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A Superconducting Linear Variable Reluctance Machine for Urban Transportation Systems

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Abstract –This paper presents a superconducting linear variable reluctance machine for the urban transportation application. The primary of the proposed motor adopts of a segmented configuration and houses both the copper armature winding and the high-temperature superconducting (HTS) field winding. The secondary consists of iron core only without no excitation sources. The proposed machine is analyzed and evaluated by the finite element method. The force characteristic is extensively analyzed. Using the modular design, the force ripple can be suppressed to 5.5% which is desirable for the urban transportation systems.

I Background

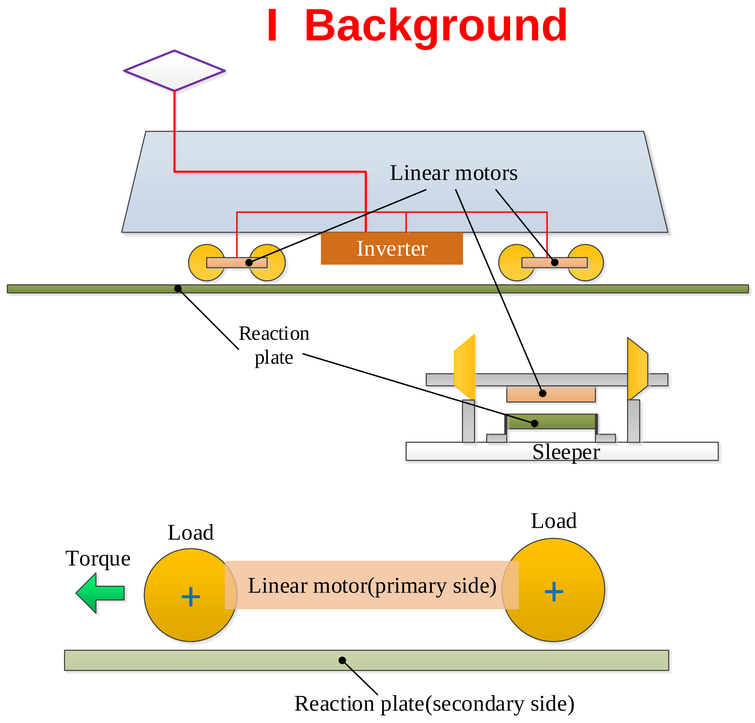

Figure 1. Urban transportation system based on linear drives.

