Bluetooth Interface with Robotic Systems using MATLAB

INTRODUCTION

- **Background**
  - Bluetooth is a low-cost, easily configurable data radio link which has been a preferred choice for wireless communication in robotic systems given its simplicity, flexibility and energy efficiency.
  - With the documentation of Application Programming Interfaces (API) and Software Development Kits (SDK), computing languages such as C/C++, MATLAB or Python have been utilized extensively to create Bluetooth interfaces for robot control.

- **Motivation**
  - Short-range wireless controlled robots are useful and desired in various fields.
  - Bluetooth is becoming a standard for wireless communications. Consequently, many commercial devices come with an API and SDKs, encouraging users to control the device with Bluetooth.
  - Combined with the capability of computing languages, Bluetooth technology can be used to build up applications offering a higher level of functionality in robotic systems.
  - Developing Bluetooth interfaces with MATLAB is desirable since MATLAB is a simple and popular computing language.

- **Problem Statement**
  - The purpose of this project is focused on leveraging Bluetooth with MATLAB to communicate and manipulate robotic systems wirelessly. A working example on designing and implementing the remotely controllable robotic system with MATLAB will be demonstrated.

APPROACH

Sphero (a robotic ball) was chosen as the robotic system to be controlled. Our goal is to control the color of the robot and also command the robot to roll according to a specified trajectory drawn in MATLAB. The control scheme are outlined as follow:

- User Input to MATLAB GUI in Computer
- Sends data in bytes coherent to packet structure
- Actions according to data received

- **Packet Structures**
  - Following the API, the packets are sent from MATLAB to Sphero in the following byte format:
    - SOP1, SOP2, DID, CID, SEQ, DLEN, <data>, CHK
  - SOP1: Start of Packet #1
  - SOP2: Start of Packet #2
  - DID: Device ID
  - CID: Command ID
  - SEQ: Sequence Number
  - DLEN: Data Length
  - <data>: Data
  - CHK: Checksum

  - Each function has a unique packet framework. The interested functions and their packet structure are listed below:

<table>
<thead>
<tr>
<th>Function</th>
<th>Packet Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set ROB LED Output</td>
<td>DID CID SEQ DLEN RED GREEN BLUE FLAG</td>
</tr>
<tr>
<td>Roll</td>
<td>DID CID SEQ DLEN Speed Heading Heading STATE</td>
</tr>
</tbody>
</table>

RESULTS

- The implementation is shown in a series of pictures below.
  - User draws trajectory
  - User adjusts color preferences
  - Sphero rolls according to trajectory

DISCUSSIONS

- The robotic device (Sphero) was successfully controlled by the implementation of the Bluetooth interface in MATLAB. This project has exhibited the simplicity and capability of MATLAB in robot control over Bluetooth.
- The significance of numeral systems in Bluetooth communication protocol is demonstrated.
- The source code used in this project is published on MATLAB Central.

FUTURE WORK

- Developing an interface to control Sphero with Myo (a gesture based Bluetooth device).
- Extracting real-time data from the IMU sensors in Sphero to MATLAB.
- Designing a home based rehabilitation activity for Sphero and Myo.
- Publishing within the Institutional Repository (IR).

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