

The background features a blue-to-red gradient with several technical diagrams. These include circular gauges with numerical scales (e.g., 40, 150, 160, 170, 180, 210, 220, 230, 240, 250, 260), dashed lines, and arrows, suggesting a mechanical or engineering context.

TRACKLESS TRAM SYSTEM

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OUTLINE

- Project Description & Requirements
- Project Decision
- Project Architecture
 - Steering
 - Feedback system
 - Communication
- Implementation
 - Setting
 - Variables
 - User Commands
 - Data Exchange
 - Emergent Interrupts
- Debugging & Testing
 - Tests
 - Debugging
- Conclusion

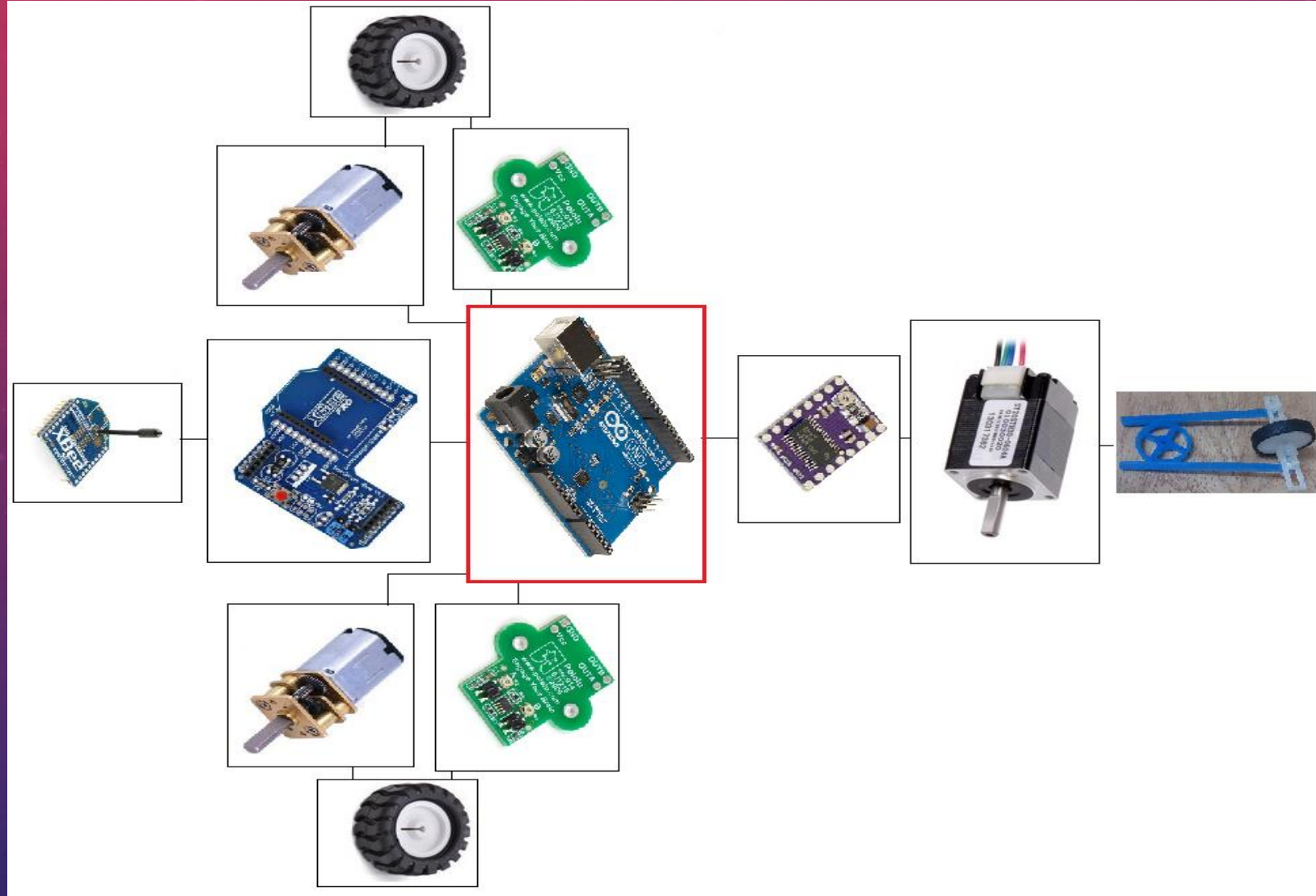
PROJECT DESCRIPTION & REQUIREMENTS

- This project describes a trackless multi-car electric tram that attempts to solve the problem cost and fossil fuel reducing emissions.
- This tram system should also be able to move freely inside the city.

