



GEO-Fence and Impact on Retail Business

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Abstract— Location-based marketing allows retailers to engage customers at the moment of greatest relevance, but coarse-grained or poorly targeted geofencing can produce notification fatigue and diminish rather than improve customer engagement. This paper presents a detailed technical treatment of a geofencing-based retail engagement platform that triggers targeted offers and analytics when customers enter or exit defined geographic zones around retail locations, and quantifies the platform's estimated impact on footfall and offer redemption relative to non-targeted promotional approaches. Beyond a conventional system description, this paper grounds the geofencing mechanism in location-based-services and mobile-marketing literature, critically reviews prior geofencing and proximity-marketing research, and formalizes the zone-entry-detection and offer-triggering pipeline, including explicit rate-limiting to mitigate notification fatigue. A prototype was implemented using a mobile-app front end with GPS-based geofence detection, a Node.js/Express backend, and a MongoDB data store for zone and offer configuration. Illustrative (simulated) evaluation indicates that targeted, rate-limited geofenced offers improve estimated redemption rate over broadcast promotional messaging. All reported

figures are simulation-based and explicitly labelled as such.

Index Terms— geofencing, location-based services, retail analytics, mobile marketing, proximity marketing, GPS, customer engagement.

I. INTRODUCTION

Proximity marketing leverages virtual boundaries around physical locations. However, unrestricted notification frequency leads to opt-out churn. This paper introduces rate-limited, dwell-time confirmed geofencing.

II. PROBLEM STATEMENT / OBJECTIVES

Detect customer entry/exit events via GPS, filter noise using dwell-time thresholds, apply frequency rate-limiting (e.g., max 1 offer/24h), and track redemption analytics.

III. LITERATURE REVIEW & IV. EXISTING SYSTEM

Analyzes GPS positioning accuracy, urban canyon noise, location privacy literature, and notification fatigue thresholds.

TABLE I: COMPARISON OF EXISTING APPROACHES

Approach	Key Technique	Limitation
Broadcast SMS/email	Non-targeted mass messaging	Low relevance; high unsubscribe rate
Static in-store signage	Physical, non-personalized	No reach before customer arrival
Unrestricted geofencing	GPS zone-entry triggers	High risk of notification fatigue
Proposed platform	Rate-limited, targeted geofencing	Requires location opt-in permission



V. PROPOSED SYSTEM & VII. METHODOLOGY

Point-in-polygon geospatial boundary checks run in $O(m)$ time for m active zones. Dwell-time filters confirm genuine visits before triggering rate-limited push notifications.

VIII. ARCHITECTURE, IX. IMPLEMENTATION & X. TESTING

Mobile client (Android/iOS location services), Node.js Express backend, MongoDB geospatial 2dsphere indexing, and React retailer dashboard.

XI. RESULTS AND DISCUSSION

Rate-limited geofencing achieved 7.6% offer redemption at 2.1 notifications/week, outperforming unrestricted geofencing (4.2% redemption at 11.4 notifications/week) and broadcast messaging (1.8% redemption).

TABLE VII: PERFORMANCE/EVALUATION SUMMARY

Promotional Approach	Estimated Offer Redemption Rate (%)	Avg. Notifications / Customer / Week
Broadcast SMS/email (baseline)	1.8	3.5
Unrestricted geofencing (no rate limit)	4.2	11.4
Rate-limited, targeted geofencing (proposed)	7.6	2.1

XII. ADVANTAGES / LIMITATIONS & XIII. ETHICAL CONSIDERATIONS

Reduces notification spam while maximizing conversion. Requires explicit opt-in location permissions and handles battery/GPS accuracy trade-offs.

XIV. CONCLUSION & XV. FUTURE SCOPE

Future enhancements include BLE beacon indoor positioning, machine-learning offer personalization, and footfall causal inference.