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Research Article

Development of Image Processing based Human Tracking and Control Algorithm for a Service Robot

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Abstract

This paper presents an human detection algorithm and an obstacle avoidance algorithm for a service robot that provides a service tracking. The mobile robot will have the ability to follow a human and avoid dynamically moving obstacles in an unstructured outdoor environment. To detect a human by an Image processing, we defined features of the human body in xml file and employed a support vector data description method. In order to avoid moving obstacles while tracking a person, we defined an ultrasonic obstacle sensor, each obstacle using the relative distance between the robot and an obstacle. For smoothly by passing obstacles without collision, a dynamic obstacle avoidance algorithm for the service robot is implemented, which directly employed a real-time position vector between the robot and the shortest path around the obstacle.

Keywords: *Raspberry pi, Ultrasonic sensor, USB Camera*

1. Introduction

Video surveillance has long been in use to monitor security sensitive areas such as banks, department stores, highways, crowded public places and borders. The advance in computing power, availability of large-capacity storage devices and high speed network infrastructure paved the way for cheaper, multi sensor video surveillance systems. Traditionally, the video outputs are processed online by human operators and are usually saved to tapes for later use only after a forensic event. The increase in the number of cameras in ordinary surveillance systems overloaded both the human operators and the storage devices with high volumes of data and made it infeasible to ensure proper monitoring of sensitive areas for long times. In order to filter out redundant information generated by an array of cameras, and increase the response time to forensic events, assisting the human operators with identification of important events in video by the use of smart video surveillance systems has become a critical requirement. The making of video surveillance systems smart requires fast, reliable and robust algorithms for moving object detection, classification, tracking and activity analysis In this thesis, a smart visual surveillance system with real-time moving object detection, tracking capabilities is presented. The system operates on both color and gray scale video imagery from a stationary camera. It can handle object detection in indoor and outdoor environments and under changing illumination conditions. The classification algorithm makes use of the shape of the detected objects and temporal tracking results to successfully categorize objects into pre-defined classes like human, human group and vehicle. The system is also able to detect the natural phenomenon fire in various scenes reliably. The proposed tracking algorithm successfully tracks video objects even in full occlusion cases

2. Design and Implementation

The objective of tracking is to closely follow objects in each frame of a video stream such that the object position as well as other information is always known. To overcome difficulties in achieving real-time tracking and improving tracking efficiency, a novel color-image real-time human body tracking system based on image processing is proposed in this paper, where a USB camera is mounted on a rotary platform for tracking moving human objects.

As far as moving object detection is concerned, we need to detect objects entering into the image frame first and subsequently identify the coordinates of the object. There are many approaches for detecting moving objects. Among them, the Opencv image processing based harrcascade classifier technique is the most popular and efficient method to detect human body in real-time surveillance. To begin with, an image without moving objects is assumed as the background image. When a target object moves into the image

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frame, there will be difference in terms of luminance values between the image with the object and the background image. By subtracting these two images, the object can be detected. For this reason, the Y component (luminance) of the image is only required. Note that background images, which might slightly vary from time to time, are critical.. As a result, the luminance value of background images might subject to variation, which is not desired. To reduce this adverse effect of background variation, we adopt a dynamic background to obtain the background image for using in the proposed approach, where 8 consecutive image frames are averaged to form the background image when there is no object entering the image. Difference image can be obtained by subtracting the background image from the current image.

When the coordinates of the target object become available, features associated with the object need to be extracted for comparison during the tracking. Traditionally, methodologies for human tracking can be classified into two types: template-based and contour-based approaches. Template matching is the most straightforward and useful method to search for the target in an image using the cascade method. Generally, the target of interest is chosen as a template in advance, and the most similar block with respect to the template is then located from an image. On the other hand, contour based methods consider the outline of the target as image information instead of the content of the target in template-based methods. We will use template-based method to meet the requirements of real-time tracking. We implemented the proposed tracking system in Raspberry board with Pentium ARM 11 based BCM2835 processor, 512MB RAM,700MHz speed under Raspbian OS software environment as the implementation platform. The resolution of each color images is 320x240 pixels. We can achieve real-time processing at about 24 frames per second. When the man enters the center of scene, the tracking system treat the man as the target object and uses it's positional information to actuate the motor of the rotary platform to keep the moving object in the center of scene.

3. Hardware

1. Raspberry Pi

Raspberry Pi is based on the Broadcom BCM2835system on a chip (SoC) is a general purpose 32-bit microprocessor is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high-definition video. We want to see it being used by kids all over the world to learn how computers work, how to manipulate the electronic world around them, and how to program. The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. The Raspberry Pi Model (BCM2835) B+ incorporates a number of enhancements and new features. Improved power consumption, increased connectivity and greater IO are among the improvements to this Powerful, small and lightweight ARM based computer.