DECISION

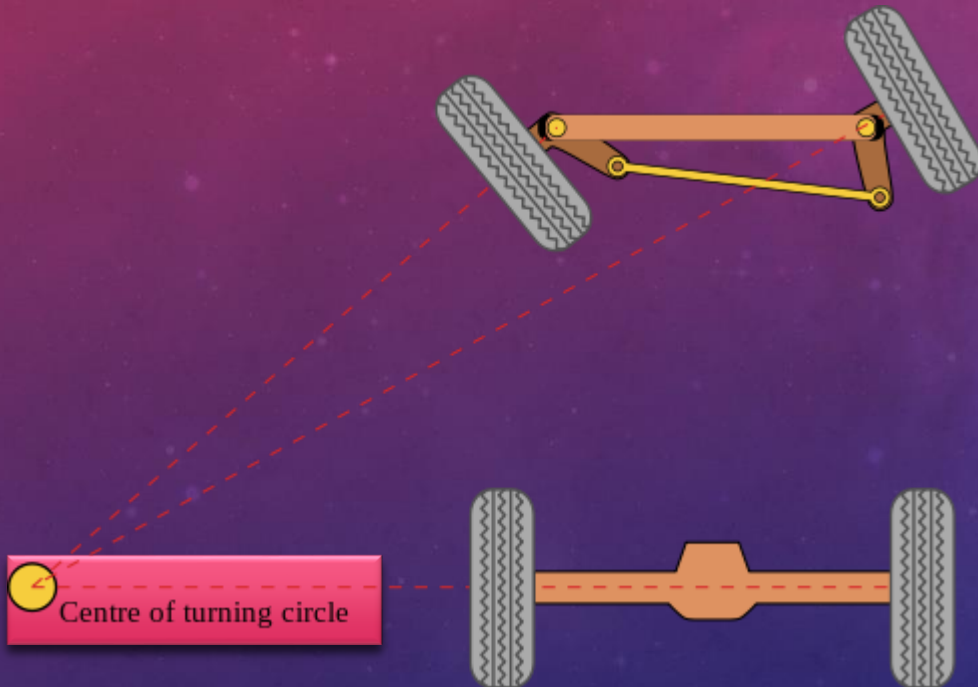
- Communication
 - ZigBee
 - WiFi
- Steering mechanism
 - Differential drive
 - Rack and Pinion steering mechanisms (many)

