통행량 실시간 분석을 위한 보행자 통행 패턴 관리시스템

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Pedestrian Management System for Real-time Pedestrian Detection

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Abstract

Pedestrian management system dedicated to the pedestrian flow passing through a F-pad is proposed. Existing techniques perform on structured environments, but still have problems detecting pedestrian pattern. This paper presents an approach using an Adaptive-DBSCAN and a Pedestrian Algorithm in real-time system. The Adaptive-DBSCAN is a new density-based clustering algorithm, which is based on DBSCAN. Furthermore, we propose the Pedestrian Algorithm to detect pedestrians effectively. So the pedestrian management system can be applied to real application with higher accuracy to count in real time.

1. Introduction

The field of pedestrian management system, PMS, is concerned with extracting useful information about the number of pedestrian, by analyzing pedestrian pattern. An accurate detecting of pedestrian flow is attractive for the entry control, building security and commercial applications. The early detecting systems are using infrared sensors and cameras with clothes color or pedestrians or the number of pedestrians' head [1]. There are, however, inherent problem of tracking pedestrian pattern to outdoor environment. Also they could not detect the passing pedestrian accurately unless there is only one pedestrian through the system at one time. Since these environments typically allow for tracking and detecting pedestrian pattern with cameras, the analysis results are equally unstructured [2].

One dominant factor contributing to unstructured detecting results is time. Thus, one solution to this problem is to consider real time while pedestrians are walking. In this paper, we present an Adaptive-DBSCAN and a Pedestrian Algorithm in real-time operation to solve the problem. It is based on a pedestrian foot pattern, each measured on a F-pad, which is IoT blocks of the pavements with switch sensors. Based on these patterns, a number of foot patterns can be applied to compute the relative distance between any two cases. Finally, the Adaptive-DBSCAN algorithm can be applied, grouping closely related cases into clusters. These clusters can subsequently be analyzed independently from one another, which improve the quality of counting results significantly. Furthermore, this paper addresses the problem of determining the number of pedestrians passing through the F-pad. By a four-stage counting strategy, the Pedestrian Algorithm can be used to measure the number of pedestrians to extend known detecting algorithms and overcome the inherent problem, which is not considering real time.

This paper is organized as follows. The following section will describe the proposed pedestrian detecting system including the Adaptive-DBSCAN and the Pedestrian algorithm.

2. Main features of Adaptive-DBSCAN algorithm

In this section, we explain the Adaptive-DBSCAN algorithm. We first explain the original DBSCAN algorithm and its limitation. Then we describe clustering techniques used in this paper.

2.1 Problem for DBSACN application to PMS

In general, Density-based spatial clustering of applications with noise (DBSCAN), which is a data clustering algorithm, is one of the most common clustering algorithms in scientific literature. It is a density-based clustering algorithm: given a set of points in some space, it groups points that are closely packed points of many nearby neighbors to cluster with two parameters: the

minimum number of points and the diameter from center [3].

One drawback of this algorithm is that they also capture used points before clustering and it occurs obscure clusters while time shift. As shown in Fig 1., the original DBSCAN keep grouping points that are observed in consecutive time units. Let C1 and C2 be the clusters of the points and let t1 and t2 be a certain time. At t1, there are some points that are merged within clusters such that C1 and C2. After passing to some extent of time which is at t2, there are more points and these are merged within in C2 although they would be in different cluster. It shows that the original DBSCAN have not dealt with grouping clusters separately when time is shift.

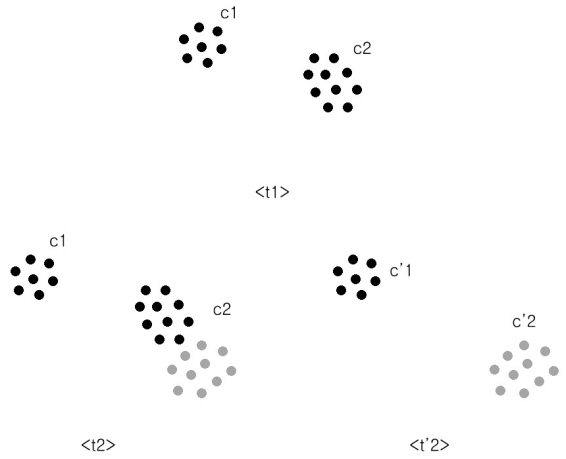

Fig 1. Data set example of the original DBSCAN.

2.2 The adaptive-DBSCAN

In the proposed system, clusters are foot pattern of pedestrians. However, it is plausible to group points to unstructured clusters as mentioned above. Pedestrian foot pattern would be gone when pedestrian past through F-pad. The proposed clustering algorithm, the Adaptive-DBSCAN, makes a new cluster without clustered points to resolve the above problem. As shown in Fig 1, the adaptive-DBSCAN groups points without clustered points. Let C' 1, and C' 2 be the clusters of the points and let t' 2 be a certain time past from t1. At t' 2, without clustered points, points are merged within a cluster, C' 2, using the Adaptive-DBSCAN.

