

AI and UAV Navigation near Powerlines

What if drones could independently monitor and inspect powerlines?

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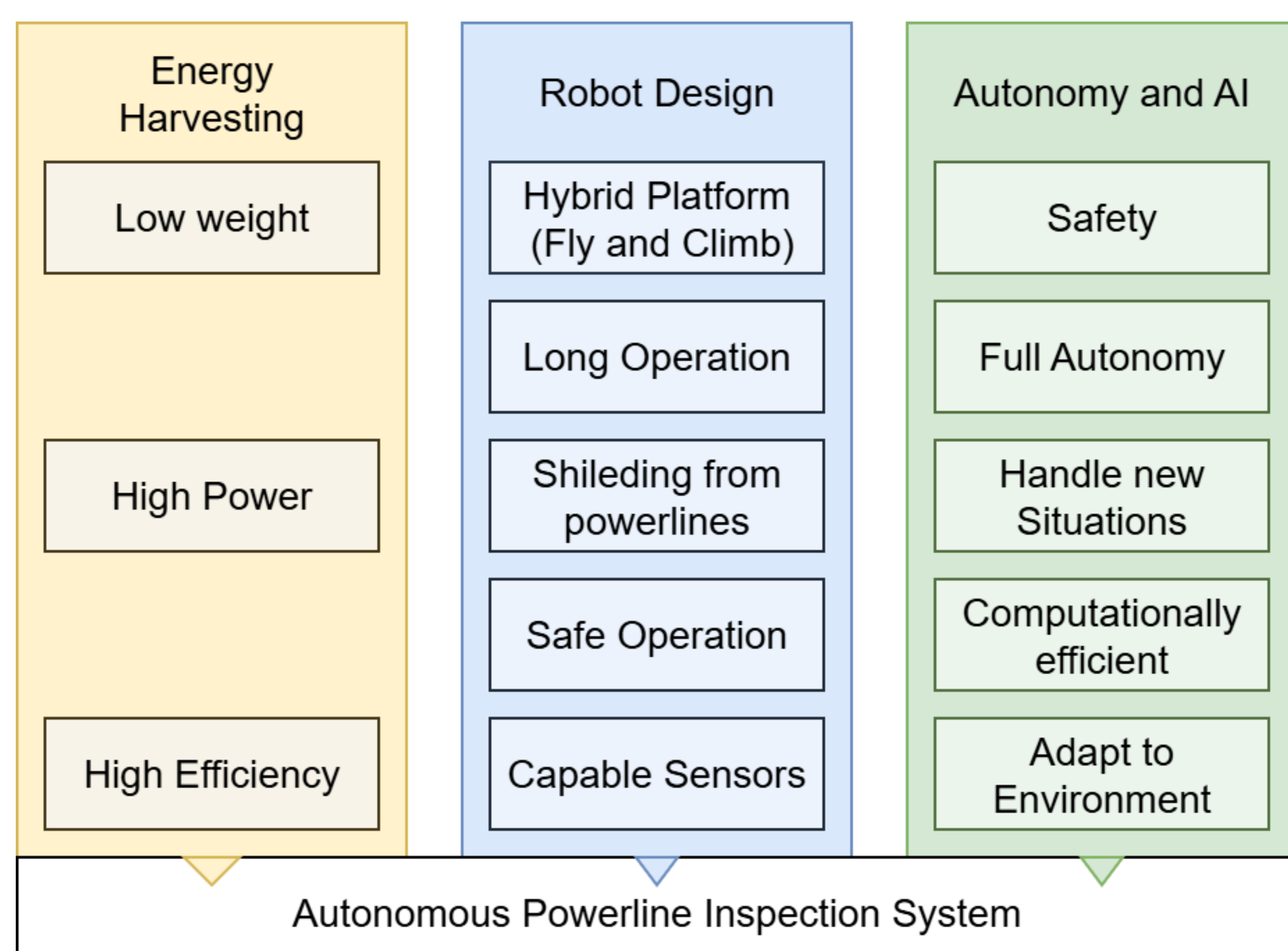
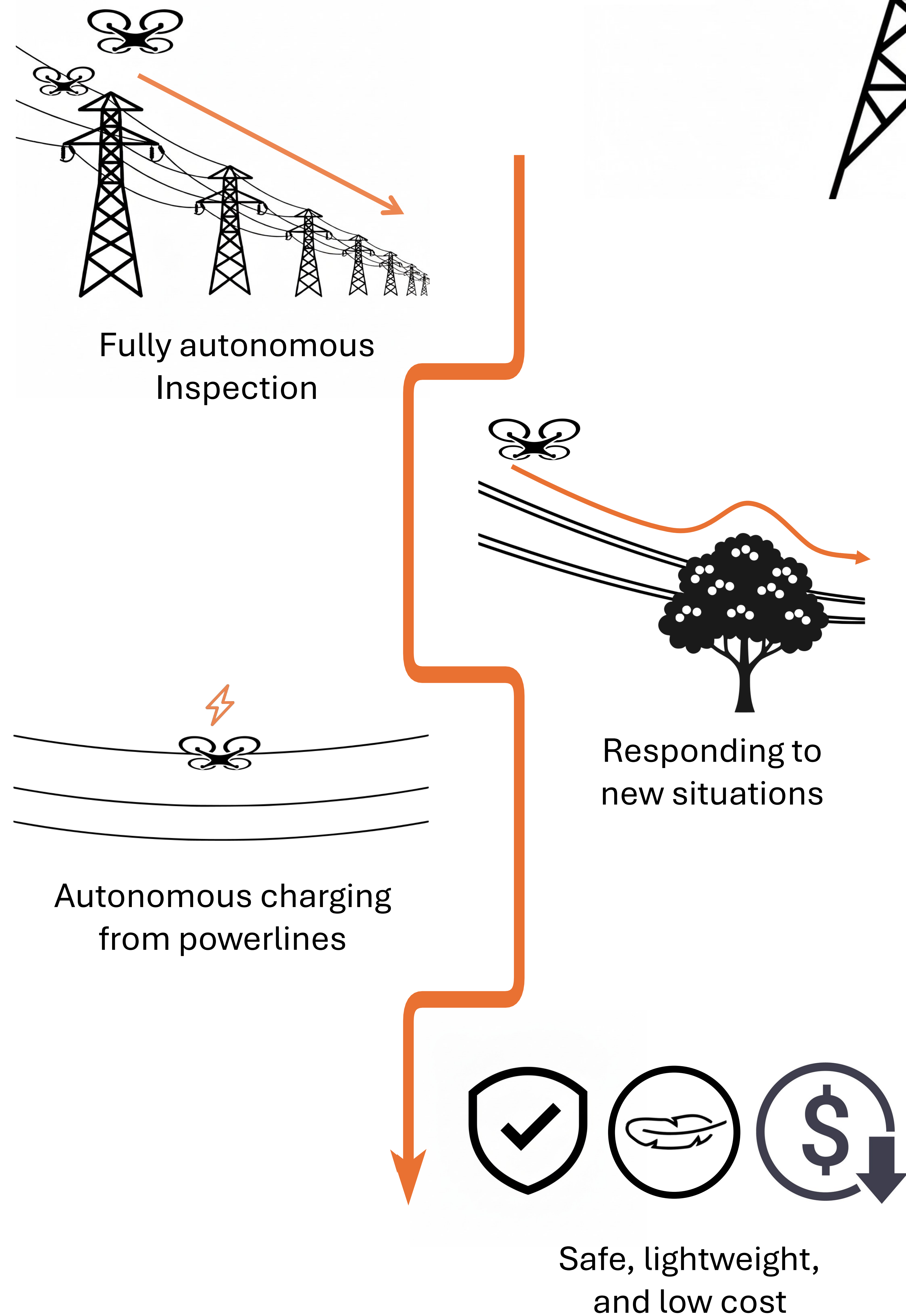
1. Background

