Problem Statement

With the aim of helping parents keep their children entertained and engaged, we designed and developed a robot toy which can be operated using a remote laptop or hand gestures.

Mission Scenario

- Set up the robot: plug the wireless module into the computer and install the accompanying software
- Power on the robot and set it on the floor
- Start tracking mode and track gestures
- Mode 1: Use gesture commands to control the robot
- Mode 2: View the video feed and tele-operate the robot from the laptop

Subsystems

Glove tracking
- Use a threshold on the HSV color space to detect the bright orange color of the glove
- Combine the blob detection algorithm and the HSV color filter to detect and track the glove

Gesture Recognition
- Capture eight consecutive frames and store the center positions and the sizes of the target area to perceive the five basic gestures: start/stop tracking, turn left, turn right and move forward and move backward

Wireless Communication
- Use a Foscam FI8918W Wi-Fi Camera along with a router to wirelessly transmit the video feed to the laptop.
- Control commands from the laptop are sent through the Xbee to the robot

Robot Design

We built three layers to hold the electrical and mechanical components:
- The power source and the power distribution board are placed on the bottom layer
- The middle layer is used for holding an Arduino controller and the motor driver.
- The top layer is built for holding the camera dock

Functional Architecture

Performance Evaluation

<table>
<thead>
<tr>
<th>Performance metric</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mobility-Drive Speed Test</td>
<td>12 cm/s</td>
</tr>
<tr>
<td>2. Obstacle detection Test</td>
<td>Obstacle Detection Range up to 20 cm</td>
</tr>
<tr>
<td>3. Tele-operation Test</td>
<td>Tele-operation Range up to 10 m</td>
</tr>
<tr>
<td>4. Gesture Recognition Test</td>
<td>Accuracy rate of 10%</td>
</tr>
<tr>
<td>5. Glove Tracking Test</td>
<td>Accuracy rate of 80%</td>
</tr>
</tbody>
</table>

Conclusions

Lessons learned
- Freeze changes early and demonstrate only what is tested
- Always have a backup for each unit
- Build multiple prototypes early in the project

Future work
- Improve gesture recognition robustness
- Add more gesture commands
- Add voice command to control the robots

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