Video Stitching with Localized 360° Model for Intelligent Car Parking Monitoring and Assistance System

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Abstract

Exploring the new avenues in the domain of video surveillance is a key aspect to maintain a secure environment by enabling several monitoring and security systems having ranges from home solution to border surveillance. Combining multiple cameras view to integrate one large view is far better than looking at each view individually. Car parking is a critical and time-consuming issue in congested cities. This study proposed a model to monitor and assist for car parking by stitching multiple videos and creating a 360 degree localized view. A complete model is proposed and steps are defined for each module including video acquisition, stitching and 360 degrees localized view. A single view is created from all individual cameras. When a car enters into a parking area, the driver is to be guided towards free slot by proposed monitoring and assistance system.

Key words:

Video Stitching, 360-degree view, Car Parking, Monitoring and assistance

1. Introduction

It is well concluded that an image is worth more than ten thousand words, while a video is worth more than ten thousand sentences. A video is a tool to capture the real-time world around us, which also plays an important role in education, entertainment and training. In the last decade, digital video processing got extensive attention in research. The hardware technologies and good standard activities are matured enough that it is now feasible to process, transmit, store, view and share between different platforms and applications.

Image-stitching combines multiple images to create one big image. It is the process of combining several images and removes overlapping fields and produces one big image. It is an idea to obtain an integrated image from multiple images by removing redundant information. Video stitching is facing many new challenges as compared to image stitching. Multiple videos are stitched together and create one video called panoramic video. It can be used for several purposes such as car parking, objects monitoring, shopping malls etc. In this work, it is used for intelligent car parking monitoring and assistance.

It is a time-consuming process to search space for your car in the car parking area which affects your business and social life [1]. It is also risky to leave your vehicle in the car parking because a vehicle can be scratched or damaged in car parking and no one will know how it has happened. Human errors are also the key elements in traffic accidents. Every car does not have the facility to see its surroundings. A video-based intelligent car parking monitoring and assistance is proposed. The vehicle is continuously monitored through video and also video-based assistance will be provided to the driver to see its surroundings and how and where he/she should park.

There are multiple fixed and dedicated cameras to capture the entire vehicle parking area. A panoramic video stitching will be used to combine the output of all cameras and produce one full panoramic view of entire parking in real time. The previous panoramic video stitching has some shortcomings such as low visual quality, poor performance, less number of videos stitching and lack in the monitoring of blind areas.

Our proposed solution assumes that the car parking area is rectangular and it can be completely captured with six cameras in a 2x3 matrix shape. All the cameras are attached with a network server computer. The input video streams are stitched together to produce one full panoramic video having good visual quality and high performance, which will be then used for monitoring and assistance. It is an intelligent system because it also informs us how many parking slots are occupied and how many are empty. The incoming car will be detected and guided to the nearest empty parking slot through arrows. A localized 360o view will be created for driver monitoring and assistance. This localized view will show surrounding area of the vehicle and it will also move with the car to assist the driver.

2. Related Work

The related work focuses on two parts which are video stitching and localized 360° view creation. The concept of the materialized view will help to produce a 360° degree localized view.

2.1 Videos Stitching

Image stitching is a mature topic. The researchers have worked a lot. There is much software that can stitch images

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very easily just by clicking such as Image Composite Editor by Microsoft, panorama studio and panorama maker etc. On the other hand, there is a lot to do in real-time video stitching. It is a hot research topic since the last decade [2]. It is also discussed with real-time preview in [3]. There are also mature software products available to create panorama view such as Windows Phone 8, Apple iOS 7, Canon PhotoStitch, Google Android Realviz Stitcher 5. The main problem in panorama stitching is moving objects which create artefacts such as ghost-like the view. Various solutions have been proposed to reduce artefacts. One solution is to have specialized hardware systems which take the images at the same time. Mrotator One-Shot Photographic head produced by Agno's which does the same work but it is expensive and bulky and it is designed for the high-end professional task and not for the consumer applications.

The author in [4] generated video panorama which works at real time and has commonly accepted standard but it can combine only two video streamings. A panoramic video is generated by stitching three video streaming in [5]. Real panorama video stitching is created using 4 cameras which generate 25 fps video [6] but it does not focus on visual quality. Another good performance real-time panorama video stitching is proposed in [7] but it was only using 2 cameras and low-resolution image. High-resolution panoramic video is also produced [8, 9] but it requires expensive and specialized hardware.

2.2 Localized 360º view creation

Materialized view concept of a database is used here. In SQL terminology view is a single table created from multiple tables. It is a virtual table not a physical table. The query runs each time this view is accessed. The physical data will not be updated through this table. It is only used for queering purpose [10]. The materialized view is an object in the database. A new relation can be constructed from the base table through a query. It is disk based table. It is recomputed when any change occurs in the base table [11]. It contains the result of a query. It creates a logical view which has the data from multiple tables located locally or at remote areas. It is found to be very effective and used for commercial purposes [12]. It eliminates the overhead of joins between tables, average, sum, count and other complex mathematical terms. It improves query processing time. Materialized view is also used for image processing in [13]. This study will use the concept of materialized view and produce localized 360º view from the created full panoramic video. The important techniques in feature detection, Matching and blending are proposed.

