ETH zürich

Center for Sustainable Future Mobility (CSFM)

Overview of technologies feasibility for overhead line end-of-energization detection

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Introduction

The aim of the project is to evaluate different technologies for **detecting the end** of energised overhead contact lines. The detection of the end of the energised line is of particular importance for the **safe operation of the pantograph,** which is responsible for the current collection on the train. The following four detection technologies have been considered and their suitability for detecting a given overhead contact line arrangement has been analysed.

1. Detection through electric field

The **presence of voltage** on an energised contact line generates an electric field. The end of the line produces a field **gradient**, and these field strength variations can be measured at the **surface of the train.** However, there are **limitations** to end of line detection by electric field:

- Electric field **disturbances** (natural: atmospheric and human-made)
- Sensing **accuracy** (technology limitations)

Representation of a train approaching the end of an energised line and the electric field gradient at the surface.

2. Detection through magnetic field

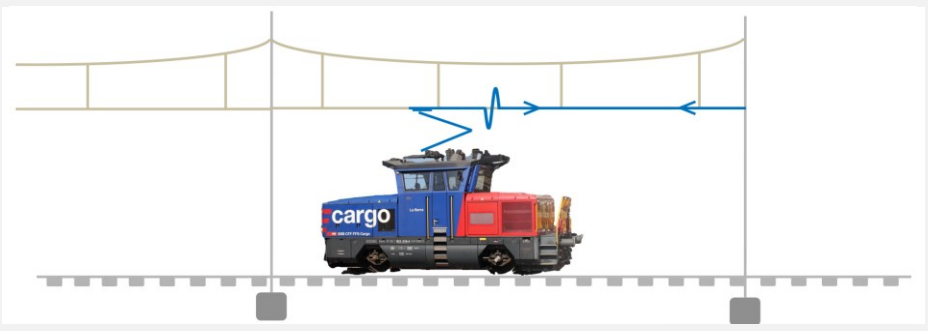
The train power supply **current**, conducted by the contact line and collected by the pantograph, generates a measurable **magnetic field**. However, magnetic end-of-line detection has the following limitations:

- Current **return path** (equal magnetic field with and without end)
- **Current distribution** over length (line impedance and other trains)
- Magnetic field **sensing** (noise limitations)

Simplified representation of the detection method of the contact line end by means of the magnetic field.

3. Detection through high frequency reflection

When a **high frequency signal** is injected into the overhead contact line from the pantograph, a change in the transmission medium will **reflect** part of the signal and this can be used to detect the end of the line. However, the interaction between all the elements of the line, together with the return path of the power supply, are a major limitation of this method.



Simplified representation of the method of contact line end detection by means of the high frequency reflection.

3. Detection through optical means

The end of the contact line can be detected by **optical means**, detecting the **discontinuity** of the line and the elements associated with the end of the line. The method is more mature and commercial products are available that provide comparable functionality.

Commercial visible and infrared vision system for track detection. Reference [1], [2]

Conclusions

In this work, four means of **detecting the end of the energised contact line** have been analysed: by **electric** field, by **magnetic** field, by **reflection** of a high-frequency signal, and by **optical** means. The suitability for **implementation** has been considered, aiming towards **optical means**.

References

1. Rail Vision, “Intelligence on track.” https://railvision.io
2. Knorr-Bremse, “Digitalization: Knorr-bremse and rail vision to test obstacle detection systems on swiss operator sbb cargo’s locomotives.”

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