Europe has approximately 500,000 km of high-voltage powerlines [1], requiring regular inspection to prevent failures with catastrophic consequences [2]. Manual inspection is labour-intensive, and current inspection drones still require human pilots [3]. Existing automated methods mainly detect faults after failure [4], so an autonomous inspection system is needed. Climbing robots provide safe operation but are limited in scope; aerial robots are mobile but harder to control and have short flight time [5, 6, 7]. A hybrid design could combine the strengths while reducing the limitations. This PhD aims at combining recent advances in AI [8], embedded systems [9], and energy harvesting [10] to develop an energy-independent, autonomous, and safe inspection system.

2. Objectives

This PhD aims to develop a low-cost, autonomous powerline inspection system that is safe, efficient, and adaptable. Research focuses on three pillars:

- 1. Robot Design:** Build a robust, durable, hybrid platform capable of both flying and climbing on a powerline. Maximize efficiency with high flight time, minimal recharging time, protective shielding from sparks, and advanced sensors.
- 2. Energy Harvesting:** Develop lightweight, high-power solutions to charge from high voltage powerlines
- 3. Intelligence & Autonomy:** Enable full autonomy, safe operation, adaptability to new situations, and efficient algorithms on limited hardware.



3. Methodology

This PhD applies a bottom-up strategy, in which system pillars will first be independently before integration. An iterative process with rapid prototyping will be employed to ensure quick results, early feedback, and efficient progress. Existing research and prior work will be leveraged wherever possible to avoid redundancy and strengthen the overall contributions. The planned tasks include: surveying the state of the art, climbing and flying actuation modes, shielding and mechanisms for safe operation, efficient localization along the powerline, situation assessment and decision-making, and adaptability and learning. These tasks are interconnected, so feedback loops between them will support iterative improvement.

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