Drive Configurations

September 23, 2008

www.robojackets.org

What is a Drive Train?

- A mechanism that moves your robot base to different positions
- Includes several components
  - Motor drivers
  - Motors
  - Gearboxes
  - Wheels/treads
  - Chassis

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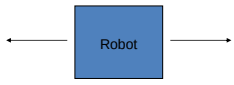
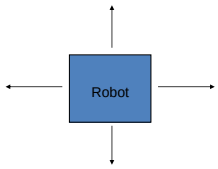
Drive Train Concepts

- Single axis drive
  - Can only move forward or backwards relative to the robot's orientation
  - Turning requires re-orienting the robot



- Double axis drive
  - Can move forward, backwards and sideways without changing the robots orientation



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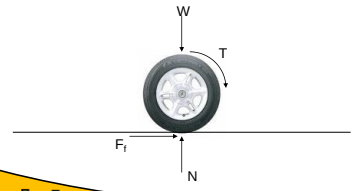
Drive Train Concepts

- Traction
  - A term referring to the amount of force that a wheel or track can apply along the ground without slipping.
  - Related to wheel or track material and contact area.



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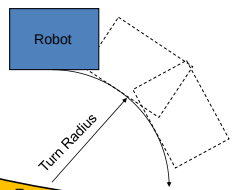
Drive Train Concepts

- Turning Radius
  - The radius of the curve created by a point on the robot when changing the robots orientation.



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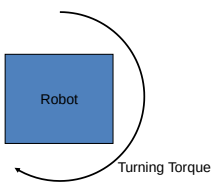
Drive Train Concepts

- Turning effort
  - The force/torque at the wheels required to turn
  - compared to the force required to drive in a straight line.



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Traction Devices (Wheels)

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Solid Wheels

- Construction
  - Inner plastic core (delrin)
  - Outer rubber molding
  - With or with out bearings
- Key Aspects
  - One solid piece
  - Wont go flat
  - Durable

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Pneumatic Wheels

- Construction (think bicycle wheels)
  - Inner core (spoked, metal hub, plastic, etc)
  - Outer rubber air supported surface

Keep inflated!

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Other Wheels

- Semi Pneumatic
  - Foam filled
  - Metal strip reinforced
- Spoke Wheels
- Casters
  - Easy to mount
  - Direction bias

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Omni Wheels

- provide force in only one direction
- use sideways rollers to slide in the other direction

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Mecanum Wheels

- Similar to omni except rollers are at 45 deg

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What to look for in wheels

- Construction
  - Sturdy rims
    - No bicycle tires, no thin plastic rims
- Modifications
  - Inserts
    - If they don't come with bearings → easier
- Intended traction surface (carpet)
  - Don't need huge tread's

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Drive Methods (Wheel Configurations)

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Tank Drive

- Uses two separately controlled drive sides
- Can use wheels or tracks.

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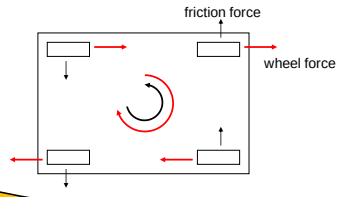
Tank Drive

- Wheel forces generate a turning torque while friction from dragging wheels sideways resists the turning torque
- By having a wheelbase wider than long the turning torque is guaranteed to overcome the frictional resistance torque.



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Tank Drive

- Advantages
  - Mechanically simple
  - Saves space
  - Zero turning radius
  - Simple controls (intuitive)
- Disadvantages
  - More turning effort/traction tradeoff
  - Single axis of motion
- Other
  - High traction can be achieved although at the cost of more turning effort

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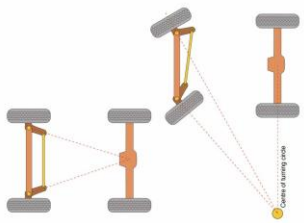
Swerve Drive

- Uses Ackermann style steering with wheels that pivot to create a curved driving path.