ARCHITECTURE

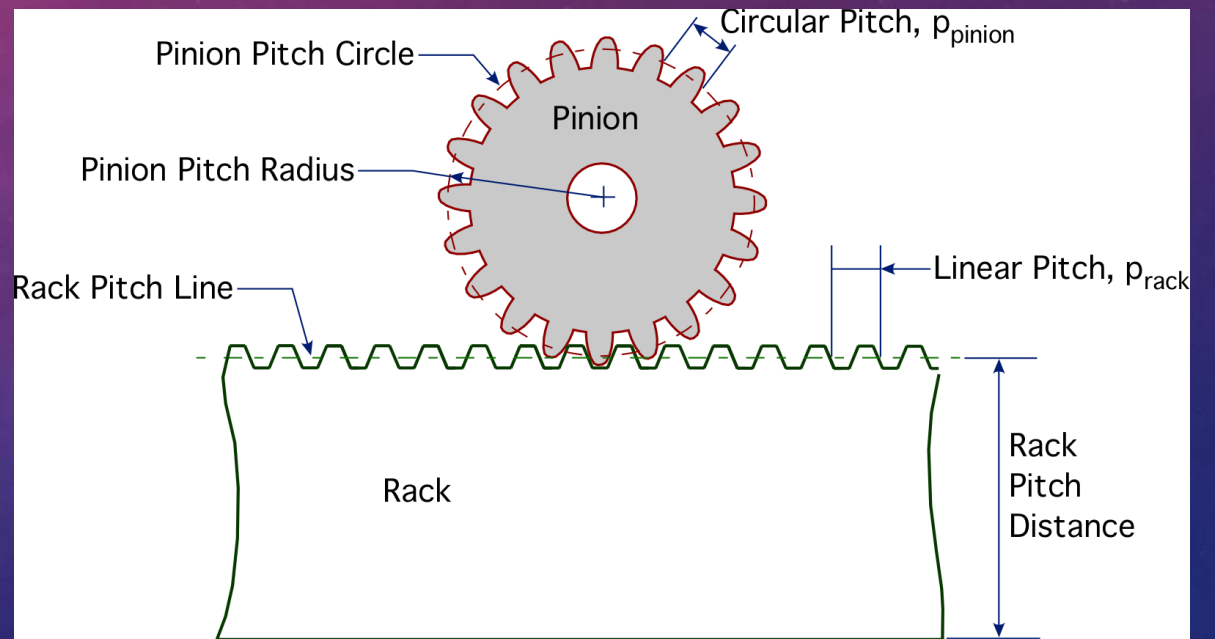


STEERING DESIGN

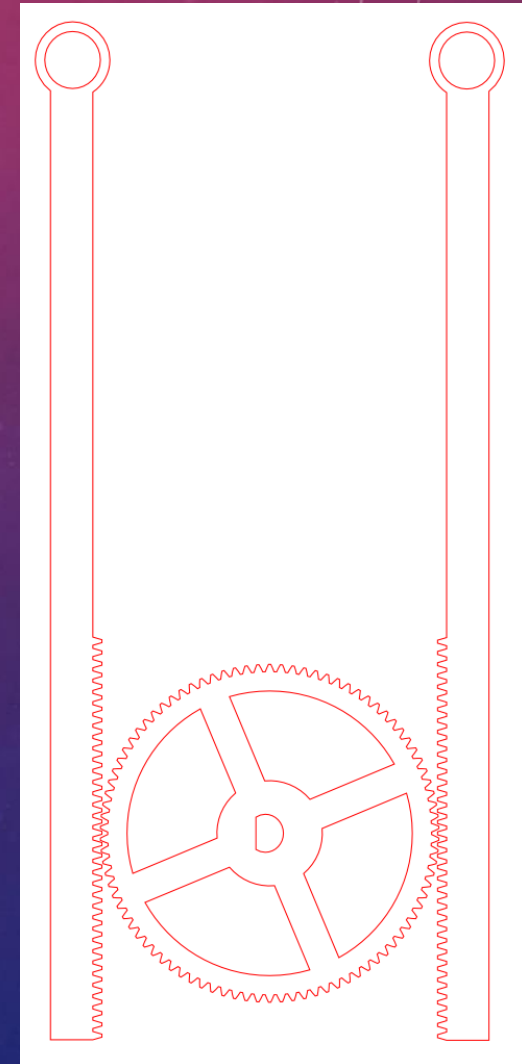
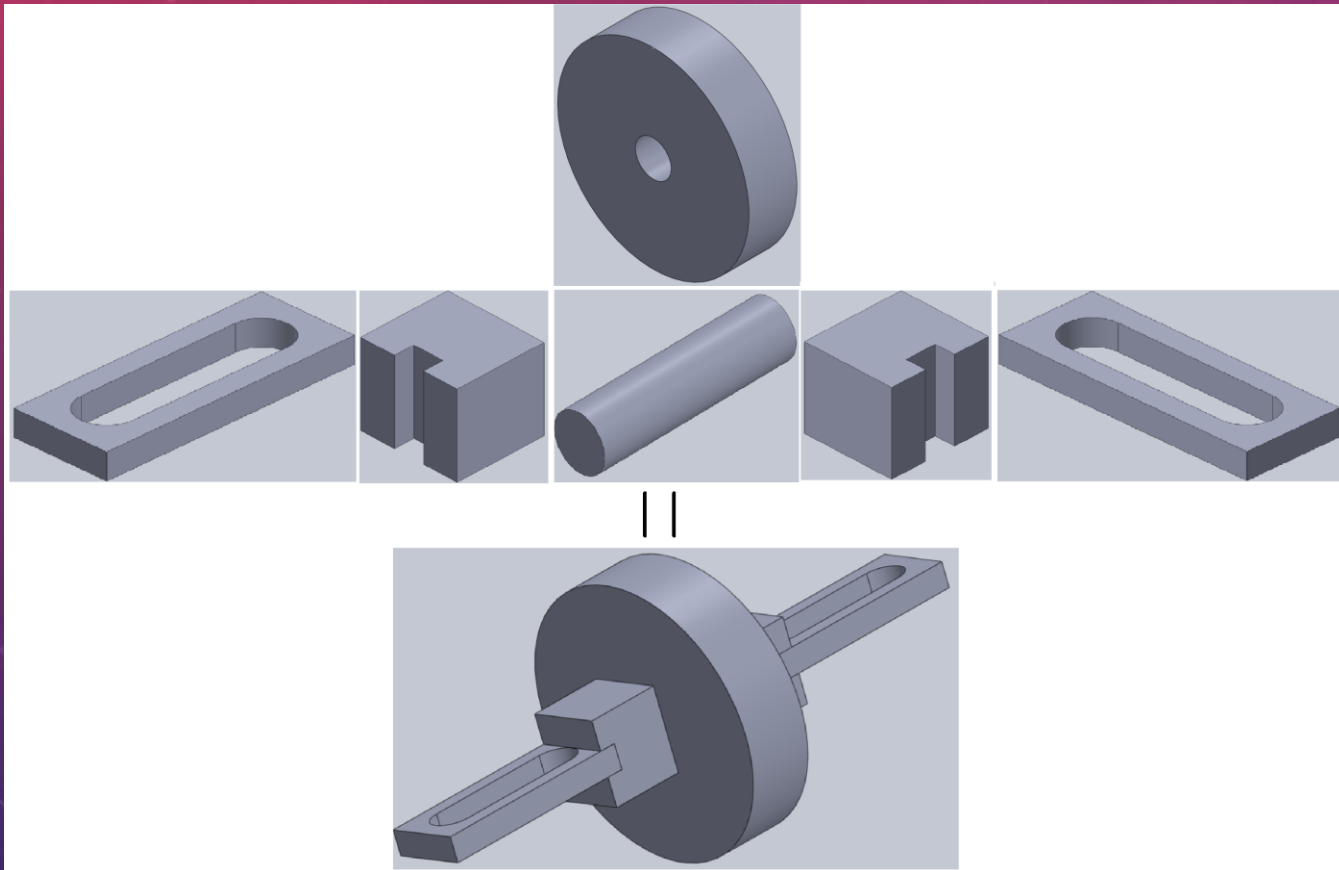
Ackerman Steering Geometry



