ROBOT FOR WOMEN SECURITY WITH SENSOR FUSION TRACKING ALGORITHM
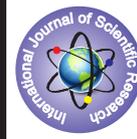
Engineering

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ABSTRACT The main aim of this paper is to conceptualize the views of using Robots for security systems. It acts as a Woman following Robot and a security guard too. The ultrasonic sensors track the activities of the woman by mapping points and gestures if something unusual happens to that person, the Robot senses the activities and make some corrective actions. The actions carried by the Robot are conveyed to the nearby police station with the picture of the victim by ZigBee. It has a pepper spray and it will spray into the eyes of the victim. It will also produce an alarm sound which makes alertness to the surroundings.

INTRODUCTION

Recent demographics show that certain parts in the world are experiencing a combination of an aging population and a declining birth rate. Therefore, interest is growing in the potential of human symbiotic robots such as daily life support robots that can care for the aged, women and young children [1]. Human symbiotic robots require sophisticated capabilities to achieve symbiosis and interaction with humans. It is essential for these robots to understand human intentions, and interact with humans and the environment. We call these technologies, which create real value for people and society, "human-centric technologies", and have developed some home robots and human symbiotic robots. In addition to these, by the use of embedded

System in robot designing, we can achieve our goal in several arenas of Embedded based Robotic applications. The development of these robots is a typical target for human-centric technologies, but these technologies are not only applicable for robots but also for all machines that humans use.

In the development of human symbiotic robots, we set one of the target criteria as the ability to recognize individuals using mapping points [2], and to understand situations in order to provide various real-life services to humans. To realize this target criterion, we think that the principal capabilities required are basic gesture and recognition of specified individuals who are in the vicinity using feature points [2]. Moreover, another important Capability common to the human symbiotic robot is that of moving safely near humans.

In light of the above considerations, we have developed SAHI, a woman following robot that finds a specified woman using FEATURE POINTS tracking functions and follow her while avoiding obstacles[5]. Woman following robots developed until now use various types of cameras for detecting a target person, and some of them use other sensors. Our newly developed robot adopts a Laser Range Finder (LRF) is mounted on the robot body to enhance the performance of woman following motion in addition with the FEATURE POINTS tracking algorithm developed using Embedded[3].

A woman following robot has to distinguish the target object from other objects and recognize it by some methods and the robot has to get the information of the target position, and continue following it quickly so as not to be left behind. At this time, camera information is often used to recognize the target. In the case of the stereo systems using two or more cameras, the distance information for the woman following motion can be obtained.

The stereo FEATURE POINTS system generates information on distance to the object being tracked. It is helpful for the woman following motion but unsatisfactory, because this information has insufficient accuracy for quick woman following motion [4]. Using the image data with a rough pixel limited by the trade-off with the calculation speed, many quantization errors will occur.

So, we designed a tracking system that uses highly accurate measurement information by operating in combination with LRF.

Our system has a feature to change the fusion rate of FEATURE POINTS and LRF data according to the congestion level of the movement of space, and so we achieved quick and stable women following motion.

This article introduces the Robot system to which the FEATURE POINTS system is applied and the behavior of the FEATURE POINTS system mounted on the Robot system are printed out, and a new sensor fusion method to overcome the problems is proposed[5]. Additionally the effect of the proposed method is shown by referring to experiment results.

FUNCTIONS

SAHI finds a specified woman and follow her. Its basic functions involved in following a woman are as follows:

1. Tracking the specified people: A developed proprietary image processing algorithm extracts and recognizes specific individuals, registering the color and texture of their clothing, and distinguishing them from cluttered backgrounds.

2. Following at her place: The robot calculates the distance between the target people and itself using stereo FEATURE POINTS and follows her with the appropriate speed to keep the distance constant.

3. Avoiding obstacles: The robot uses ultrasonic sensors integrated in the robot's base to detect obstacles and automatically generates a route to avoid them.

4. Resuming contacting when the robot misses her: If the Robot loses sight of its target, it searches for the woman or calls out to re-establish contact. The woman following motion control, including obstacle avoidance and contact resumption, can be explained.

For the woman following function, we have constructed two function modules as shown in figure 1, the Target Detection Module and the Motion Control Module, in the SAHI's control system.