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Swerve Drive

- Advantages
  - mechanically simple (with 2WD)
  - low turning effort with high traction wheels
  - Simple controls in open areas
- Disadvantages
  - large turning radius
  - difficult to power all wheels
  - can lose traction on non-level terrain
  - difficult to control in tight spaces due to turn radius

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Crab Drive

- Allows each wheel to pivot so all wheels face the driving direction.
- Wheels can pivot independently or synchronously

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Crab Drive

- Advantages
  - Very low turning effort
  - High traction with all wheels in driving direction
  - Very maneuverable
- Disadvantages
  - Mechanically complex
  - Current designs take up a lot of space
  - Difficult controls (non-intuitive)

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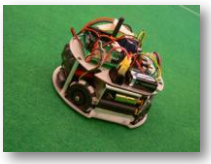
Holonomic - Omni-Drive

- Uses omni-wheels to achieve double axis drive
- Sacrifices traction for maneuverability

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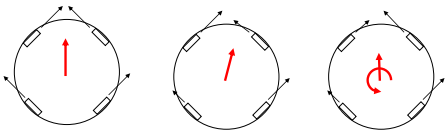
Holonomic - Omni-Drive

- Wheels are placed in a formation that allows for motion in all directions.
- By adding velocity vectors (speeds and directions) the motion of the robot can be controlled



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Holonomic - Omni-Drive

- Advantages
  - Very low turning effort
  - Very maneuverable
  - Mechanically simpler than crab drive
- Disadvantages
  - Complex controls (non-intuitive)
  - Low traction
  - Omni wheels can fail with so many moving parts (plastic)

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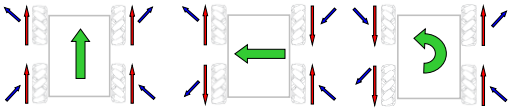
Holonomic - Mecanum

- Wheels are placed in a tank style layout
- Forces are at 45 degrees due to rollers
- Add up velocities similar to omni.



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Holonomic - Mecanum

- Advantages
  - Very low turning effort
  - Very maneuverable
  - Same wheel layout as tank
- Disadvantages
  - Complex controls (non-intuitive)
  - Mechanum wheels are more complex than omni wheels

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Drive Base Inspection

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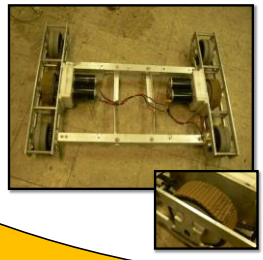
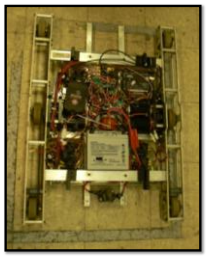
Wide or Narrow

2006 CircuitRunners



2008 TechnoTitans



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Configurations Seen in FIRST

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3x3 Tank

- Past kit bots have this configuration (2x2)
- Middle wheels should be lower to give added turning performance.
- Advantages
  - Good strength for pushing
  - Relatively simple
- Disadvantages
  - Less turning performance than Ackerman

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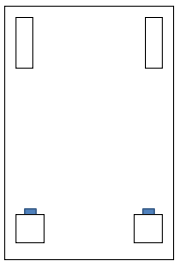
Tank w/ castors



- Advantages
  - Mechanically simple
- Disadvantages
  - Castor bias
  - No traction in front or back (depending on configuration)
  - If motors aren't properly controlled
    - Could pop up

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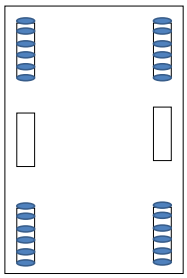
Tank w/ Omnis

- Idea
  - Make it easier to turn while still retaining some traction.
- Advantages
  - No castor bias
  - Reduced turning friction
- Disadvantages
  - Easier to get spun around by opponent



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Resources for wheels

- Further reading
  - http://en.wikipedia.org/wiki/Wheel
- Places to buy
  - http://www.mscdirect.com
  - http://www.robotmarketplace.com
  - http://www.mcmaster.com
  - http://www.andymark.biz

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