

Image Recognition of Small Humanoid Robot

SDR-4X II

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1. Introduction

We have developed a small humanoid robot (SDR-4X) for entertainment purpose. SDR-4X is aimed to work autonomously in home environment. SDR-4X is 58cm in height and 6.5Kg in weight. It has 28 DOF in major joints (6DOF for each leg, 2DOF for trunk, 5DOF for each arm, and 4DOF for neck). It is capable of generating various motions and sounds such as walking, dancing and singing. It has 7 microphones and 2 CCD Camera, which enable sound localization, speech recognition, and image recognition. In the demo we will focus on image recognition capability of SDR-4X.



Fig.1:SDR-4X dancing

2. Description of Technology

2.1. Vision Sensor

SDR-4X has a newly developed micro stereo vision system installed inside its head. It is capable of calculating disparity images from left and right eye CCD cameras in real-time. The disparity image and color image captured at the same time are sent to main CPU one after the other.

2.2. Navigation

It is very crucial for an autonomous biped robot to recognize where it can walk. We have developed technology to allow SDR-4X to navigate through unknown and unstructured environments. The navigation system is mainly consisted of 4 parts. One is to recognize floor by applying plane extraction method on range image. The second part constructs self-centered stochastic occupancy grids from the measurement of floor and non-floor pixels. The third part makes a path plan on occupancy grids with avoiding obstacle grids, and also generates a footstep plan for walking along the path. The last part uses color landmarks to localize the robot within a known landmark configuration, it also enables the robot to build a new map while checking whether to match the known maps in the database.

2.3. Human Localization

To interact and to entertain human, it is necessary to find a human and to approach it. SDR-4X first reacts to plosive sound such as handclap. By estimating the direction of sound source, it turns then looks for interesting regions in images. The results of motion detection and face detection are used to localize human. It can also register and identify faces up to 10 people at a time.

3. Description of Demonstration

We are planning to have 3 demos to show image recognition technologies and its applications and entertainment performances in between them.

3.1. Landmark Traveling Game

In this demo, several color landmarks in disc shape are placed on the floor. SDR-4X first walks 2m forward while looking around to search landmarks. Then it randomly selects one of the observed landmarks and travels to it with avoiding obstacles. After reaching the destined landmark, it selects another landmark and repeats traveling. The disparity image, result of plane extraction, and recognized occupancy grid with landmark position estimation can be shown on monitor by wireless connection to laptop PC.(Fig. Shows the landmark traveling of SDR and occupancy grids).

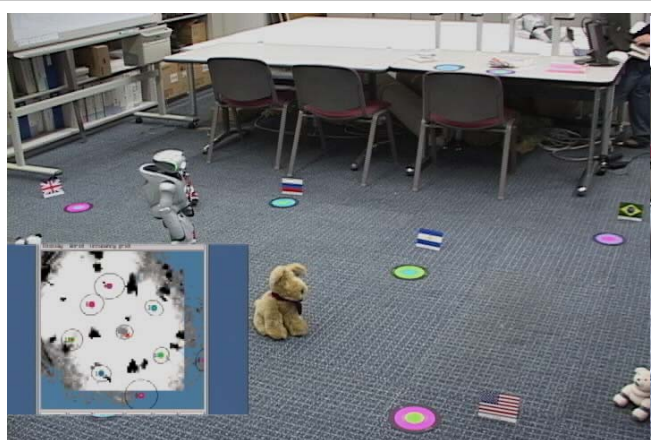


Fig.2: Landmark traveling game



Fig.3: Human localization

3.2. Ball Kicking

In this demo, the fast color-based recognition is used to recognize and to track the ball, By coordination of vision system and motion control system, SDR-4X shows the ball kicking behavior.

3.3. Beckoning to SDR-4X

In this demo, SDR-4X is surrounded by a couple of people. One first claps his hand to attract attention of SDR-4X. It turns around as it recognizes the sound source direction. If the other claps his hand, SDR-4X is attracted to that direction. After SDR-4X turns its head and body, one person waves his hand to attract attention of SDR visually. If it succeeds in finding a face in that direction, it tries to reach the person with tracking his face. It also tries to identify his face and speaks up his name after reaching the person.

3.4. Singing & Dancing

SDR-4X has a large repertoire of dancing and singing. It can perform them between those demos described above.