II Motor Design

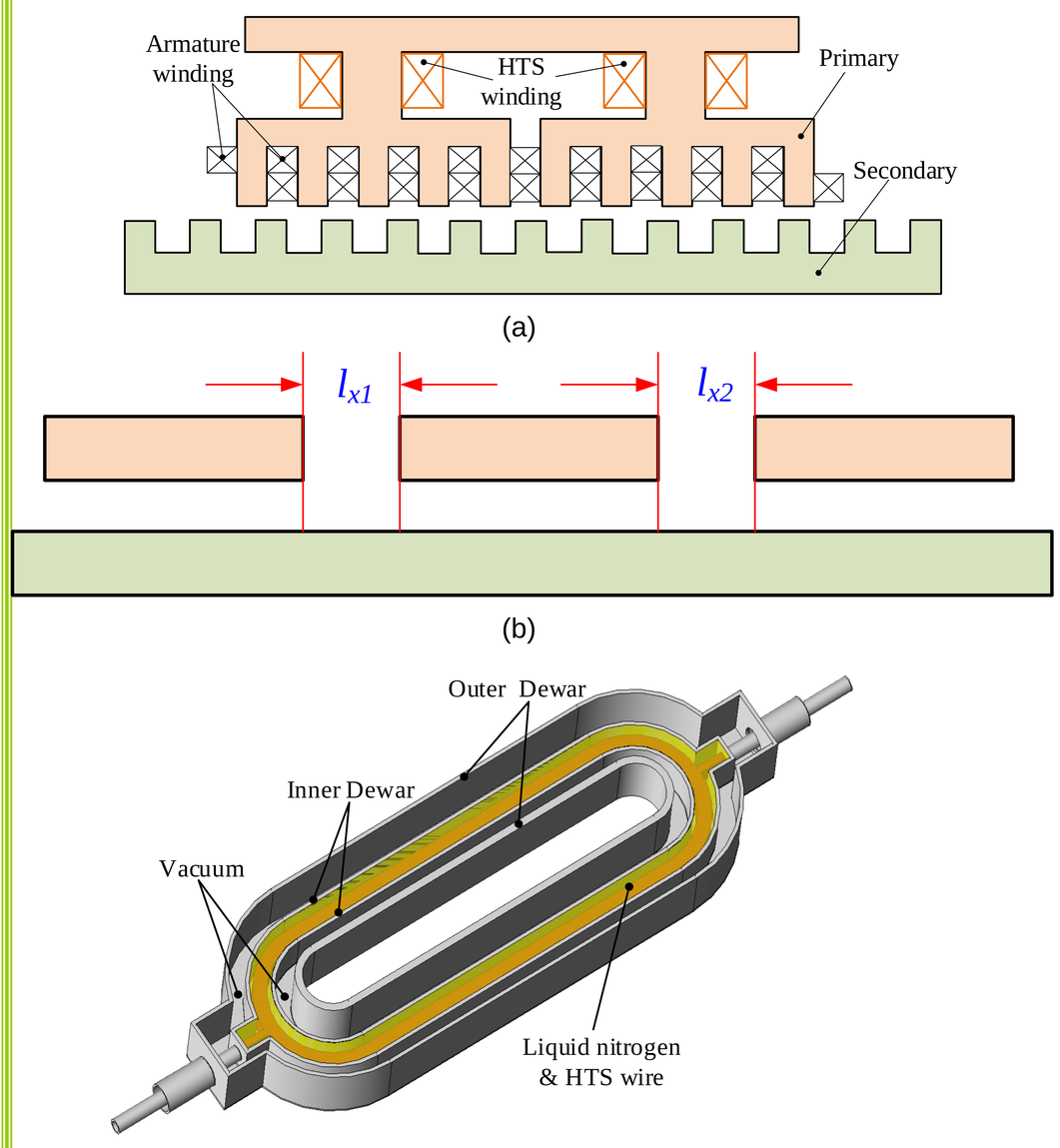

Figure 2. Proposed HTS linear machine. (a) Modular mover segment. (b) Mover having 3 modular segments. (c) Cooling Dewar.

- Short primary and long passive secondary
- HTS field winding and copper armature winding on the primary side
- Segmented primary for minimizing the force ripple
- Flexible flux control via the HTS field winding

III Results

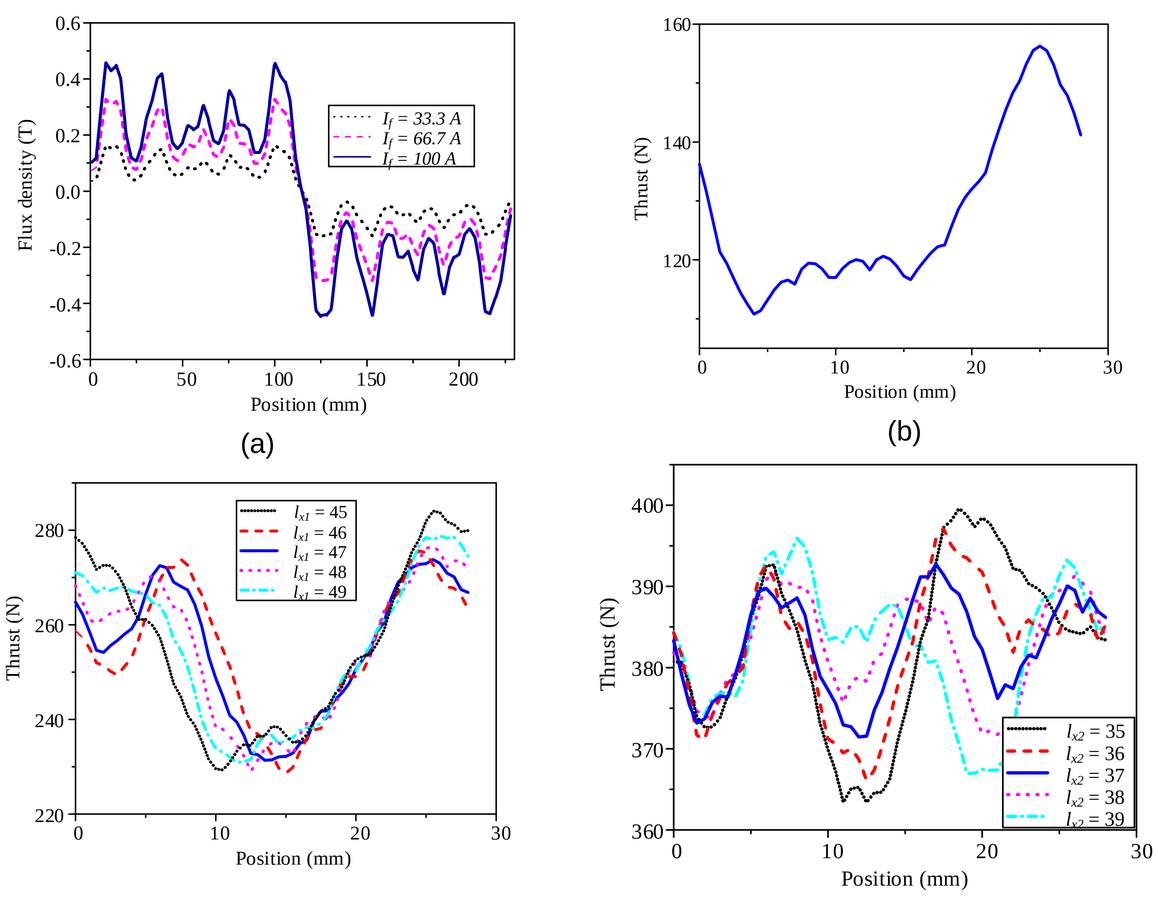

Figure 3. (a) Air-gap flux density under different excitations. (b) Thrust of one module of the mover. (c) Thrust of two modules of the mover. (b) Thrust of three modules of the mover.

