

Weekly Presentation

Week 40

Luleå University of Technology

September 29, 2020

Group members

- Y-students

- ▶ Martin Blaszczyk - Project leader and object detection
- ▶ Edward Cedergård - Arm and gripping tool
- ▶ Niklad Dahlqvist - Arm and gripping tool
- ▶ Måns Norell - Movable base

- D-students

- ▶ Edward Källstedt - Object detection
- ▶ Albin Martinsson - Arrowhead and Git

Overview

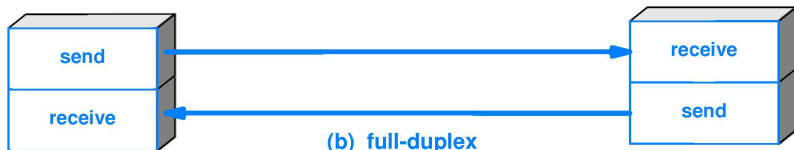
What we have done and what we are working on:

- Full duplex to half duplex serial communication
- Dynamixel data packages

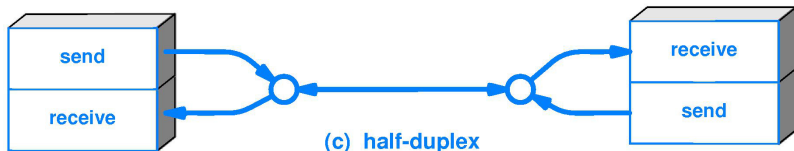
Full-duplex to half-duplex



(a) simplex

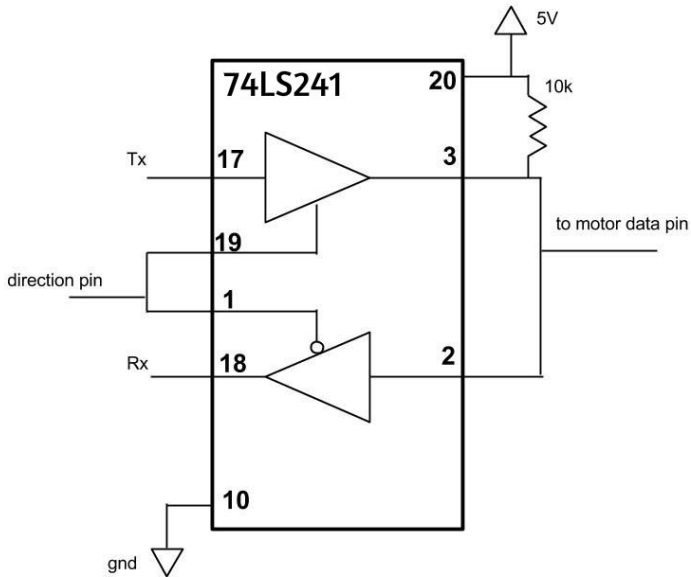


(b) full-duplex

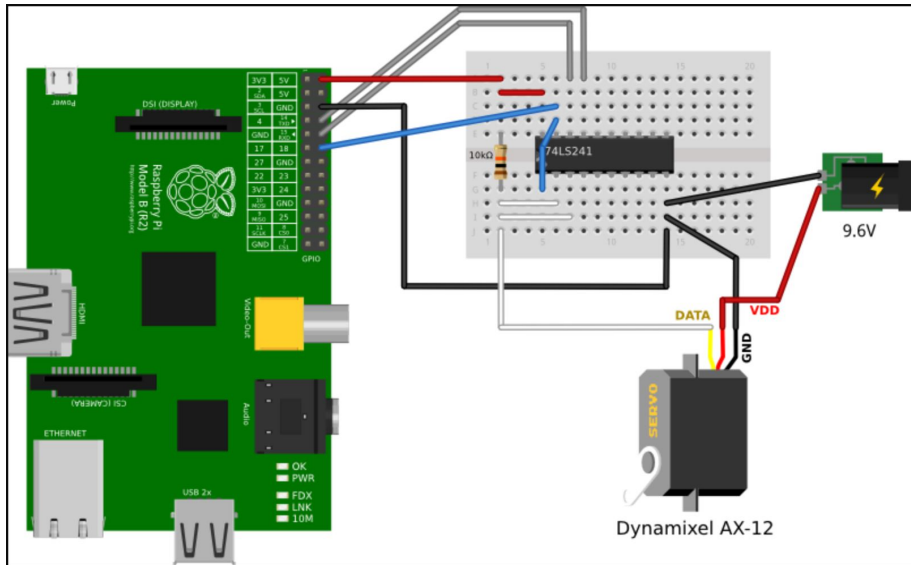


(c) half-duplex

Dynamixel communication



Circuit



Dynamixel data packages overview

- Data packets structure
- Timing of response
- Example package

Dynamixel data packages

Instruction package - send to the motor

| Header | ID | Length | Instruction | Param 1 | ... | n | Checksum |
|--------|----|--------|-------------|---------|-----|---|----------|
| 0xFFFF | ID | Length | Instruction | param 1 | ... | n | Checksum |