3. Problem Statement

The previous work has various issues such as low visual quality [6], require expensive and specialized hardware [8,9] and works with less number of cameras [4]. It is also necessary to monitor blind areas in video panorama. There are artefacts which creates ghosting like effects. Erasing these artefacts is computationally hard.

The previous work is mostly related to either panoramic video stitching or car parking software. These are not available in one integrated system. Therefore it is necessary to have a video-based intelligent car parking which can address the issues discussed in the above paragraph and identifying the occupied parking slots, empty slots, nearest empty slots and also identify the new incoming car. It should also assist the driver by providing localized 360º view and direction system.

4. Proposed Solution

This study mainly focuses on multiple videos stitching and also producing a 360º localized view. Our work is first to produce the localized 360º view. This concept will be used to propose a video-based intelligent car parking monitoring and assistance. Empty and occupied car parking space is identified. Incoming car is identified and a localized 360º view is created which will provide assistance to the car driver by showing the surrounding area of the car and guide him or her to the nearest empty car parking place. The system will be connected to the network server. There will be client software installed in other systems. The users can see the panoramic video and localized 360º view in the client software.

The system is divided into four modules such as videos acquisition, videos stitching, intelligent car parking and localized 360º view.

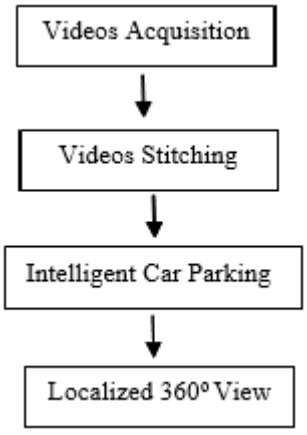

Fig. 1 Four Modules of the proposed model

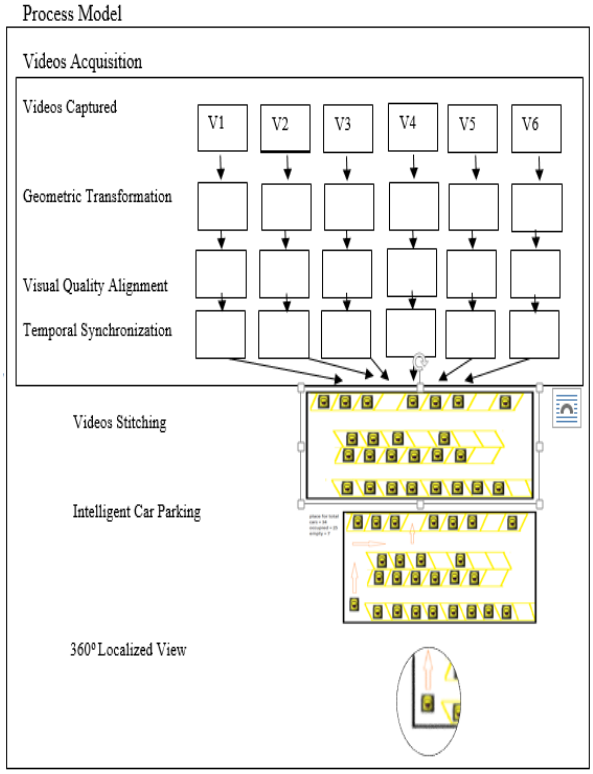

Fig. 2 Process Model as a Whole

4.1 Videos Acquisition Module

This module takes the input video streams from 6 cameras located in 2x3 rectangular matrix shapes. This module has a preprocessing stage. It is used to synchronize accurately videos streams. It has three steps such as Geometric alignment, visual alignment and frame alignment.

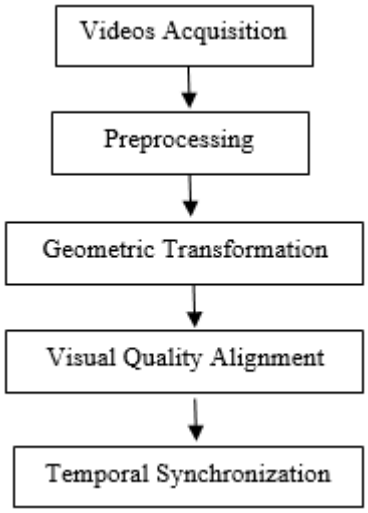

Fig. 3 Proposed Video Acquisition steps

Preprocessing in necessary because optical centres of the cameras may not be exactly at the same location, Visual quality of two videos captured from different cameras can be different and frame timing can be changes which will create artefacts.

