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Smart and Automatic Car Parking Through Obstacle Detection and Motion Identification

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Abstract:
In this study, we present a new indoor positioning and environment perception system for generic objects based on multiple surveillance cameras. In order to assist highly automated driving, our system detects the vehicle's position and any object along its current path to avoid collisions. A main advantage of the proposed approach is the usage of cameras that are already installed in the majority of parking garages. We generate precise object hypotheses in 3D world coordinates based on a given extrinsic camera calibration. Starting with a background subtraction algorithm for the segmentation of each camera image, we propose a robust view ray intersection approach that enables the system to match and triangulate segmented hypotheses from all cameras. By using ultrasonic sensors we can detect the obstacle location from the vehicle.
Key words: Microcontroller, Ultrasonic sensor, Usb camera, PC matlab, Motor driver, Motors, Buzzer.

I.   Introduction

In this study, we introduce an infrastructural embedded approach for localization and tracking of generic objects for indoor environments. We focus on the example of parking garages to establish a positioning system in the context   of   autonomous driving. Its main target is to detect and track vehicles and secondary objects along its current path. Due to the lack of GPS information and non-sufficient on-board vehicle sensors an infrastructural system which communicates with the   autonomously driving car has to be precise, reliable and real-time capable. If an object crosses the path of   the vehicle,   the system has to raise a warning to avoid a collision. Because arbitrary objects (e.g., other vehicles, small / tall humans, bicycles, or animals) should be recognized by the system, size and shape constraints are ignored. To achieve these aims, we use surveillance cameras already installed in the majority of the parking garages and extend their purpose to an external vehicle localization system. Thus, the approach is inexpensive, does not require additional hardware except the infrastructural car-to-environment communication, and is transferable to other indoor scenarios, e.g., tunnels, factories etc
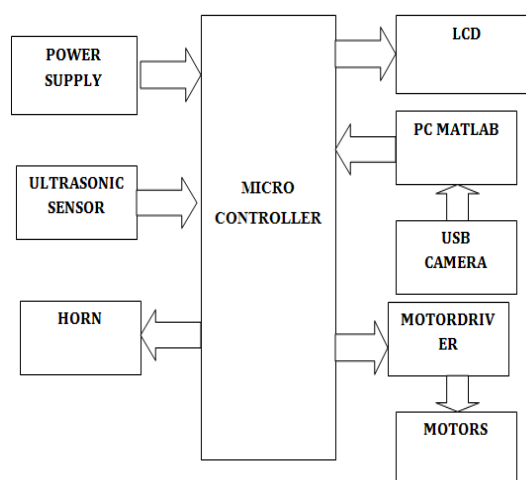

Fig.1.Block diagram

Ultrasonic sensor:
The sensor is primarily intended to be used in security systems for detection of moving objects, but can be effectively involved in intelligent children's toys, automatic door opening devices, and sports training   and   contact-less-speed   measurement equipment.

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Modern security systems utilize various types of sensors to detect unauthorized object access attempts. The sensor collection includes infrared, microwave and ultrasound devices, which are intended to detect moving objects. Each type of sensor is characterized by its own advantages and drawbacks. Microwave sensors are effective in large apartments because microwaves pass through dielectric materials. But these sensors consist of expensive super-high frequency components and their radiation is unhealthy for living organisms.

Infrared sensors are characterized by high sensitivity, low cost and are widely used. But, these sensors can generate false alarm signals if heating systems are active or temperature change speed exceeds some threshold level. Moreover, infrared sensors appreciably lose sensitivity if small insects penetrate the sensor lens. Ultrasound motion detection sensors are characterized by small power consumption, suitable cost and high sensitivity. That it why this kind of sensor is commonly used in home, office and car security systems. Existing ultrasound sensors consist of multiple passive and active components and are relatively complicated for production and testing. Sensors often times require a laborious tuning process.
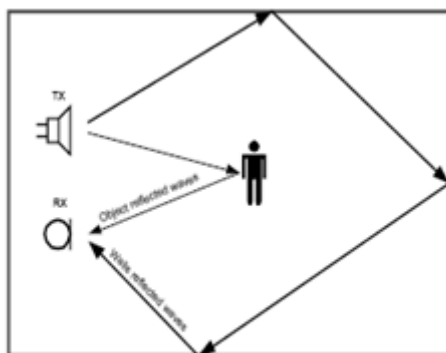
Figure : Basic Sensor Operation Principle

The ultrasound transmitter **TX** is emitting ultrasound waves into sensor ambient space continuously. These waves are reflecting from various objects and are reaching ultrasound receiver **RX**. There is a constant interference figure if no moving objects are in the placement.

Any moving object changes the level and phase of the reflected signal, which modifies the summed received signal level. Most low cost sensors (car security systems, for instance) perform reflected signal amplitude analysis to detect moving objects. In spite of implementation simplicity, this detection method is characterized by a high sensitivity to noise signals. For example, heterogeneous airflows, sensor vibrations, room window and door deformations, and gusts can change the interference figure and generate false alarm signals.

Fig..*Initial Clusters*

Better noise resistance may be obtained if the receive sensor is performing reflected signal frequency analysis instead of amplitude examination. The reflected signal spectrum emulates a Doppler Effect. Frequency components of the moving object speed vector have a component in the direction of ultrasound radiation propagation. Because ultrasound waves reflect from the windows, walls, furniture etc., the sensor can detect object movements in any direction. To implement this principle, the sensor must perform selection and processing of Doppler Effect frequency shift to detect moving objects.

The air condition systems, heat generators, and refrigerators typically include movable parts, which can cause device vibrations that generate high-frequency Doppler components in the reflected ultrasound signal. The heterogeneous variable temperature airflows are characterized by different ultrasound propagation speed that can raise low-frequency Doppler components in the reflected signal. That is why the noise resistant motion detection sensor should limit the Doppler signals' frequency range from lower and upper bounds to satisfactory false-alarm free operation.

The ultrasound motion detection sensor has been developed in compliance with operation principles considered above.

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Conclusion

This study presents an indoor positioning system for generic objects by means of a camera network. Objects are segmented using a background representation. To generate precise and plausible world hypotheses we intersect view rays of these objects and track them in a world representation. We focus on the detection of generic objects of arbitrary size which can be performed without prior training. However, our system is indeed precise enough to locate an object for applications like collision warning. We also want to point out that the proposed system is based on surveillance cameras, a majority of modern parking decks are equipped with. Therefore, it does not require additional hardware expense. In the future, we want to investigate refinements of the image processing pipeline to handle remaining drawbacks we have identified. The effect of strong light sources needs to be reduced by further segmentation methods. The problem of overlapping objects in a single ROI – which occurred in only one camera image – has to be analyzed more deeply and can be solved by extending the proposed triangulation method.

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