

# DD ROBOT

- Magnus Videos Control
- Differential Drive Robot (DD\_Robot)
  - Magnus Model of DD\_Robot
- Engineering Education Academy Model

<https://www.youtube.com/@mouhknowsbest>

Magnus-  
Control Videos  
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Odometry 33K views • 10 years ago

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Control Design Basics 10K views • 10 years ago

**Implementation**

- Each time the controller is called

```
void #1  
a_dot=0; //old_w;  
E=E-r;  
u=k1*r+k2*E;  
old_w=u;
```

10:27

**Control of Mobile Robots- 1.8 Implementation**

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**Control of Mobile Robots-1.4 Cruise-Controllers**

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**Lecture 1.3 – On the Need for Models**

- Control Theory – How pick the input signal  $u$ ?
- Objectives:
  - Stability
  - Tracking
  - Robustness
  - Disturbance rejection
  - Optimality

10:40

**Control of Mobile Robots-1.3 On the Need for Models**

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**The Basic Building Blocks**

- State – Representation of what the system is currently doing
- Dynamics – Description of how the state changes
- Reference – What we want the system to do
- Output – Measurement of (some aspects of) the system

7:27

**Control of Mobile Robots-1.2 What's Control Theory Anyway**

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**Lecture 1.1 – Control of Mobile Robots**

- Magnus Egerstedt
  - Professor, School of Electrical and Computer Engineering, Georgia Institute of Technology
  - Two research domains
    - Control theory
    - Robotics
  - Research domains
    - Swarm robotics
    - Behavior-based control
    - Field robotics

8:08

**Control of Mobile Robots-1.1 Control of Mobile Robots**

C63 AMG Black Series INSANE BURNOUT

1:05

peugeot 508 RXH

1:04

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peugeot RCZ

0:30

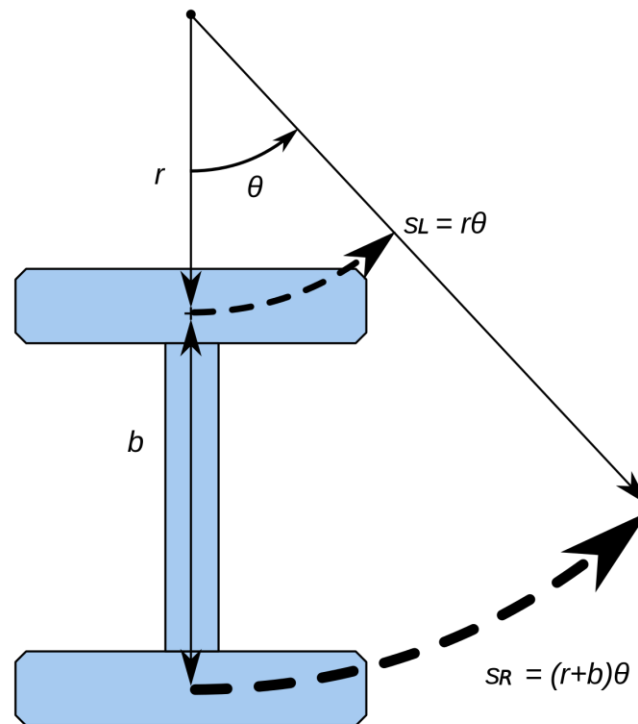
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2

54°F Mostly su... 7:30 PM

[https://en.wikipedia.org/wiki/Differential\\_wheeled\\_robot](https://en.wikipedia.org/wiki/Differential_wheeled_robot)

A **differential wheeled robot** is a [mobile robot](#) whose movement is based on two separately driven [wheels](#) placed on either side of the robot body. It can thus change its direction by varying the relative rate of rotation of its wheels and hence does not require an additional steering motion. Robots with such a drive typically have one or more castor wheels to prevent the vehicle from tilting.



NOTE: NOATION DIFFERS  
FOR EVERY DISCUSSION OF DD\_ROBOTS!!