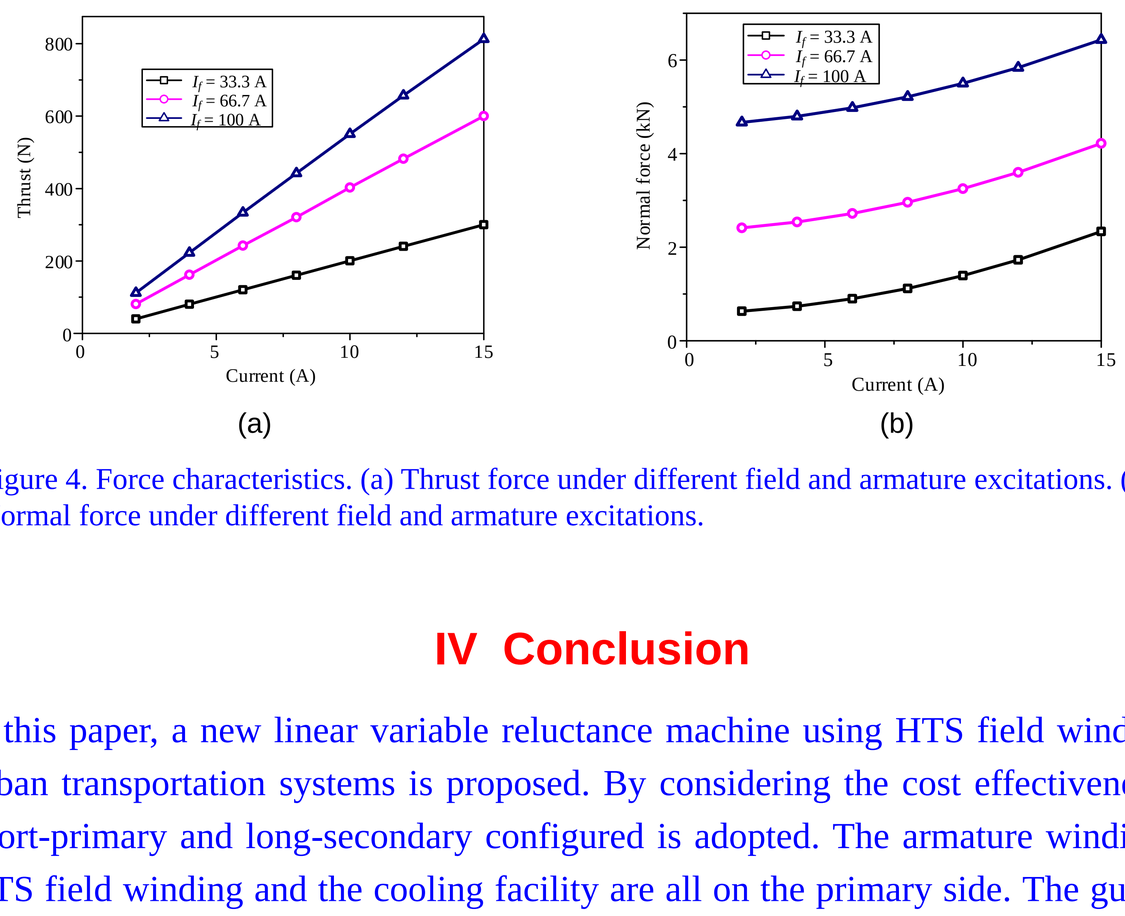

Figure 4. Force characteristics. (a) Thrust force under different field and armature excitations. (b) Normal force under different field and armature excitations.

IV Conclusion

In this paper, a new linear variable reluctance machine using HTS field winding for urban transportation systems is proposed. By considering the cost effectiveness, the short-primary and long-secondary configured is adopted. The armature winding, the HTS field winding and the cooling facility are all on the primary side. The guideway is passive with the magnetic iron core. In order to minimize the thrust ripple, the primary is segmented into three identical modules. By fine tuning the separation of three modules, the thrust ripple is reduced to **5.5%.** Since the DC current in the HTS field current can be preciously controlled, the thrust force and the induced voltage of the proposed machine can be easily controlled. It is very useful to control the vehicle for different operations such as startup, acceleration, cruise and deceleration.

Note: More details please refer to the full paper or contact with the author via wlli@eee.hku.hk

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