Sample videos captured from multiple cameras are given as under:

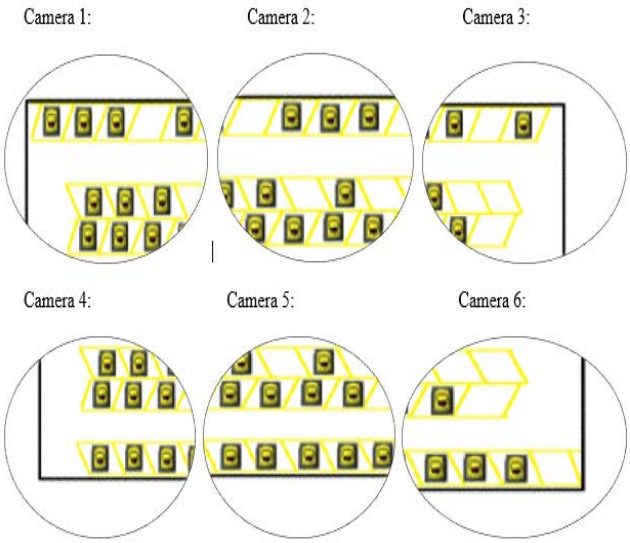

Fig. 4 Individual Camera View

4.2 Videos Stitching

Multiple incoming video streams are stitched in real time and produce one full panoramic view. It has three steps such as feature detection, matching and blending.

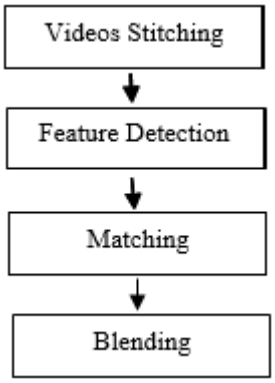

Fig. 5 Proposed Video Stitching Steps

4.2.1 Feature detection

Feature Detection is used to find features or region of interest in the overlapping part of the image. For this purpose ORB detector [14] are used which is oriented

FAST (Feature from Accelerated Segment Test) [15] and rotated BRIEF (Binary Robust Independent Elementary Features) [16].

4.2.2 Matching

RANSAC (Random Sample Consensus) [17] is a probabilistic algorithm. It eliminates outliers to ensure the effectiveness of the matched corner pairs. It finds a good transformation.

4.2.3 Blending

Blending technique is applied across the stitch so that the stitching would be seamless. Multiband blending technique is used to generate final full view panoramic video. Blending technique removed ghost-like effects and smoothened the video.

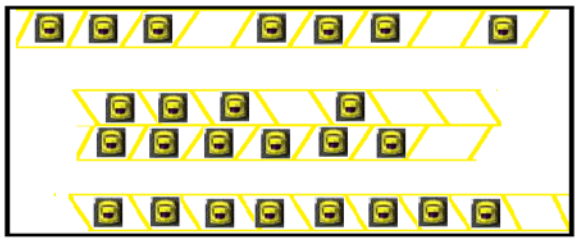

Fig. 6 Car parking view after stitching

4.3 Intelligent Car Parking

Proposals Car parking will direct and guide intelligently. It shows us how many parking slots are empty and how many are occupied. The incoming vehicle and the nearest parking slot are identified. The vehicle is guided to the nearest parking slot through arrows. For further extension one can also use machine learning techniques, GA and SVM for feature selection and classification respectively [18].

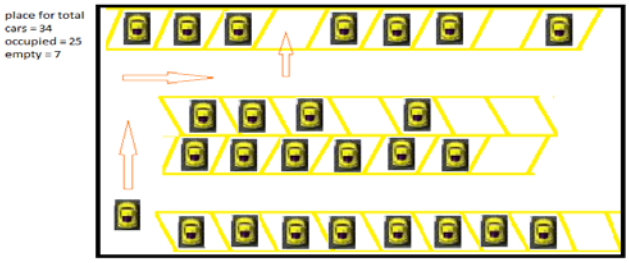

Fig. 7 Intelligent Car Parking view

4.4 Localized 360º View

This concept is taken from the database as discussed in the related work. A separate localized 360º view is created from the existing panoramic video which will assist the driver. This surrounding 360º view also moves with the vehicle.

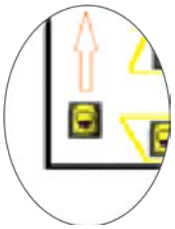

Fig. 8 Individual view

5. Conclusion

It is very difficult for a person to find an empty slot in the car parking within a congested city environment. The proposed study provides monitoring and assistance to both the driver and car parking owner. The car parking area is mostly big and there are multiple cameras installed. In this study, one view is created by integrating the views from all installed individual cameras. When the driver enters in parking area he can get the view of whole parking area. An empty slot is to be identified and then driver is guided to that empty slot through arrows according to the proposed model.

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