Fig.1: Raspberry Pi Board

2. L293D- Current Driver

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications. All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo- Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN.

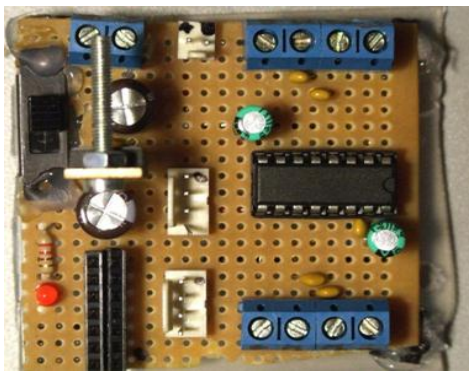

Fig.2: L293D Driver

When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs. When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293D, external high-speed output clamp diodes should be used for inductive transient suppression.

3. Ultra Sonic 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. The ultrasound transmitter(TX)emits 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.

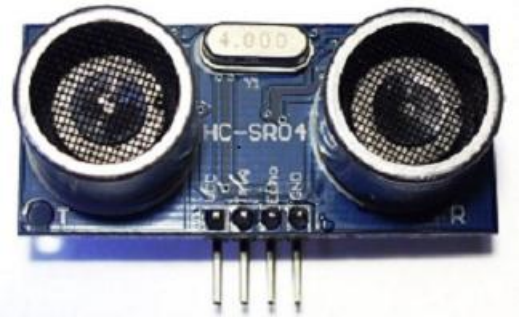

Fig.3: Ultrasonic sensor

4. Reflection due to ultrasonic sensor

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. 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.

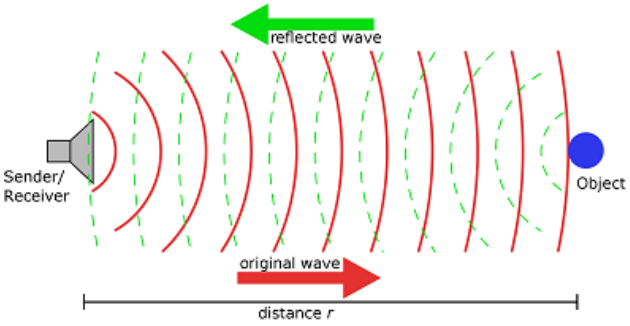

Fig.4: Reflection waves of ultrasonic sensor

5. USB Camera

A webcam is a video camera that feeds or streams its image in real time to or through a computer to computer network. When captured by the computer, the video stream may be saved, viewed or sent on to other networks via systems such as the internet, and email as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which connects using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops. The term 'webcam' (a clipped compound) may also be used in its original sense of a video camera connected to the Web continuously for an indefinite time, rather than for a particular session, generally supplying a view for anyone who visits its web page over the Internet. Some of them, for example, those used as online traffic cameras, are expensive, rugged professional video cameras.

Fig.5: USB Camera

6. Power Supply

The input to the circuit is applied from the regulated power supply. The AC input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating AC voltage. So in order to get a pure DC voltage, the output voltage from the rectifier is fed to a filter to remove any AC components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

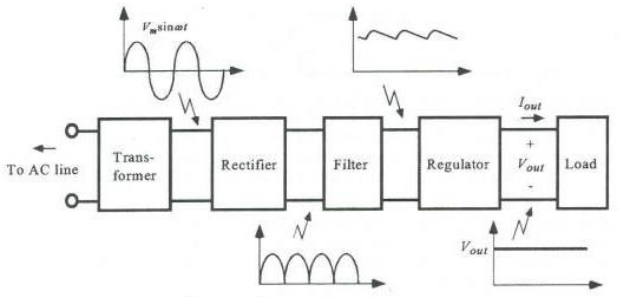

Fig.6 Components of a regulated power supply

QT IDE

Qt is a cross-platform application framework that is widely used for developing application software that can be run on various software and hardware platforms with little or no change in the underlying codebase, while having the power and speed of native applications. Qt is currently being developed both by the Qt Company, a subsidiary of Digia, and the Qt Project under open-source governance, involving individual developers and firms working to advance Qt.Digia owns the Qt trademark and copyright. Qt is available with both commercial and opensource GPL v3, LGPL v3 and LGPL v2 licenses. Qt is used mainly for developing application software with graphical user interfaces (GUIs); however, programs without a GUI can be developed, such as command-line tools and consoles for servers. An example of a non-GUI program using Qt is the Catalyst web framework.

