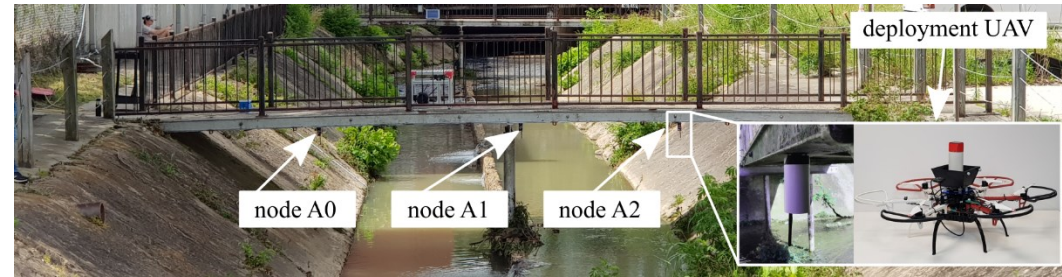
EPM-aided sensor deployment:

- two EPMs used
- lightweight PLA 3D printed frame
- wireless 2.4 GHz enhanced ShockBurst protocol
- UAV pilot control EPMs independently



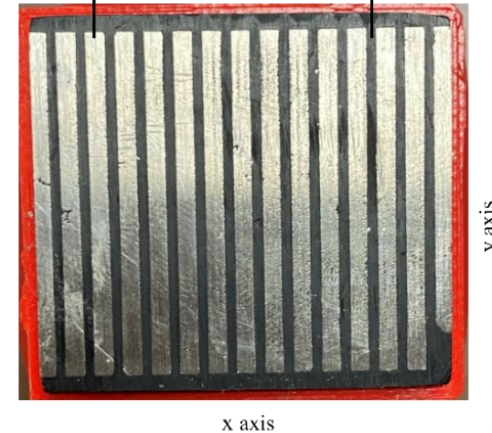
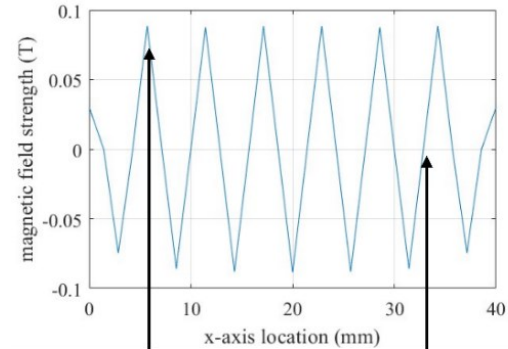
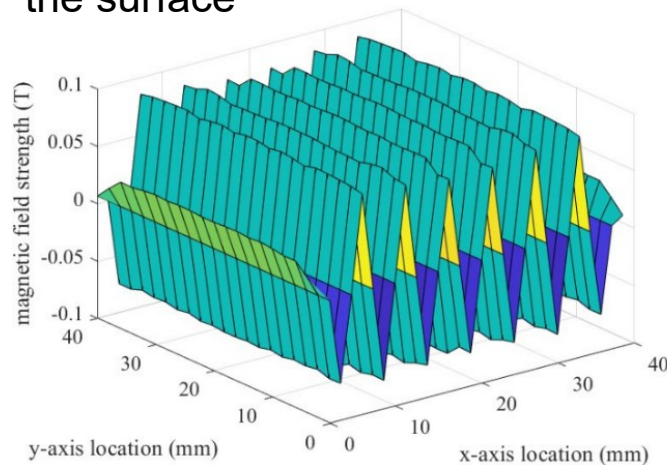
EPM-aided sensor deployment:

- sensor network deployment
- record natural vibrations
- reconstruct mode shapes
- monitor shifts structural damage through mode shapes.