Status return package - receive from the motor

| Header | ID | Length | Error | Param 1 | ... | n | Checksum |
|--------|----|--------|-------|---------|-----|---|----------|
| 0xFFFF | ID | Length | Error | Param 1 | ... | n | Checksum |

Instruction package

| |
|--------|
| Header |
| 0xFFFF |

Header allways fixed.

Instruction package

| | |
|--------|----|
| Header | ID |
| 0xFFFF | ID |

ID is a unique number for each motor connected.

Instruction package

| | | |
|--------|----|--------|
| Header | ID | Length |
| 0xFFFF | ID | Length |

Length of the message, excluding the header bytes.

Instruction package

| | | | | | | |
|--------|----|--------|-------------|---------|-----|---------|
| Header | ID | Length | Instruction | Param 1 | ... | Param n |
| 0xFFFF | ID | Length | Instruction | param 1 | ... | Param n |

Parameters, depends on the instruction.

Instruction package

| | | | | | | | |
|--------|----|--------|-------------|---------|-----|---|----------|
| Header | ID | Length | Instruction | Param 1 | ... | n | Checksum |
| 0xFFFF | ID | Length | Instruction | param 1 | ... | n | Checksum |

The checksum is calculated as

$$\text{Checksum} = (\text{ID} + \text{Length} + \text{Instruction} + \text{Parameter1} + \dots + \text{Parameter N})$$

where " " is the "not" operation and only the lower byte is used.

Status return package

| | | | | | | | |
|--------|----|--------|-------|---------|-----|---------|----------|
| Header | ID | Length | Error | Param 1 | ... | Param n | Checksum |
| 0xFFFF | ID | Length | Error | Param 1 | ... | Param n | Checksum |

Similar to instruction package but each bit in the error byte represents one possible error.

Timing of return package

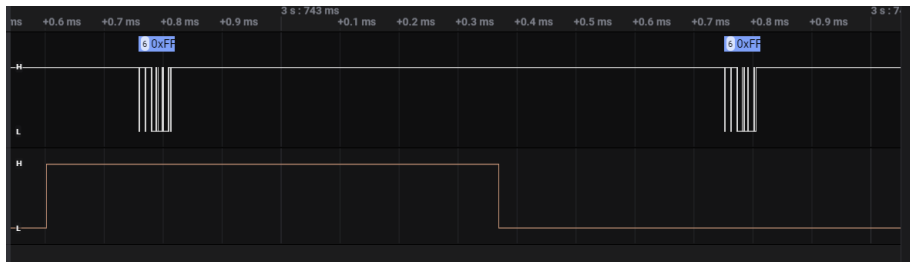
- Return delay can be set for each motor
- Values between 0 - 508 microseconds

Example package

| Header | ID | Length | Instr. | P.1 | P.2 | P.3 | Checksum |
|--------|------|--------|--------|------|------|------|----------|
| 0xFFFF | 0x01 | 0x04 | 0x03 | 0x1E | 0x00 | 0x00 | 0xD9 |

Writes the data 0x0000 at memory position 0x1E. (Goal position = 0)



Logic analyzer example



Logic analyzer example

■ Async Serial ✓

> Trigger View ▲ ☐

Data   PRO

Type to search ?

| | TYPE | START | DURATION | DATA |
|---|------|--------------|----------|------|
| ■ | data | 3.74275917 s | 9.5 µs | FF |
| ■ | data | 3.74276917 s | 9.5 µs | FF |
| ■ | data | 3.74277917 s | 9.5 µs | 01 |
| ■ | data | 3.74278917 s | 9.5 µs | 02 |
| ■ | data | 3.74279917 s | 9.5 µs | 01 |
| ■ | data | 3.74280917 s | 9.5 µs | FB |
| ■ | data | 3.74375229 s | 9.5 µs | FF |
| ■ | data | 3.74376231 s | 9.5 µs | FF |
| ■ | data | 3.74377233 s | 9.5 µs | 01 |
| ■ | data | 3.74378235 s | 9.5 µs | 02 |
| ■ | data | 3.74379237 s | 9.5 µs | 00 |
| ■ | data | 3.74380239 s | 9.5 µs | FC |

Demonstration

- https://youtu.be/f_JAT8srcIc

Additional information

- <https://emanual.robotis.com/docs/en/dxl/ax/ax-12a/>
- <https://emanual.robotis.com/docs/en/dxl/protocol1/>
- <http://www.crustcrawler.com/products/bioloid/docs/AX-12.pdf>

Movable Base

What has been done

- CAD model for base have been made
- Controllers have been made to move the base to a specific point in space
- Real world limitations have been applied to the controllers

CAD Model

THIS IS NOT THE FINAL BASE
MODEL

It's for prototyping and is modelled
to be modular and easy to attach
parts to

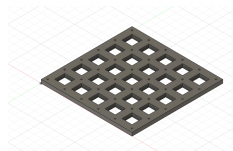


Figure: Model of base

New Controllers

Two **PID** controller are made in order to move to a user specific coordinate by

- Setting the robot to a specific angle
- Move the robot a user defined distanced

Simulations With Limitations

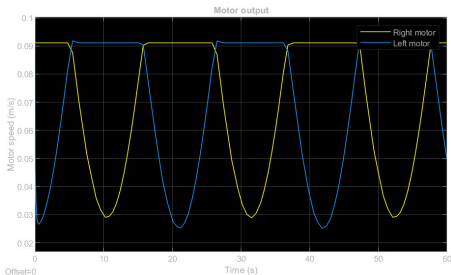


Figure: Motor speeds

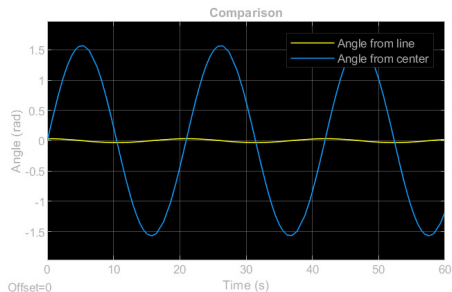


Figure: The angle towards the center and the angle towards the line comparison

Simulations With Limitations

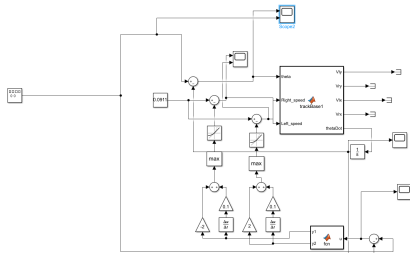


Figure: Block diagram

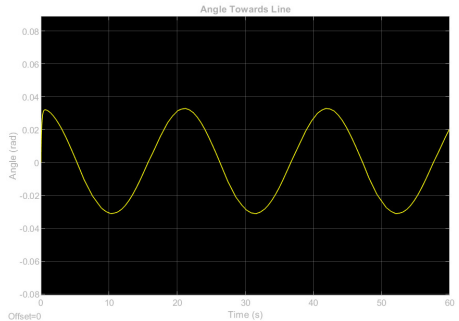


Figure: The angle towards the line

What Is To Be Done

- Stability analysis on **PIDs**
- 3D print and build robot
- Implement controllers on robot

Machine Vision Progress

- Rewritten in C++
- Added configuration options
- QR-Code detection implemented

Machine Vision Progress

- <https://www.youtube.com/watch?v=b7bSlFM6s4o>

Machine Vision Future Improvements

- QR detection optimizations
- QR orientation
- Pathfinding

Overall timetable

| Sep | Oct | Nov | Dec |
|--------------------|--------------|------------|--------------|
| Concept generation | Evaluation | Evaluation | |
| Theory | Prototyping | Evaluation | Finishing up |
| Simulation | Evaluation | Evaluation | |
| Prototyping | Final Design | Evaluation | |

Time plan for September

| Subproject | Week 1 | Week 2 | Week 3 | Week 4 |
|------------------|---------|------------|-------------|----------------|
| Arrowhead | Reading | Setup | API | Prototyping |
| Movable base | Reading | Modeling | Simulation | Implementation |
| Arm and grip | Reading | Kinematics | Simulation | Prototyping |
| Object detection | Reading | Testing | Prototyping | Evaluation |

Questions?