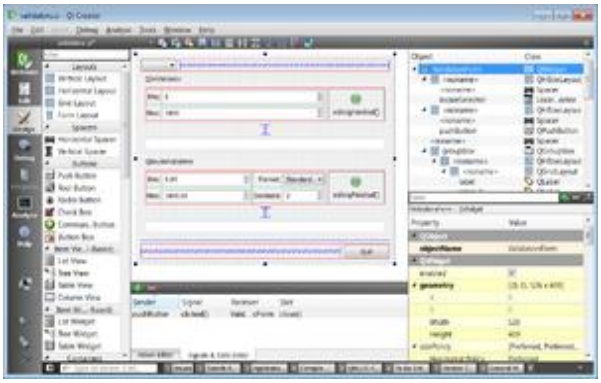

Fig.7 GUI designing in Qt Creator using embedded Qt Designer

GUI programs created with Qt can have a native-looking interface, in which cases Qt is classified as a widget tool kit.Qt uses standard C++ with extensions including signals and slots that simplifies handling of events, and this helps in development of both GUI and server applications which receive their own set of event information and should process them accordingly. Qt supports many compilers, including the GCC C++ compiler and the Visual Studio suite. Qt also provides Qt Quick, that includes a declarative scripting language called QML that allows using JavaScript to provide the logic. With Qt Quick, rapid application development for mobile devices became possible, although logic can be written with native code as well to achieve the best possible performance. Qt can be used in several other programming languages via language bindings. It runs on the major desktop platforms and some of the mobile platforms. It has extensive internationalization support. Non-GUI features include SQL database access, XML parsing, JSON parsing, thread management and network support.

4. Experimental Results

Project Result

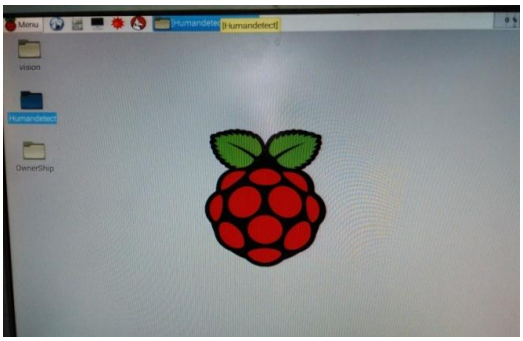

Fig.8 Raspberry pi operating system

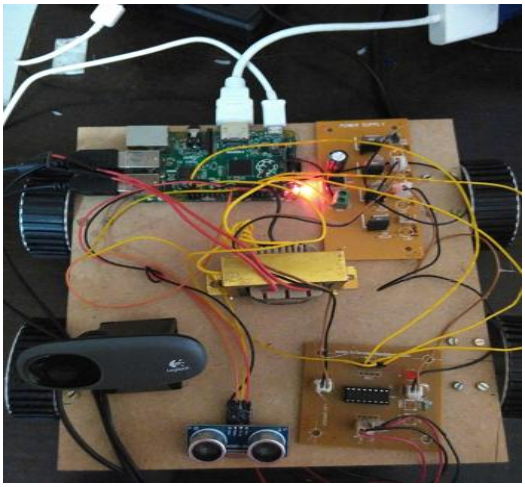

Fig.9: Hardware assembly

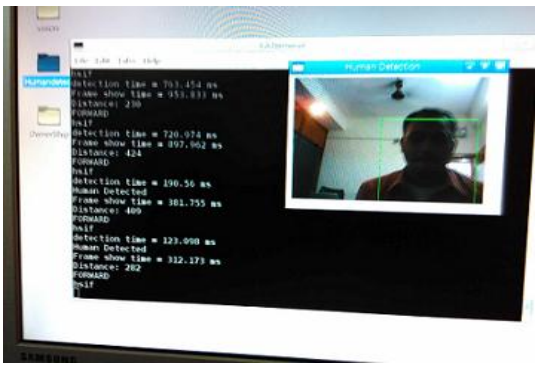

Fig.10: Camera detecting the object and distance

Conclusion

With the aim at single human-body tracking, a novel color image real-time human body tracking system based on image processing is proposed in this paper for identifying the target based on color and spatial information. To improve tracking performances, classifier techniques are used to pre-process the image for reducing computations required and achieving real-time tracking. Thanks to the setup of the USB camera which is mounted on a rotary platform, position information of the target object in the image can be used to control the movement of the platform for locking the tracking object around the central area of the image frame via the proposed approach. Therefore, tracking performance is significantly improved. The experiments results have shown that the proposed tracking system is capable of real time tracking human objects in about 25 frames per second.

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