Software Requirements Specification

CS684 Project

Automated Learning Robot

Group 20

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1 Introduction

This project involves design and implementation of a self-learning bot. A manual bot which performs a specific task is placed in an arena. A camera is mounted on top of the arena. The learner bot will observe the task and learns the action. Once the learning is complete, then the learner bot can perform the same task as the manual bot.

Section 2 contains the overall description that affects the product and its requirements.

Section 3 has all the technical functional requirements and documentation of interfaces, user and system requirements, supportability and constraints.

1.1 Definitions, Acronyms and Abbreviations

- FPS: Frames per second
- USB: Universal Serial Bus
- SVN: Apache Subversion software
- GUI: Graphical User Interface

1.2 References

None

2 Overall Description

Product Perspective

This project is a small step in the direction of automated learning bots. The automated bots learn the task performed by the manual bot. Thus the instructor need not program each bot specifically.

Product Functions

One manually controlled robot performs a task in an arena. Its movement is captured by an overhead camera connected to a computer. The computer uses MATLAB to process the images and identify the task performed by the manual robot.

Then the computer transfers the encoded task to the automatic robot using Zigbee wireless module. The automatic robot decodes the task and performs it.

Constraints

- The task should be clear enough to be captured by an overhead camera. This limits the task to be composed of simple movements and collecting some sensor values
- The resolution and FPS of the camera

Assumptions and Dependencies

- No wireless signal interference in the arena
- Zigbee wireless module will have a range over the entire arena
- A good camera is available to identify the task and distinguish colours clearly

Requirements Subsets

- Two Firebird V robots with ATmega2560 microcontrollers
- One overhead camera connected to a computer through USB
- An arena with a green base. Black disk to cover the manual robot and coloured indicators on the robot. The arena should have good lighting conditions
- Five each of red, green and blue LEDs to signal sensor value collection
- Two XBee modules: one for the automatic robot and another for the computer

3 Details

3.1 Functionality

The major functionalities can be divided into the following blocks:

i. **Manual robot control:** This is used to manually control the movement of the first robot

ii. **Runtime capture of task:** The overhead camera captures the task performed by the manual robot and transfers it to the computer

iii. **Task detection algorithm:** The computer processes the images using MATLAB and detects the motion of the manual robot. Each sensor value to be measured will be colour-coded by specific colors using LEDs

iv. **Task encoding:** The coordinates and distances need to be converted from the camera frame to the actual arena frame. The detected task will be encoded in a particular format (illustrated in the following example). An encoding of **20F30R25B90L** means: 20 cm forward, 30 degree right turn, 25 cm back and 90 degree left turn

v. **Wireless transfer:** The computer then transmits the encoded task to the automatic robot using XBee module

vi. **Automatic robot control:** The automatic robot decodes the task and then performs it

3.2 Supportability

- Firebird V ATmega2560 architecture will be supported
- Our code will pass the Splint Static analyzer
- Doxygen documentation standards and Firebird-specific guidelines will be followed
- Use of SVN for version control

3.3 Design Constraints

- The frequency of change in the path of the manual robot is limited by the camera used and the processing capacity
- The different types of sensor reading operations is limited by the ability to colour-code each operation distinctly

3.4 On-line User Documentation and Help System Requirements

- User manual will be provided for all the functional blocks specified in Section 3.1
- The source code will be documented using Doxygen

3.5 Interfaces

3.5.1 User Interfaces

A simple GUI to display the detected path of the manual robot and the encoded task will be developed. We can transmit the encoded path to the automatic robot through the GUI.

3.5.2 Hardware Interfaces

- Webcam connected to a computer through USB
- AVR ISP mkII for programming Firebird V

3.5.3 Software Interfaces

- AVR Studio
- MATLAB with image processing libraries

3.5.4 Communications Interfaces

Two XBee modules. One on the Firebird robot, and the other on the computer. These should be configured to enable serial communication using Zigbee protocol.