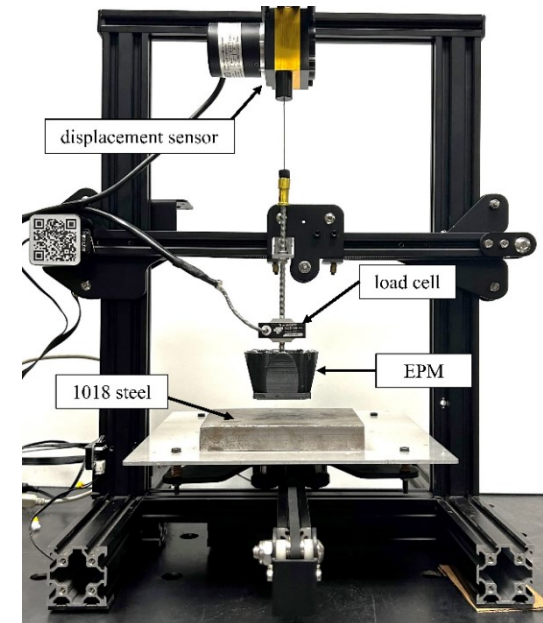
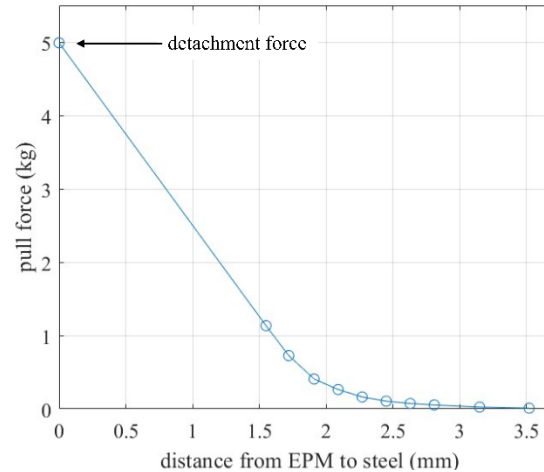
Surface field strength scanning:

- DC gaussmeter probe used to scan surface
- field strength peaks while EPM is on
- high strength and uniformity across the surface



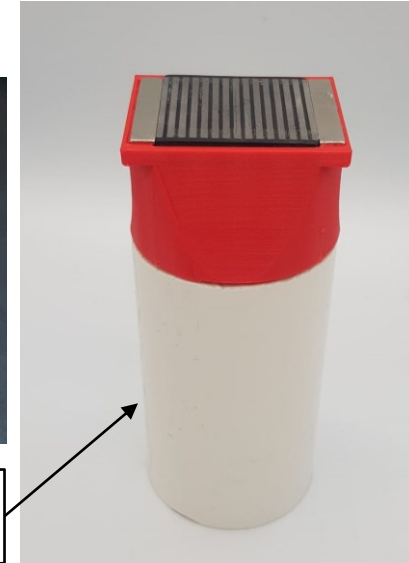
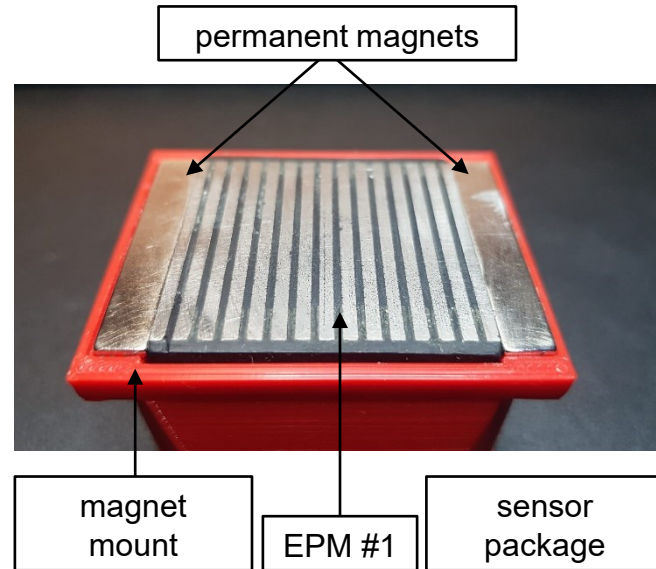
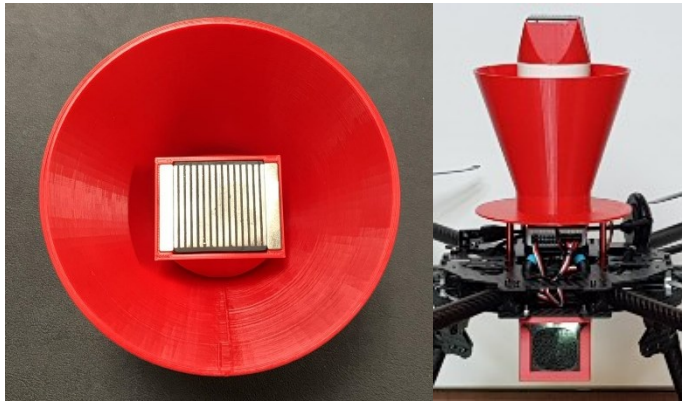
Magnetic pull strength:

- load cell and displacement sensor
- EPM is lowered onto the ferromagnetic surface
- pull force per distance in kg/mm is recorded
- detachment force is 5 kg



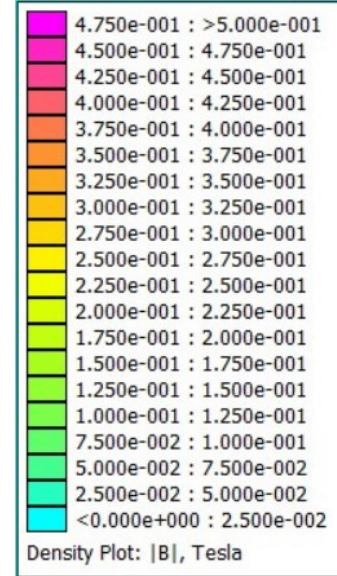
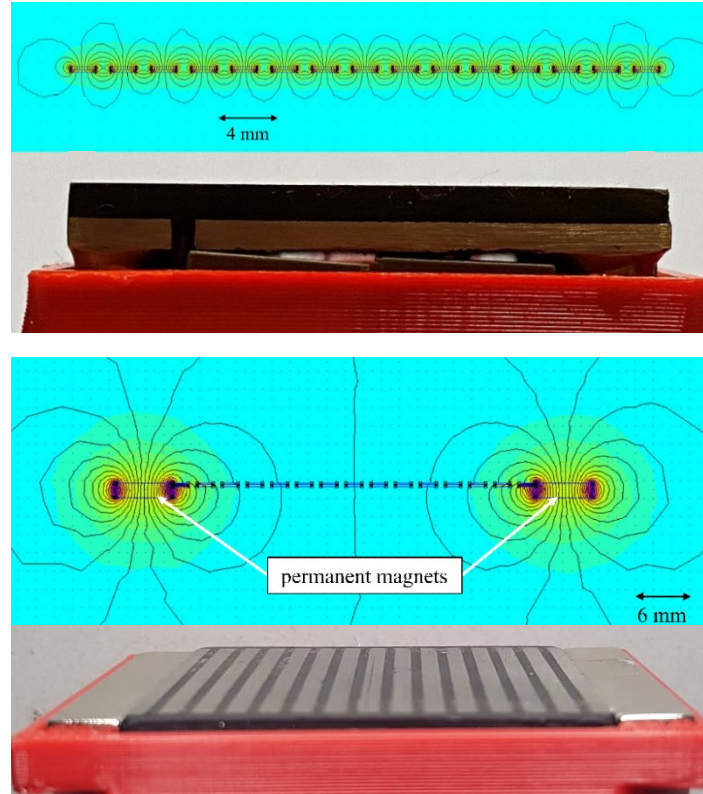
Proposed magnet design:

- NdFeB Grade N42 permanent magnet bars
- dimensions: 40 x 6.35 x 1.6 mm
- placement: parallel to EPM bars



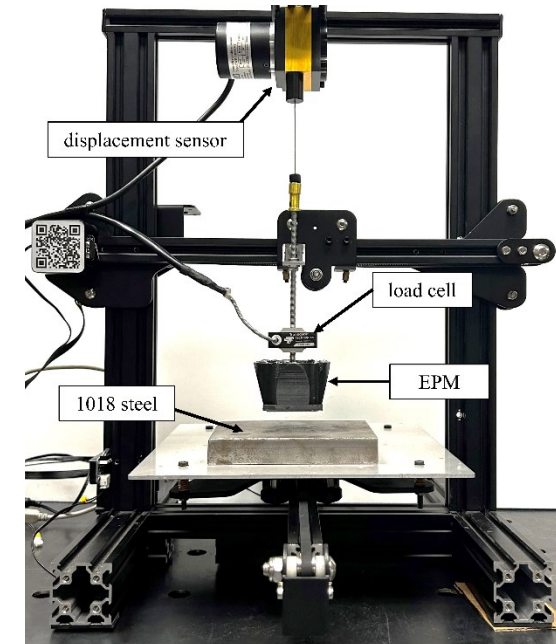
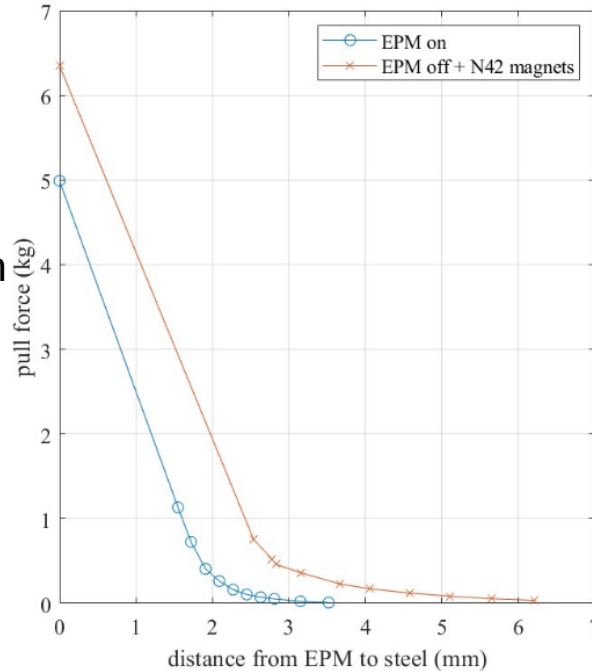
Finite element method magnetics:

- magnetic field geometry is compared
- permanent magnet configuration increased field range
- simple solution without the need for additional power

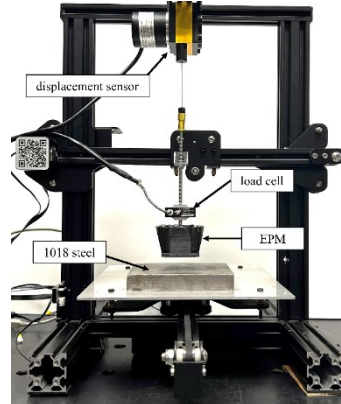
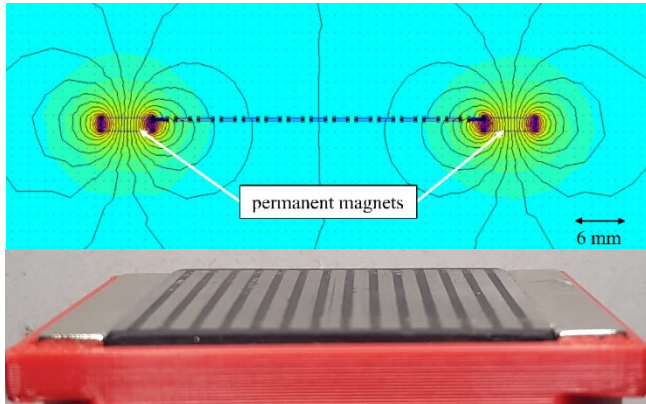
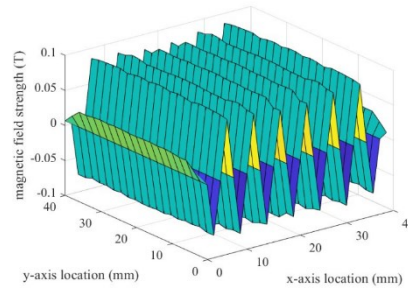


Force vs distance curves:

- additional 6.4 kg of pull force are added
- field range extended from 3 mm to over 6 mm
- total added weight is 5.8 g
- total pull force is 11.4 kg



- UAV field deployment with modified magnet design



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Thank you for listening

Questions?



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