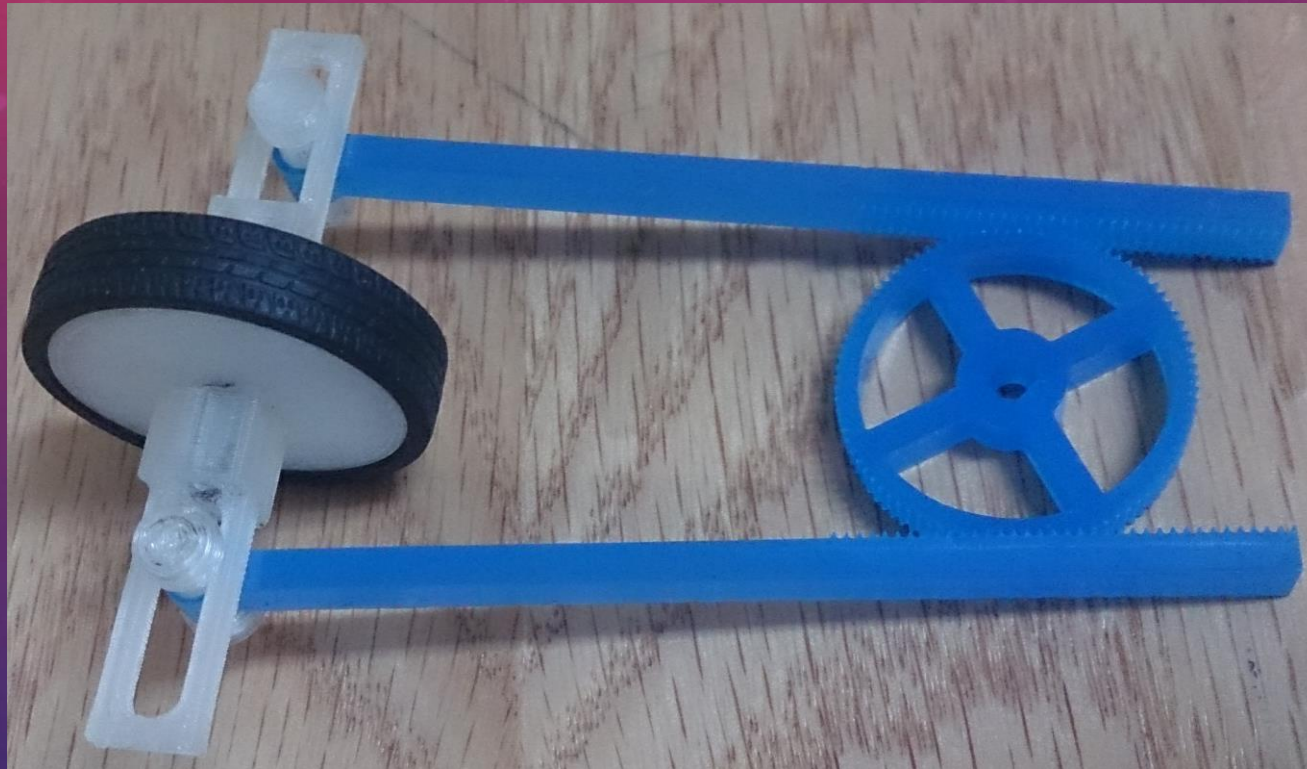
Rack & Pinion



STEERING COMPONENTS DESIGN



STEERING COMPONENTS FABRICATION



FEEDBACK SYSTEM

Speed feedback



Angel feedback



COMMUNICATION



Pilot

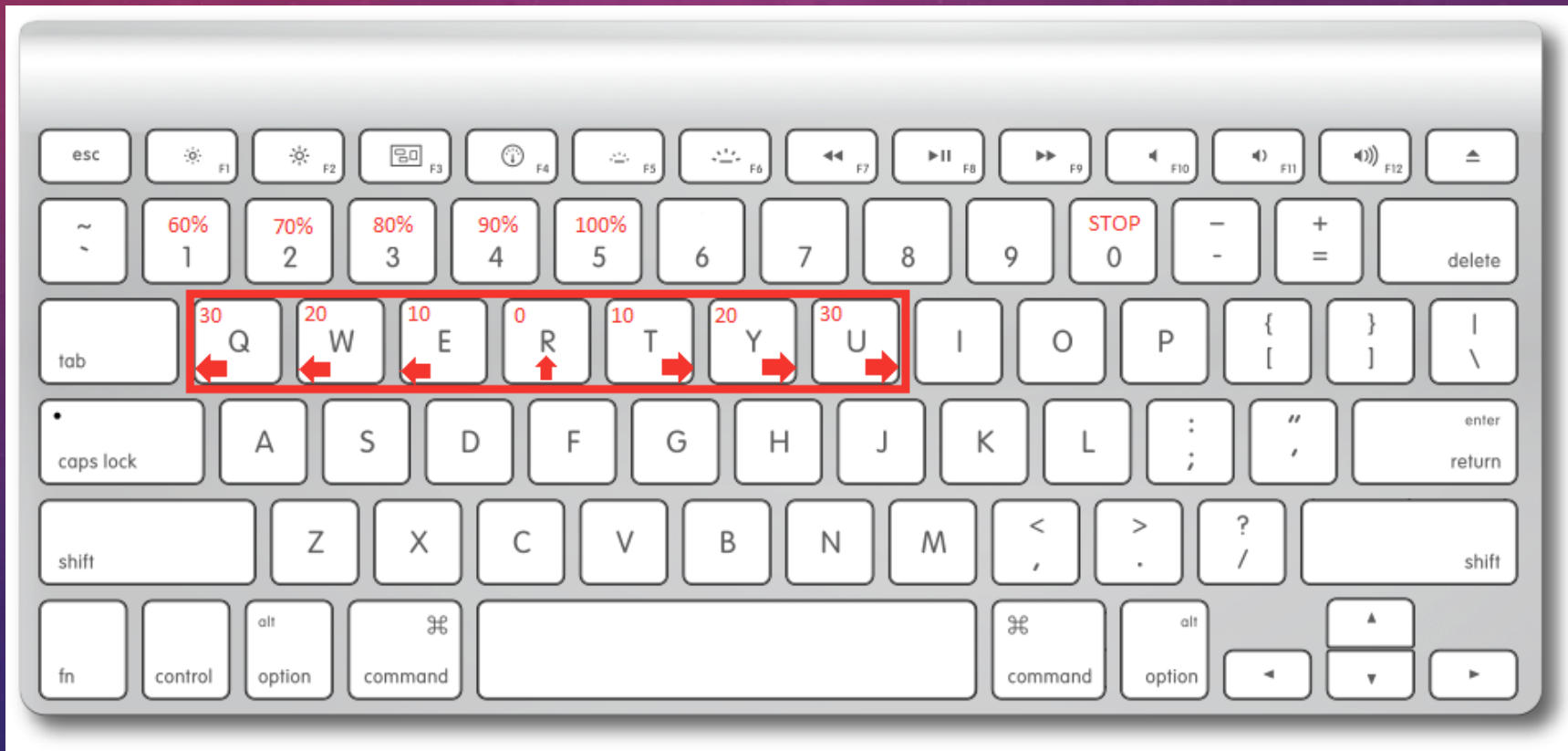
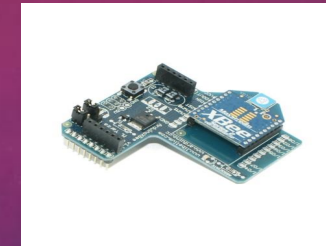
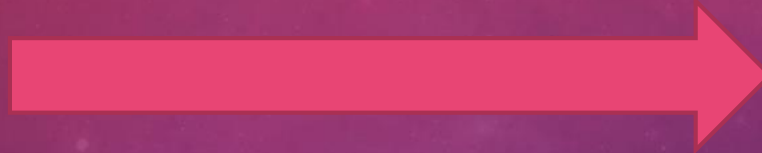


Trailer

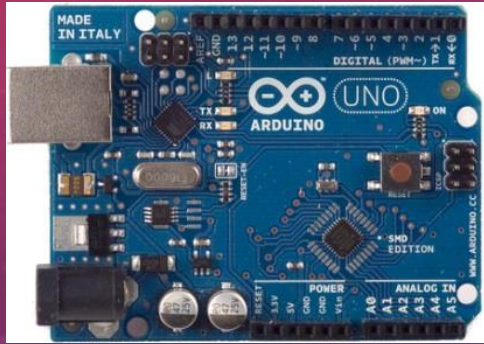
Trailer



USER COMMANDS



DATA STORED



Pilot

- int speedLevel
- int distanceCovered



Trailer

- int distanceCovered
- QueueArray <nextAngel> queue

```
Class nextAngel(){  
• char angel  
• int turnLocation  
}
```


DATA TRANSMITTED

Whenever the can changes direction

Whenever it receives it



- Angel
- distanceCovered

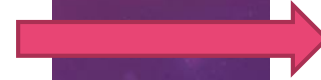
Pilot

Every 10ms

- distanceCovered



Trailer



- Angel
- distanceCovered

Every 10ms

- distanceCovered



Trailer

SPECIAL CASES

- Low batteries.
- Sudden stops

“needs more work”

TESTING

- Communication:

test 1



test2

A screenshot of the XCTU software interface. The window title is 'XCTU'. The interface is divided into two main panels. The left panel, titled 'Radio Modules', lists four modules with their names, functions, and ports. The right panel, titled 'Radio Configuration', shows 'Firmware information' and 'Networking & Security' settings.