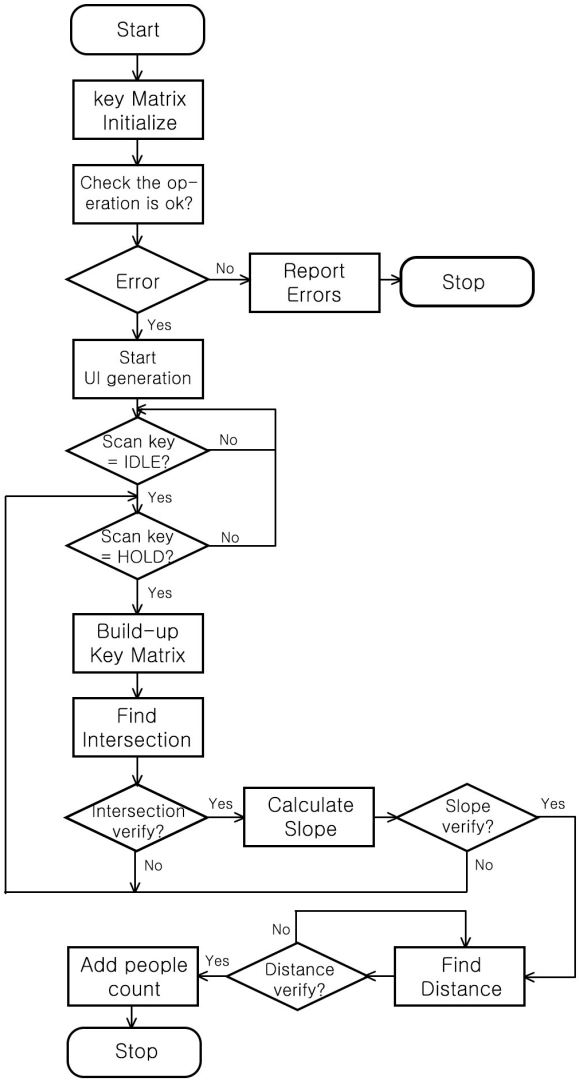

Fig 2. The Pedestrian Algorithm: counting algorithm for the pedestrians passing through F-pad

3. Pedestrian Algorithm

In this section, we explain the Pedestrian algorithm. In the proposed system, F-pad is set on the ground so that the foot pattern of passing pedestrians will be observed. To achieve a detecting for the pedestrian passing through the F-pad, the proposed algorithm is described in Fig 2. In the proposed algorithm, there are 4 conditions to determine how many pedestrians are passing.

3.1 Details of pedestrian foot patterns

In general, based on the F-pad, there are four foot patterns to be extract such as PRESSED, HOLD, RELEASED, and IDEL. These four patterns are considered to be able to provide how many pedestrians being contained in the patterns. It

can support information for tracking and discriminating between pedestrians when they pass F-pad. When a pedestrian walks through F-pad, one foot got four patterns, which is PRESSEND, HOLD, RELEASED, and IDEL in a row. Before one foot releasing, the other foot presses F-pad. In other words, IDEL pattern on one foot and HOLD pattern on the other foot might be a condition to match foot patterns, which is a pedestrian. Thus, distinguishing patterns for discriminating pedestrians are extracted for analyzing each moving foot.

3.2 Decision for pedestrian classification

In order to determine whether a set of patterns is suitable enough to be considered a pedestrian or not, we need an intersection (Px, Py) among HOLD points, IDLE points, and each end points of a counting line by the following equations Fig 5. The counting line is a middle line on the F-pad to decide that a pedestrian passes F-pad.

$$(\mathrm{Px},\mathrm{Py}) = \left(\frac{(x_1y_1 - y_1x_2)(x_3 - x_4) - (x_1 - x_2)(x_3y_4 - y_3x_4)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)}, \right.$$
$$\left. \frac{(x_1y_1 - y_1x_2)(y_3 - y_4) - (y_1 - y_2)(x_3y_4 - y_3x_4)}{(x_1 - x_2)(y_3 - y_4) - (y_1 - y_2)(x_3 - x_4)} \right)$$

Fig 5. Formula of intersection with four points

where (x_1, y_1), (x_2, y_2) are each end points of counting line, and (x_3, y_3), (x_4, y_4) are HOLD point and IDLE point. Final (Px, Py) is obtained by applying the nearest point, which is [Ceil(Px+0.5), Ceil(Py+0.5)]

3.3 Decision for directional movement

In the tracking process, if one foot that has IDLE pattern put on F-pad, then the other foot that has HOLD pattern could be derived in range of 45 degrees. In the proposed algorithm, we present 60 degrees for the range of two foot patterns.

3.4 Decision for minimum distance between two feet

The pedestrian detecting system results are influenced by the minimum distance measures. In this step, we explain the minimum distance measures that can be used in the algorithm. Based on the result of above conditions, the distinguishing foot pattern is extracted by Delaunay Triangulation Algorithm. The above four conditions are sufficient to count pedestrians for most of the general situations through F-pad.

6. Conclusions

Pedestrian detecting system could deliver valuable results into the number of passing pedestrians in real-time system. In this paper, we have presented a pedestrian detecting system, which can effectively track pedestrian patterns dedicated to passing through the F-pad. The early detection method of pedestrians could track when pedestrians pass through a gate or door in a certain time. However, we have introduced the concept of the Adaptive-DBSCAN and the Pedestrian Algorithm, which extract valuable patterns real-time operation. Based on the two proposed algorithms, inherent problems, which is that pedestrians should walk through indoor environment and at a certain time, can be overcome. Therefore, the proposed pedestrian counting system will be more effective than other counting systems.

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