

P²-Loc: A Person-2-Person Indoor Localization System in On-Demand Delivery

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On-demand delivery is a fast developing business where gig couriers deliver online orders within a short time from merchants to customers. Couriers' accurate indoor locations play an essential role in the business. Most of the existing indoor localization methods cannot be applied in practice due to the high cost or data unavailable on off-the-shelf smartphones. This paper explores a new angle to solve the problem in a *relative and infrastructure-free* fashion. We design a person-to-person localization system that can (1) detect encounter events via Bluetooth on couriers' smartphones, and (2) infer couriers' relative locations to all the indoor merchants via deep learning on a graph neural network. The system is infrastructure-free, map-free, and compatible for off-the-shelf devices. We deploy the system on a real-world industry platform. The system runs on the smartphones of 4,075 couriers around 79 merchants for a month. The evaluation in a mall area shows that P²-Loc improves the mean average error compared with state-of-art infrastructure-based, report-based, and encounter-based methods. We also use an application analysis based on real-world orders and trajectory data to show that the P²-Loc can save around \$40,000 for the platform every day with improved indoor localization results.

CCS Concepts: • **Human-centered computing** → **Ubiquitous and mobile computing design and evaluation methods**.

Additional Key Words and Phrases: Indoor Localization, Graph Learning, On-Demand Delivery

ACM Reference Format:

Yi Ding, Dongzhe Jiang, Yu Yang, Yunhuai Liu, Tian He, and Desheng Zhang. 2022. P²-Loc: A Person-2-Person Indoor Localization System in On-Demand Delivery. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 6, 1, Article 9 (March 2022), 24 pages. <https://doi.org/10.1145/3517238>

1 INTRODUCTION

Nowadays, on-demand delivery [14, 16, 79, 86] is an emerging business for Gig Economy [33] where gig workers deliver orders (e.g., food) within a short time (e.g., 30 minutes) from merchants to customers. This business grows rapidly with several on-demand delivery platforms worldwide (e.g., DoorDash [17] and Eleme [16]).

To achieve timely delivery, couriers' real-time localization is one of the indispensable supporting services involving all the stakeholders including couriers, merchants, customers, and platforms such as courier navigation [85],

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2474-9567/2022/3-ART9 \$15.00

<https://doi.org/10.1145/3517238>