Sensory Robotics - surface scanning

Goal:

Scanning - reconstruction of a 3D surface with the help of a 2D laser scanner and a 2-axes accelerometer.

Short description of the exercise:

Software environment: MATLAB
Tools to use during this lab:

- 2D laser scanner (Hokuyo URG-04LX-UG01);
- 2-axes accelerometer (Phidget 1053);
- the wall of an arbitrary carton-box.

The two sensors are mounted to the same measurement platform (wooden plate).
The laser scanner returns us distance values of those points, which are intersecting points between an imaginary flat, circular shape around the head of the sensor and the environment.
The standstill accelerometer can help you to define the tilt angles of the measurement platform in two different directions.
The task: set the measurement platform in different tilt-angles and measure with both of the sensors in approximately the same time; then try to reconstruct the environment on the basis of the distance-values in the different planes + the accompanying tilt angles.

Before the measurement, please read carefully these documents::

- **`laserscanner_description___URG_04LX_UG01.pdf`**: general description of the laser scanner;
- **`laserscanner_communication_protocol___URG_04LX_UG01.pdf`**: the communication protocol of the laser scanner (most important chapters: 5, 6.2, 7, 8.1; our measurement will use *3-character encoding*);
- **`accelerometer_2axis___Phidget_1053.pdf`**: the manual of the accelerometer (most important: pages 10-13.).

How to use the laser scanner:

We can communicate with the laser scanner over serial line (RS-232). The commands and the sensor's responses are ASCII text messages. Main steps of the usage (on the basis of the given sample code):

1. initialization of the serial port in MATLAB,
2. setting up communication protocol 2.0 and higher speed to the serial line,
3. acquiring status information from the sensor,
4. acquiring a complete measurement cycle, parsing the response packets in order to have the 3-character encoded data of the distance values, then convert this data to normal numbers,
5. closing the device and the serial port as well.

How to use the accelerometer:

We can communicate with the accelerometer through library (dll) calls. The raw output of the accelerometer in standstill state is between +/- 1 g per axis (acceleration measured as a ratio of 'g').
The minimal commands necessary to get measurement values from the sensor:

1. loading the library,
2. preparing + opening the sensor object,
3. acquiring the acceleration values per axis, then converting them to tilt-angles (comment: axis 0 is perfect, but axis 1 has some problems, so the source code contains a converting function to the dynamics-range),
4. closing and deleting the sensor.

If you can be present physically in the laboratory:

Description of the measurement:

1. Please try the devices separately first:
    a. the serial port number allocated to the laser scanner can be found under Control Panel / System / Device Manager,
    b. please be careful when selecting the header-file during the library-load to the accelerometer,
    c. in the case of the accelerometer: after every lib-call please wait a minimal time (eg. 0.1 sec.) in order to preserve the system in consistent state.
2. If the devices are working individually, try to use them from one script/function. Maybe it is useful to save the measurement results into **`.mat`**-files, in order to do the further processing (reconstruction) independently from the devices.

During online education:

Description of the measurement:

- In a band new script please load the recorded data (**`hokuyo_and_phidget_measurement_data.mat`** - in the tutorial video, the content of it is clearly explained.);
- please implement the 3D reconstruction (also explained in the video).

Available source-codes:

Already given:

- **`hokuyo_laserscanner_test.m`**: sample script to the laser scanner - *during online education just understand it*,

- **`phidget_accelerometer_test.m`**: sample function to the accelerometer - *during online education just understand it*,
- **`close_serials.m`**: the only aim of this script is at to be able to close serial objects accidentally left without reference - *during online education just understand it*,
- (**`phidget21Matlab_Windows_x64.h`** és **`_x86.h`**: do not open nor modify these files, they are necessary to the library-loading).

Please prepare:

- a script recording the measurement data of the two devices in the same time (approximately) - *if you can be physically present in the laboratory*,
- a script reconstructing the environment from the measurement data.

What and when to send:

What:

- all of your created source codes,
- your report.

Please include in your report: the difficulties of the measurement, the observed mailfunctions of the sensors, the details of your registration algorithm; the details of the operation of the devices (character-coding, angle-calculation, etc.).

Deadline: indicated in moodle.

Thank you.
Miklós