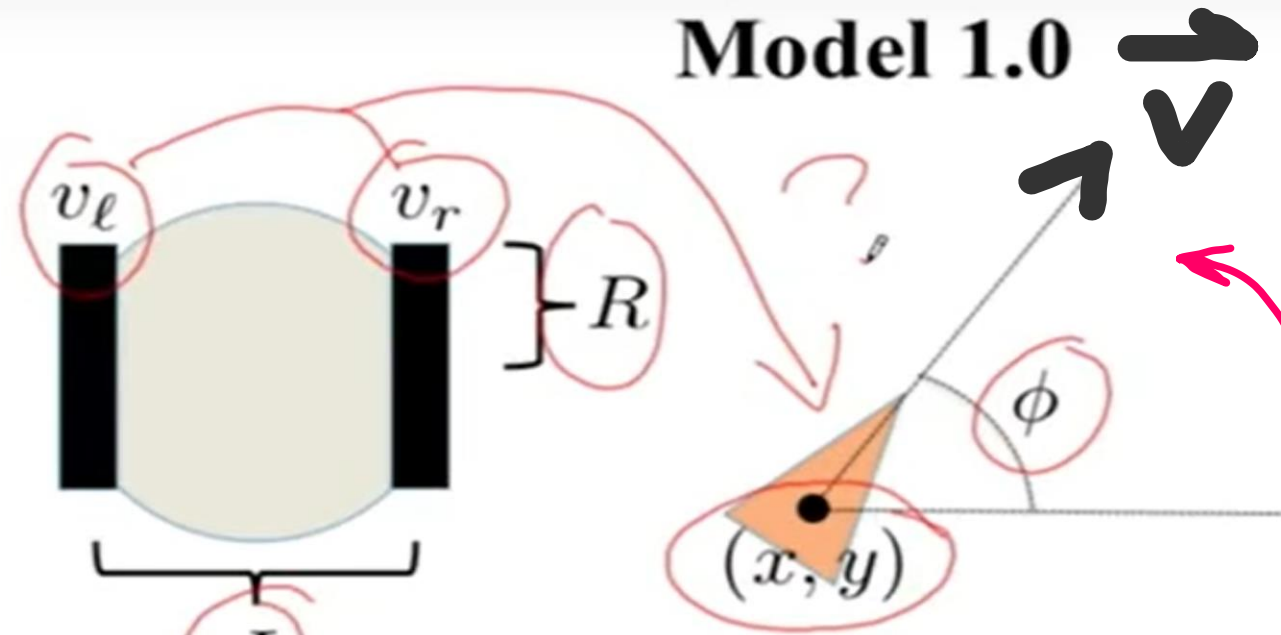
Control of Mobile Robots- 2.2 Differential Drive Robots

Press Esc to exit full screen

## Lecture 2.2 – Differential Drive Robots

- In order to control mobile robots, we need models
- Differential drive wheeled robots – a very common type





### Model 1.0

$$\omega = \dot{\phi}$$

Changes in x, y  
in m/sec terms of  
wheel rotational velocities  
rad/sec.

$$\begin{cases} \dot{x} = \frac{R}{2}(v_r + v_l) \cos \phi \\ \dot{y} = \frac{R}{2}(v_r + v_l) \sin \phi \\ \dot{\phi} = \frac{R}{L}(v_r - v_l) \end{cases}$$



## Magnus Result

- R wheel radius (m)
- L wheel base (m)
- $v_r, v_l$  wheel rotation (rad/sec)
- x projection of  $\mathbf{V}$  on x axis
- y projection of  $\mathbf{V}$  on y axis
- w robot rotation (rad/sec)

Inputs to Robot - Controlled

- $v_r, v_l$  rate of rotation of wheels in radians/sec

Desired Motion of Robot (Commands)

- v m/s and w rad/sec
- So v is magnitude of vector  $\mathbf{V}$

## Model 2.0

$$\begin{cases} \dot{x} = v \cos \phi \\ \dot{y} = v \sin \phi \\ \dot{\phi} = \omega \end{cases}$$

Design for this model!

$$v = \frac{R}{2}(v_r + v_l) \Rightarrow \frac{2v}{R} = v_r + v_l$$
$$\omega = \frac{R}{L}(v_r - v_l) \Rightarrow \frac{\omega L}{R} = v_r - v_l$$

$$\begin{cases} \dot{x} = \frac{R}{2}(v_r + v_l) \cos \phi \\ \dot{y} = \frac{R}{2}(v_r + v_l) \sin \phi \\ \dot{\phi} = \frac{R}{L}(v_r - v_l) \end{cases}$$

Implement this model!

$$v_r = \frac{2v + \omega L}{2R}$$
$$v_l = \frac{2v - \omega L}{2R}$$

far the wheels are apart, and the radius of the wheel. And with these parameters,

# Engineering Education Academy

## Kinematics of Differential Drive Robots and Odometry

<https://www.youtube.com/watch?v=RZIZcDxQ8P4>

12,491 views Jul 31, 2021 [Robotics](#)

**Differential Forward Kinematics Equations of Differential-Drive robots** along with explanation of the non-holonomic motion constraints for them and odometry accompanied by MATLAB demos and animations are studied in this video.