Radio Modules

Name	Function	Port
XBEE WIF	XBEE Wi-Fi	usbserial-00001124 - 9600/8/N/1/N - AT
XBEE 802	XBEE 802.15.4	usbserial-00001224 - 9600/8/N/1/N - AT
XBEE 802	XBEE 802.15.4	usbserial-00001424 - 9600/8/N/1/N - AT
XBEE 802	XBEE 802.15.4	PL2303-00001324 - 9600/8/N/1/N - AT

Radio Configuration

Firmware information

Property	Value	Status
Product family	XB24	Written and default
Function set	XBEE 802.15.4	Written and not default
Firmware version	10ec	Changed but not written

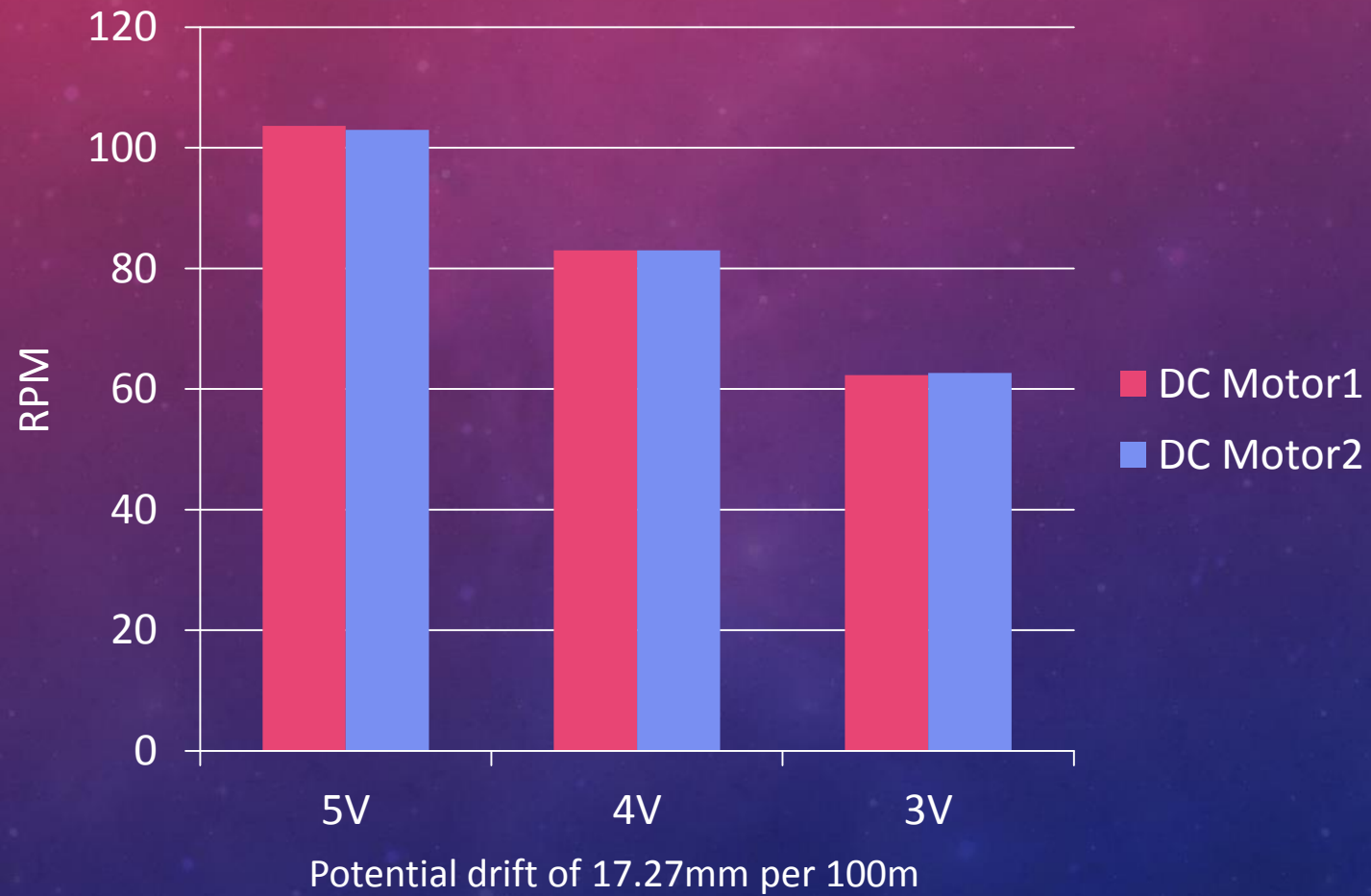
Networking & Security

Modify networking settings

Parameter	Value	Status
CH Channel	C	Written and default
ID PAN ID	3332	Written and default
DH Destination Address High	0	Written and default
DL Destination Address Low	0	Written and default
MY 16-bit Source Address	0	Written and default
MM MAC Mode	802.15.4 + MaxStream header w/ACKS [0]	Written and default
RR XBee Retries	0	Written and default
RN Random Delay Slots	0	Written and default
NT Node Discover Time	19 x 100 ms	Written and default
NO Node Discover Options	0	Written and default
CE Coordinator Enable	End Device [0]	Written and default
SC Scan Channels	1FFE Bitfield	Written and default
SD Scan Duration	4 exponent	Written and default
A1 End Device Association	0000b [0]	Written and default
A2 Coordinator Association	000b [0]	Written and default
AI Association Indication	0	Written and default
EE AES Encryption Enable	Disable [0]	Written and default