Two camera images of the target woman including cluttered backgrounds are captured concurrently by the original versatile multimedia front-end processing board named MFeP and sent to the Target Detection Module. At the Target Detection Module, the target woman is detected by the newly developed image processing algorithm, and the result (distance and direction data of the target woman from the robot) is sent to the Motion Control Module through the network. At the Motion Control Module, the two wheels and the head of the robot are controlled cooperatively to follow the target woman smoothly. LRF is mounted and used to track in this module.

The Target Detection Module runs on Windows PC and the Motion Control Module runs on Linux PC, because the Windows PC has many image processing applications, and the robot motion control requires real-time processing.
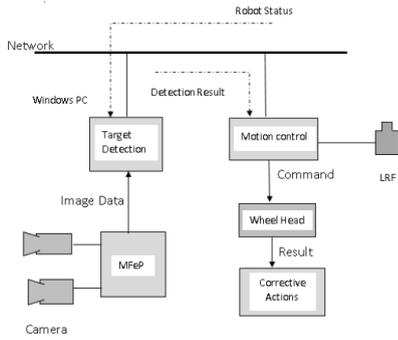
Figure 1: Block diagram of function module

The frame rate of the image processing system is about 15 fps, and the control cycle of the motion control system is 1 kHz.

ENVIRONMENTAL CONGESTION

An experiment of woman following motion was performed using SAHI mounted with this sensor fusion method. From this experiment, in open space, it was confirmed that the Robot can follow fast and smoothly who moves quickly and randomly.

In the experiment, the woman moves to the translational direction of the robot at a maximum speed of about 1.2 m/s, and to the rotational direction of the robot at a maximum speed of about 5.0 m/s at a point of 1.5m from the robot[6].

FAST FOLLOWING MOTION

When the woman passes over an obstacle in the neighborhood as illustrated in Fig 2, the robot can continue following without losing sight of the person.

It is understood that the direction element of the follow reference (heavy-line) smoothly changes from LRF information (deep-color, thin-line) to camera information (light-color, thin-line) according to the congestion degree of the environment (dotted-line) in the figure 2. In addition, the robot can continue following normally without losing sight of the followed object in the case of the meeting and parting motion (pseudo crossing motion) involving two people as illustrated in the scenery of the experiment[4].

In this experiment, two people who have approached have instantaneously exchanged a rate vector, at the time of the encounter. This motion of the target results in a high probability of misidentification when the robot refers only to the positional history of the target measured by LRF as shown in fig 2. However, the following motion can be perfectly continued in this system where the designed sensor fusion is mounted.

On the other hand, we have confirmed that the robot can follow the target correctly, distinguishing the situation accurately without guessing wrong as to the general cross-motion of the target, too.Because the above-mentioned movements, such as the non-directional movement, the fast movement, the crossing and pseudo-crossing motion with other people, and the occlusion are events that occurs naturally in the human coexistence space, it is very important for the service robot to have these woman following abilities in these situations
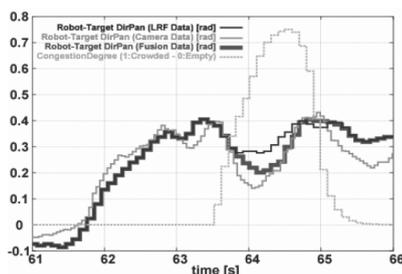

Figure2: Woman Direction and Congestion Degree in the success tracking

CONCLUSION:

The woman following robot SAHI equipped with a stereo camera and FEATURE POINTS System and LRF is introduced. SAHI has the FEATURE POINTS-Based Tracking system and the FEATURE POINTS-Based Motion Control system. SAHI can do the woman following motion using the tracking information. Moreover, SAHI used LRF as another sensor for the tracking performance gain.

The respective problems of the FEATURE POINTS and LRF tracking systems are pointed out and an improvement method based on the idea of the FEATURE POINTS-LRF Sensor Fusion system is proposed. One feature of this new system is that the fusion rate changes depending on the congestion information of the environment. The experimental movement results of applying these systems to SAHI are reported. The efficiency of the proposed method is confirmed by the experiment.

As discussed here, efforts to achieve an advanced application using sensors independently are subject to an unavoidable limit. So, a system design integrating information from two or more types of sensor is required. Because the FEATURE POINTS data containing abundant information plays a key role in the complex system, further development of the FEATURE POINTS system is desirable.

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