Robot Pose: [2:42](#)

Derivation of Differential Forward Kinematics Equations: [3:24](#)

Different Types of Motion for Differential-Drive Robots: [23:25](#)

MATLAB Animation Demo: [28:07](#)

Non-Holonomic\* Motion Constraint: [31:17](#)

Pfaffian Constraints: [37:41](#)

Odometry: [38:54](#)

\* **Robot cannot move SIDEWAYS**

# Kinematics of Differential Drive Robots and Odometry

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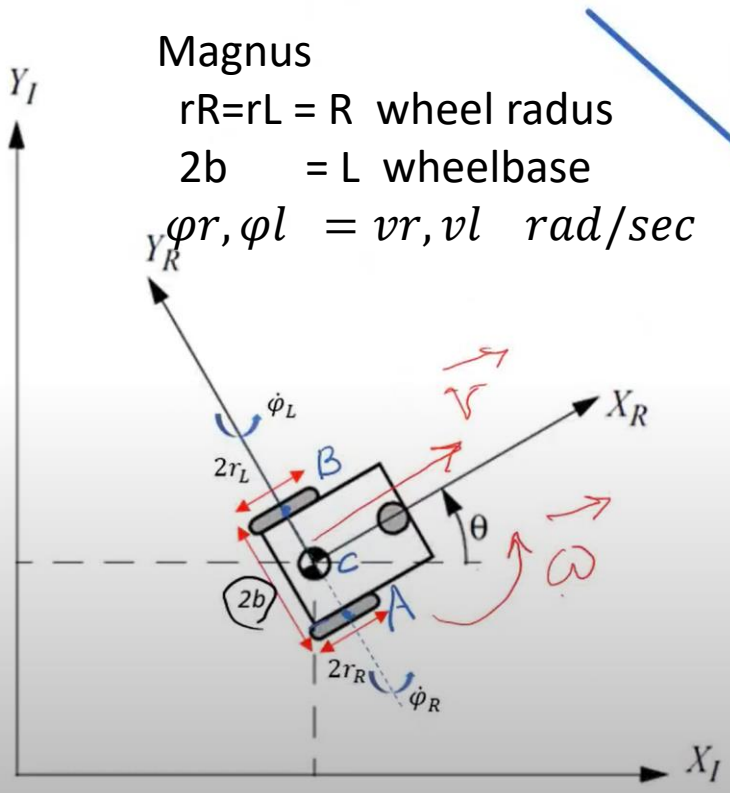
Mobile Robot Kinematics

New Section 1 New Section 2 New Section 4 New Section 5 New Section 3 New Section 6

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Difference in RPM of the wheels makes the robot move forward/backward and rotate:

Magnus  
 $r_R = r_L = R$  wheel radius  
 $2b = L$  wheelbase  
 $\phi_r, \phi_l = v_r, v_l$  rad/sec



$$\begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = R_z(\theta) \begin{bmatrix} V \\ 0 \\ \omega \end{bmatrix} = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 \\ \sin(\theta) & \cos(\theta) & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} V \\ 0 \\ \omega \end{bmatrix} \quad (1)$$

$$\begin{bmatrix} V \\ \omega \end{bmatrix} = \begin{bmatrix} \frac{r_R}{2} & \frac{r_L}{2} \\ r_R & -r_L \\ 2b & -2b \end{bmatrix} \begin{bmatrix} \dot{\phi}_R \\ \dot{\phi}_L \end{bmatrix} \quad (2)$$

$$(1) \& (2) \Rightarrow \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix} = \begin{bmatrix} \frac{r_R}{2} \cos(\theta) & \frac{r_L}{2} \cos(\theta) \\ \frac{r_R}{2} \sin(\theta) & \frac{r_L}{2} \sin(\theta) \\ \frac{r_R}{2b} & -\frac{r_L}{2b} \end{bmatrix} \begin{bmatrix} \dot{\phi}_R \\ \dot{\phi}_L \end{bmatrix} \quad (3)$$

+ Add Page

Differential Drive Robots:



GET USED TO VARIOUS NOTATIONS -  
THE MATH RESULT SHOULD BE THE SAME