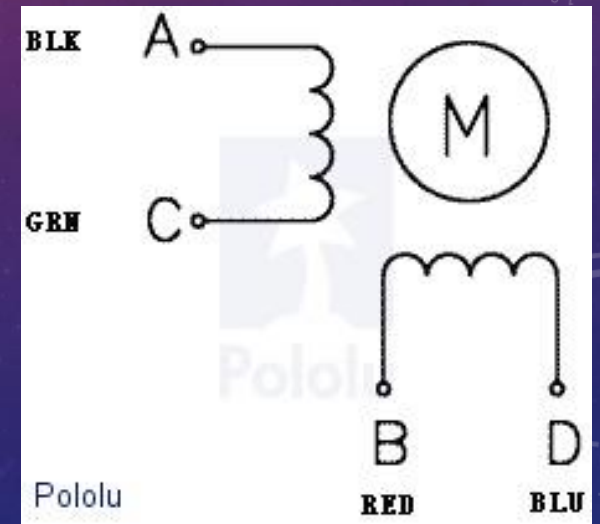
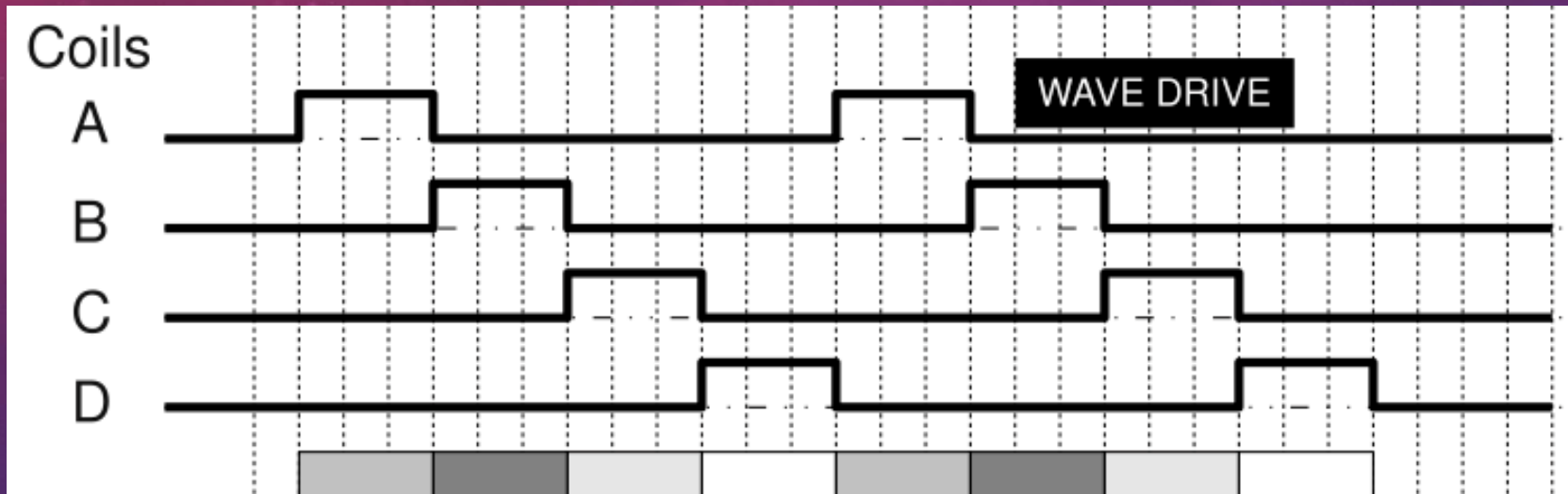
TESTING

- Feedback system:



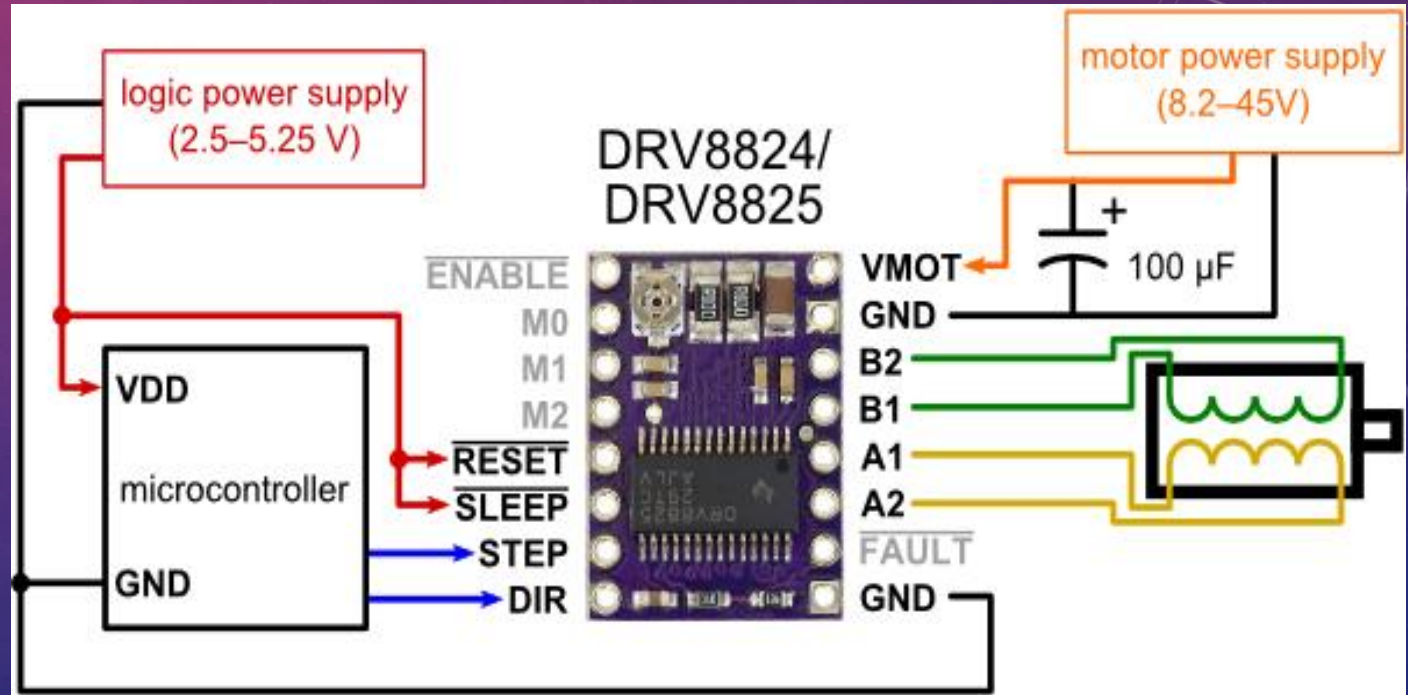
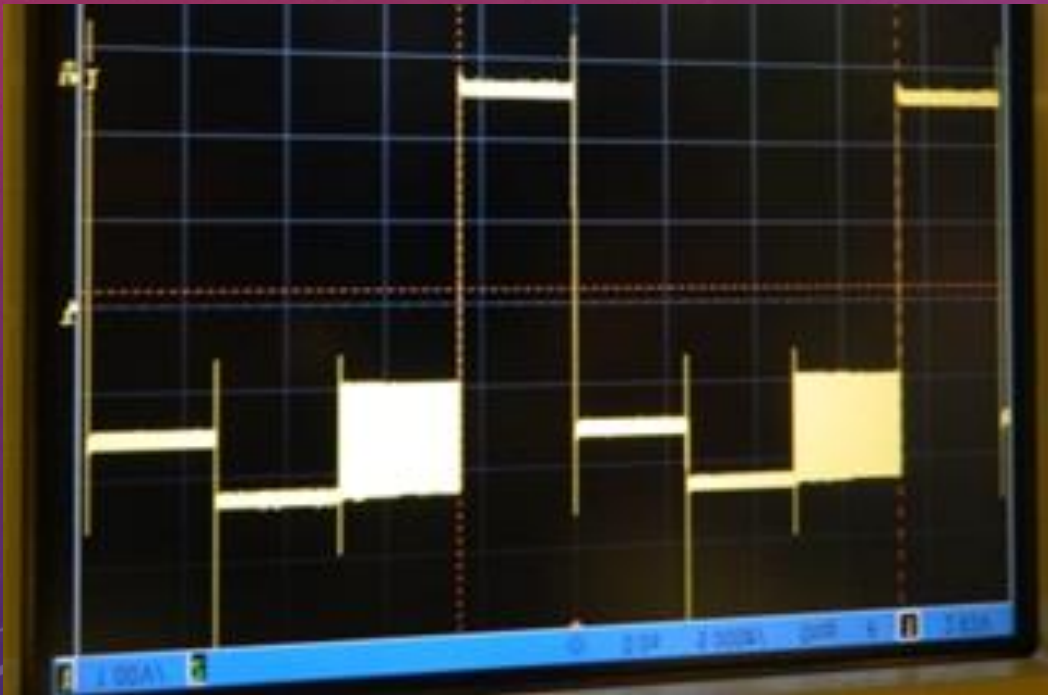
DEBUGGING

- Stepper motor:
 - Direct voltage



DEBUGGING

- Driver:



CONCLUSION

- Feasible solution
 - Considerably cheaper.
 - No infrastructure needed.
- Learned a lot
 - Scheduling.
 - Communication and synchronization.
 - debugging properly.
 - Improvising custom solutions.



STANDARDS:

