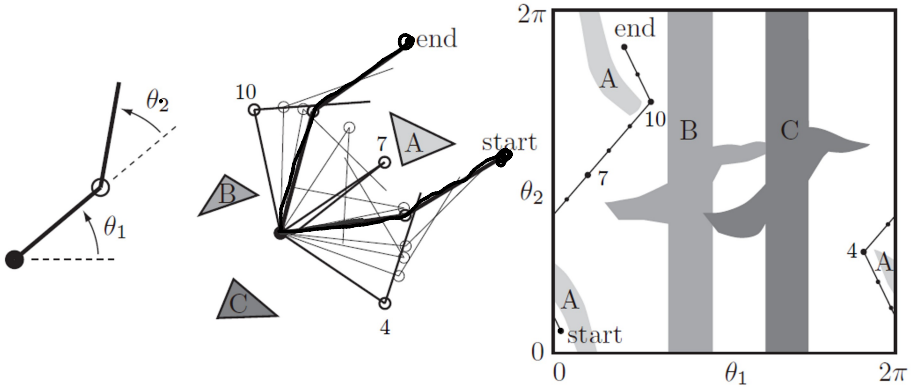
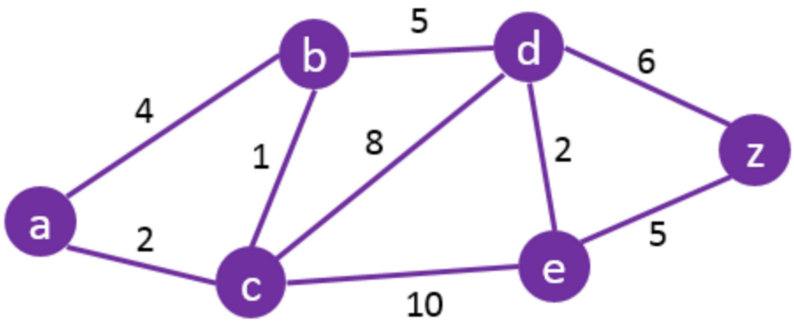
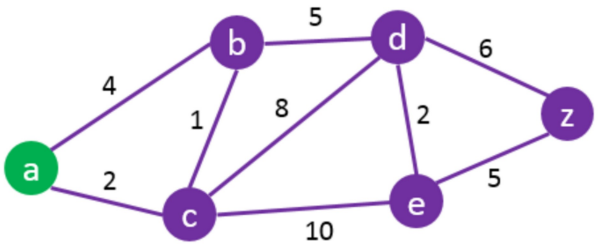
Path Planning - Σχεδιασμός Τροχιάς

Sunday, May 24, 2020 11:59 PM

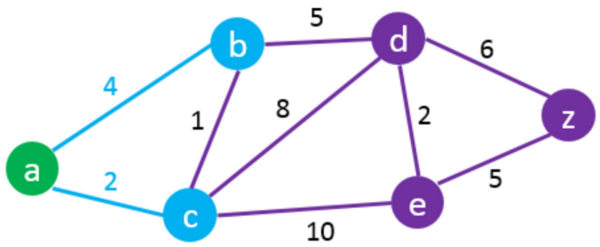


Dijkstra's Shortest Path

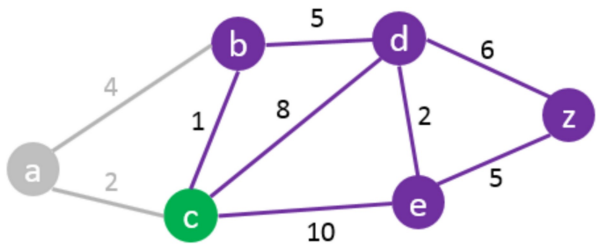




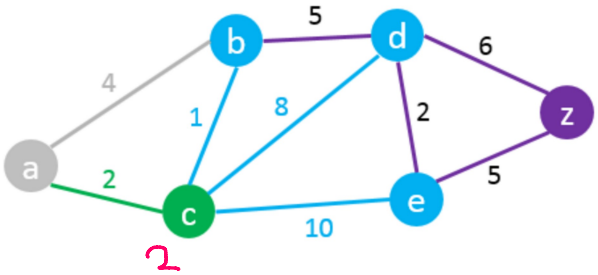
Node	Status	Shortest Distance From A	Previous Node
A	Current Node	0	
B		∞	
C		∞	
D		∞	
E		∞	
Z		∞	



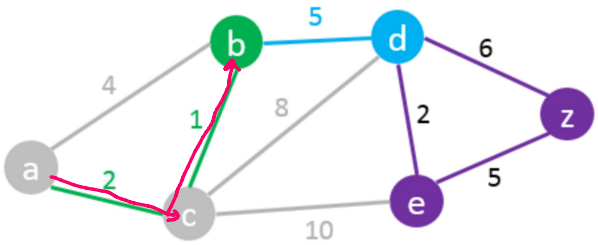
Node	Status	Shortest Distance From A	Previous Node
A	Current Node	0	
B		∞ 4	A
C		∞ 2	A
D		∞	
E		∞	
Z		∞	



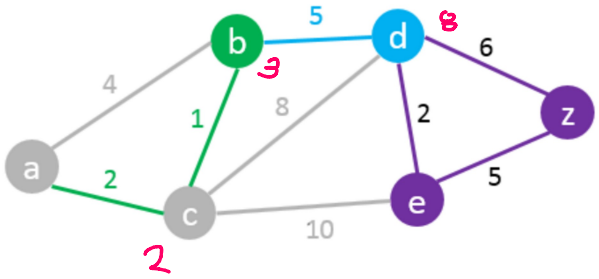
Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B		∞ 4	A
C	Current Node	∞ 2	A
D		∞	
E		∞	
Z		∞	



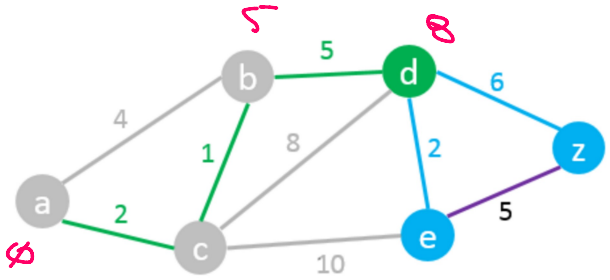
Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B		4 2+1=3	C
C	Current Node	2	A
D		∞ 2+8=10	C
E		∞ 2+10=12	C
Z		∞	

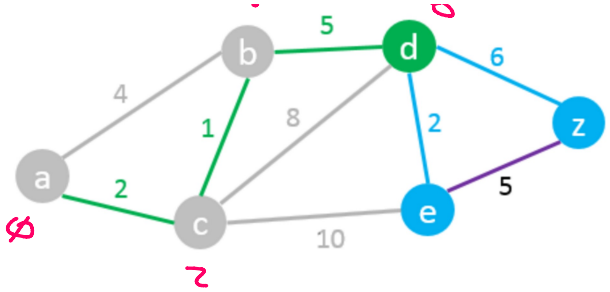


Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B	Current Node	3	C
C	Visited Node	2	A
D		10	C
E		12	C
Z		∞	

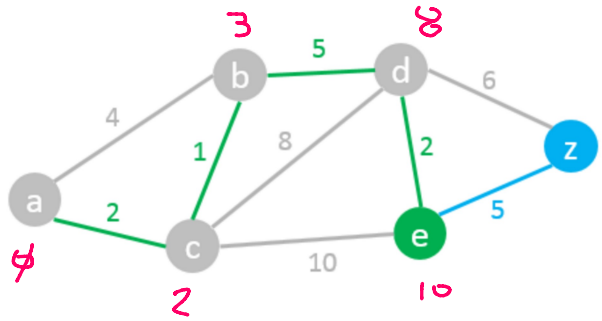


Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B	Current Node	3	C
C	Visited Node	2	A
D		~~10~~ 3+5=8	B
E		12	C
Z		∞	

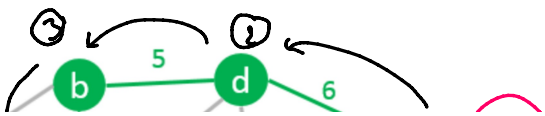


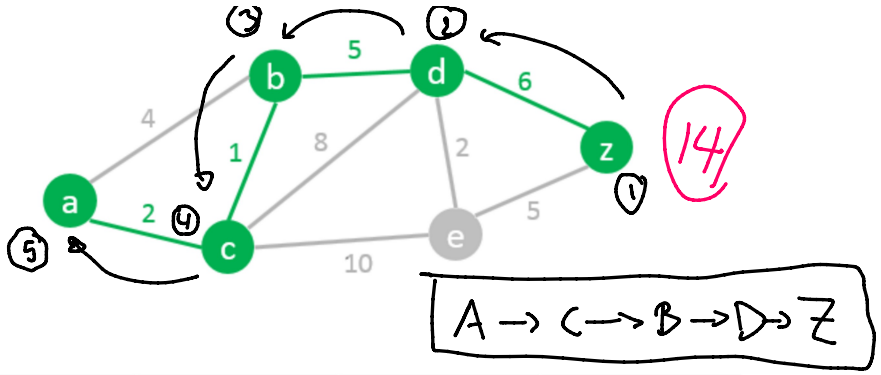


Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B	Visited Node	3	C
C	Visited Node	2	A
D	Current Node	8	B
E		~~12~~ 8 + 2 = 10	D
Z		~~∞~~ 8 + 6 = 14	D



Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B	Visited Node	3	C
C	Visited Node	2	A
D	Visited Node	8	B
E	Current Node	10	D
Z		14 ~~10 +5 =15~~	D





Node	Status	Shortest Distance From A	Previous Node
A	Visited Node	0	
B	Visited Node	3	C
C	Visited Node	2	A
D	Visited Node	8	B
E	Visited Node	10	D
Z	Current Node	14	D

https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm#/media/File:DijkstraDemo.gif

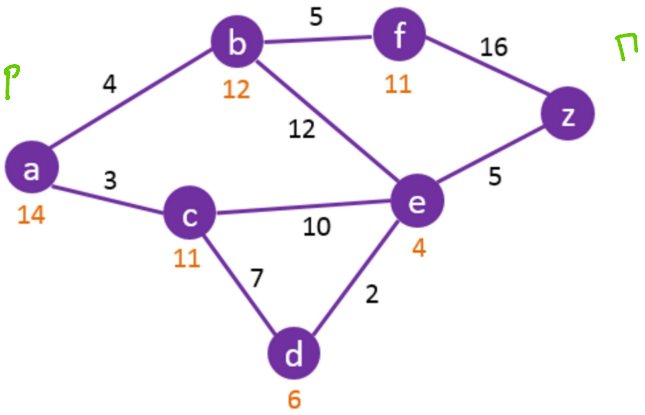
BPOx01

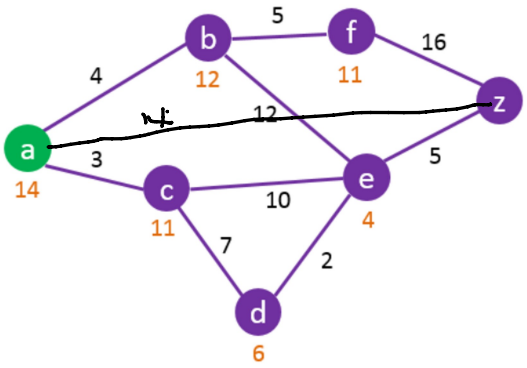
$$O\left(|E| + |V| \log \frac{|E|}{|V|} \log |V|\right)$$

kOMBo1

A* Shortest Path

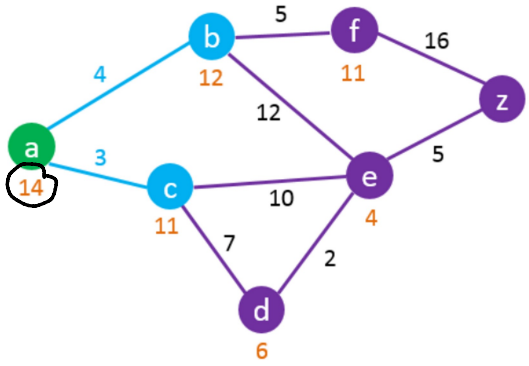
A → Z



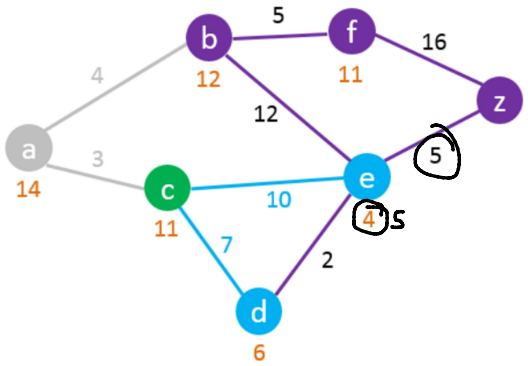


Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Current	0	14	14	
B		∞	12		
C		∞	11		
D		∞	6		
E		∞	4		
F		∞	11		
Z		∞	0		

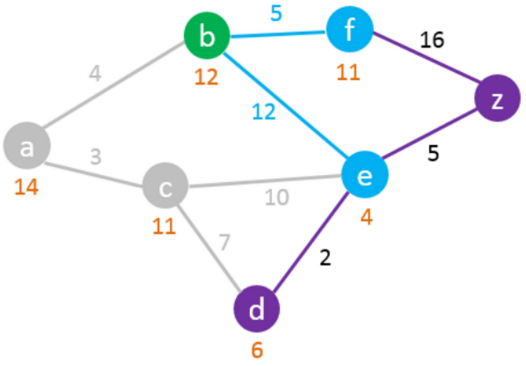
* Total Distance = Shortest Distance from A + Heuristic Distance to Z



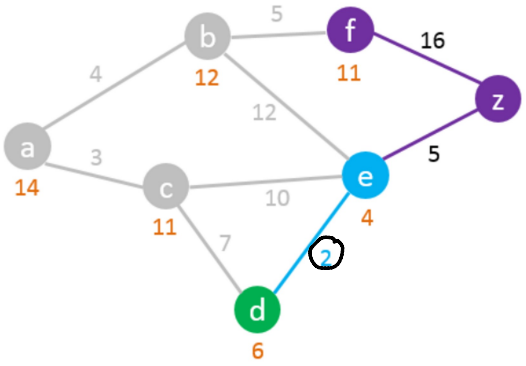
Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Current	0	14	14	
B		∞ 4	12	16	A
C		∞ 3	11	14	A
D		∞	6		
E		∞	4		
F		∞	11		
Z		∞	0		



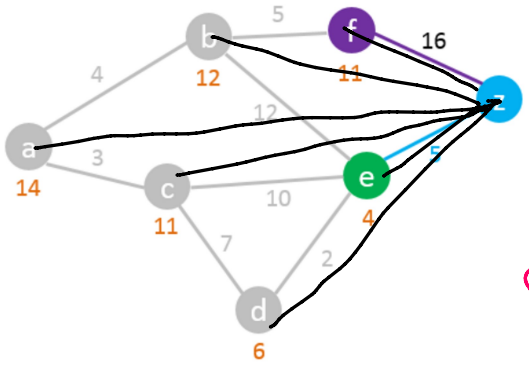
Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Visited	0	14	14	
B		4	12	16	A
C	Current	3	11	14	A
D		∞ 3+7=10	6	16	C
E		∞ 3+10=13	4	17	C
F		∞	11	∞	
Z		∞	0	∞	



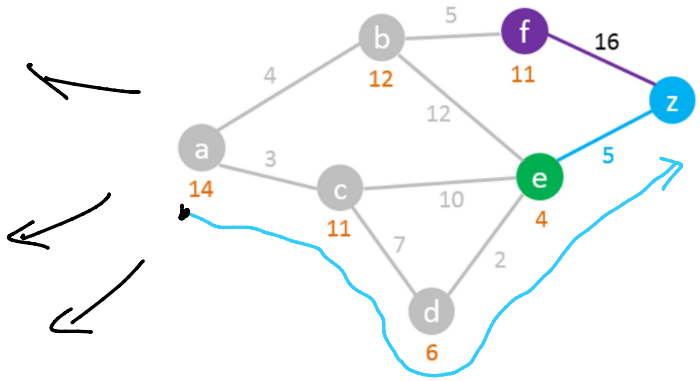
Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Visited	0	14	14	
B	Current	4	12	16	A
C	Visited	3	11	14	A
D		10	6	16	C
E		13 4+12=16	4	17	C
F		∞ 4+5=9	11	20	B
Z		∞	0		



Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Visited	0	14	14	
B	Visited	4	12	16	A
C	Visited	3	11	14	A
D	Current	10	6	16	C
E		10+2=12	4	16	D
F		9	11	20	B
Z		∞	0		



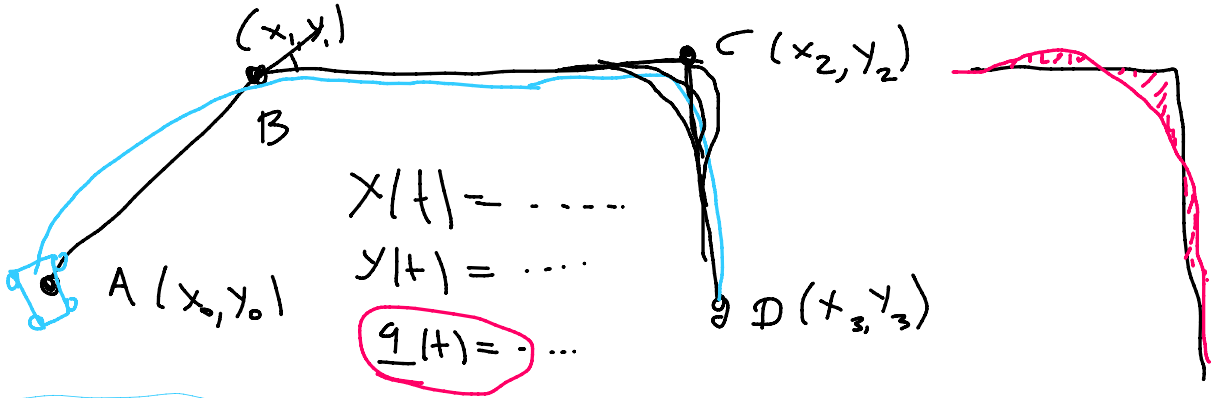
Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Visited	0	14	14	
B	Visited	4	12	16	A
C	Visited	3	11	14	A
D	Visited	10	6	16	C
E	Current	12	4	16	D
F		9	11	20	B
Z		∞ 12+5=17	0	17	E



Node	Status	Shortest Distance From A	Heuristic Distance to Z	Total Distance*	Previous Node
A	Visited	0	14	14	
B	Visited	4	12	16	A
C	Visited	3	11	14	A
D	Visited	10	6	16	C
E	Visited	12	4	16	D
F		9	11	20	B
Z	Current	17	0	17	E

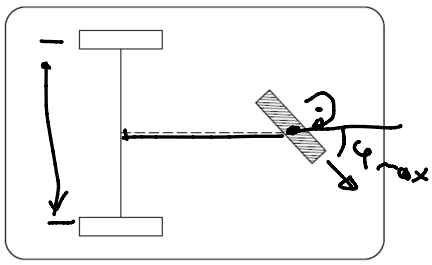
A → C → D → E → Z

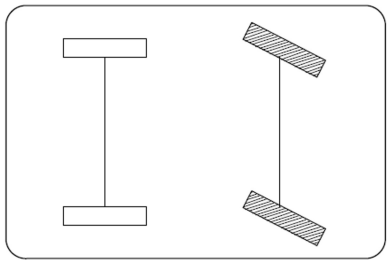
Σχεδιασμός Τροχιάς στο πεδίο του χρόνου

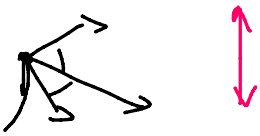


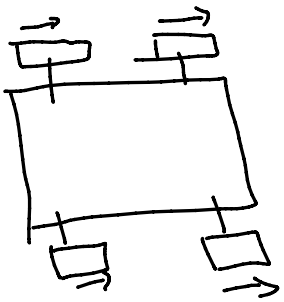
ΠΕΡΙΟΡΙΣΜΟΙ ΚΙΝΗΜΑΤΙΚΗΣ ΟΧΗΜΑΤΟΣ

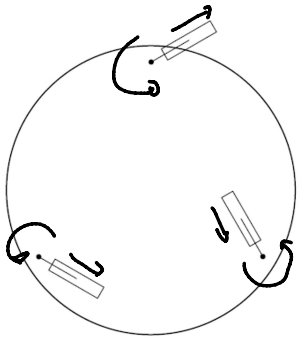
ΑΡΧΙΖΟΥΜΕ 11:15

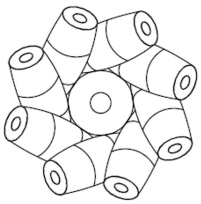






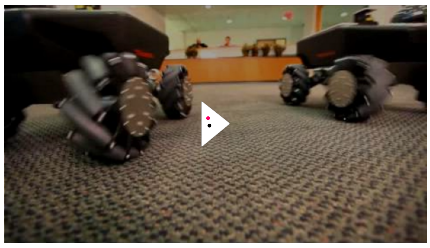




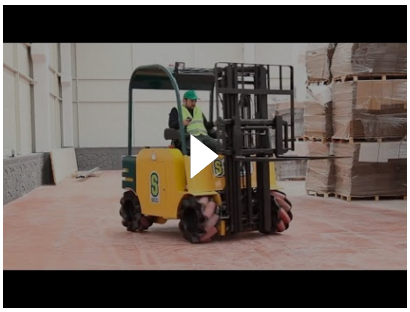


A Mecanum (or Swedish) wheel

Robotnik Summit XL HL OMNI - Mecanum Wheels

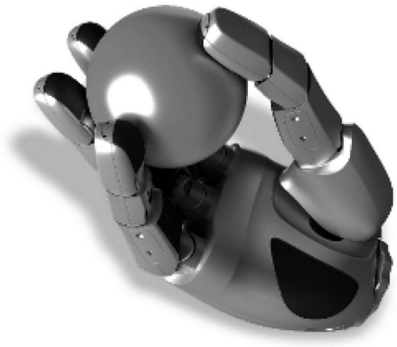


This Forklift Moves In Any Direction!

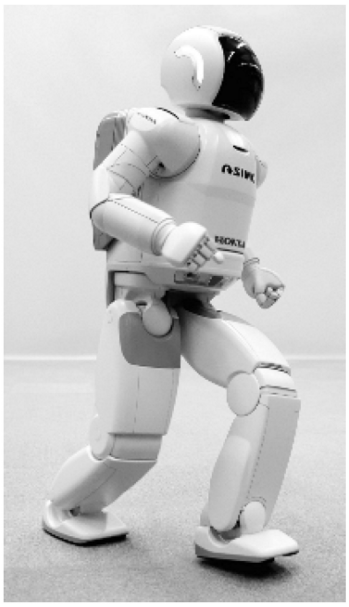


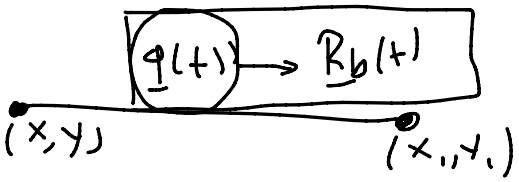
The KUKA KR 60 Jet robot


FlexPicker
ABB

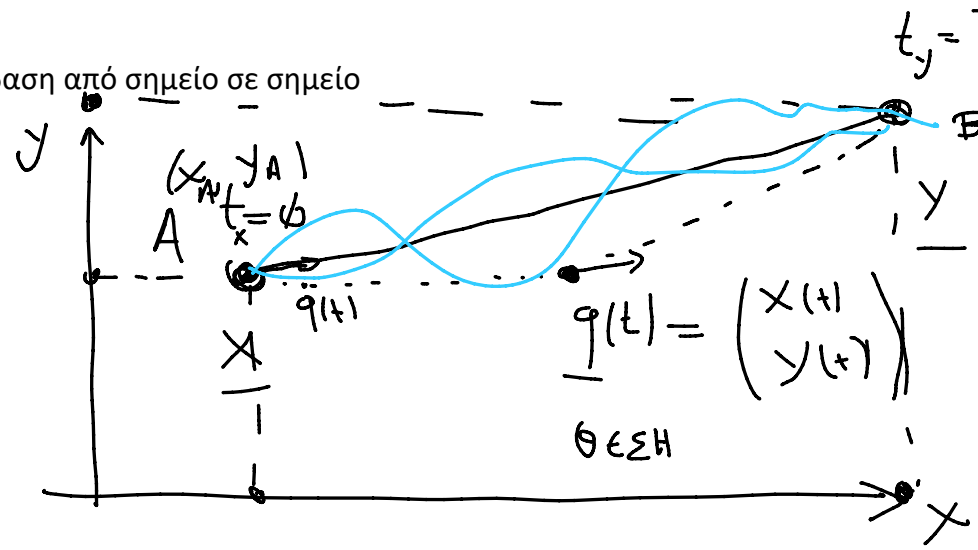


The vacuum robot Roomba, employing a differential-drive kinematics,





Μετάβαση από σημείο σε σημείο



x(t)
y(t)

x(0) = x_A

y(0) = y_A

x(T) = x_B

y(T) = y_B

I: Αδράνεια Moments of inertia

Στ(t): ροπή μοχλέρ

q(t): θέση στο χώρο

$m \cdot \vec{a} = \vec{F}$

Νόμοι κινήσης:

$$I\,\ddot{q}(t) = \Sigma(t)$$

τ

$$\int_0 \dot{\underline{q}}(t)\,dt = \underline{y} - \underline{x}$$

Ο ΠΕΡΙΟΡΙΣΜΟΣ ΤΟΥ ΤΣΙΓΚΟΥΝΗ:

ΕΛΑΧΙΣΤΟΠΟΙΗΣΗ ΡΟΠΗΣ

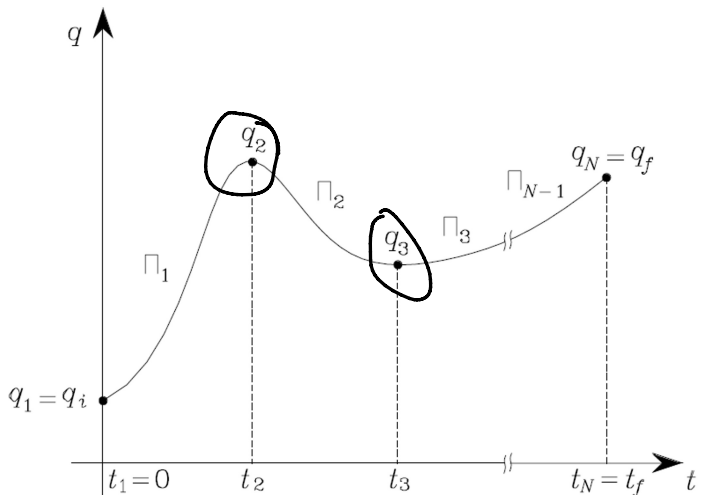
$$\min_{\underline{q}} \int_0^T \left|\ddot{\underline{q}}(t)\right|^2 dt \longrightarrow \underline{q}(t) = \underline{\alpha} t^2 + \underline{\beta} t + \underline{\gamma}$$

$$\Downarrow$$

$$\underline{q}(t) = \underline{a}_3 t^3 + \underline{a}_2 t^2 + \underline{a}_1 t + \underline{a}_0$$

$$\underline{q}(0) = \underline{x}\,, \quad \underline{q}(T) = \underline{y}$$

ΠΑΡΑΔΕΙΓΜΑ ?



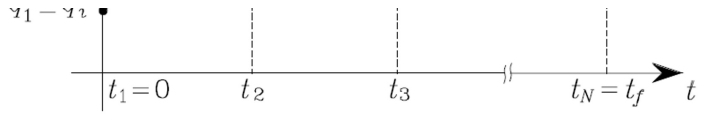
q_1

t_1

t_2

t_3

t_N



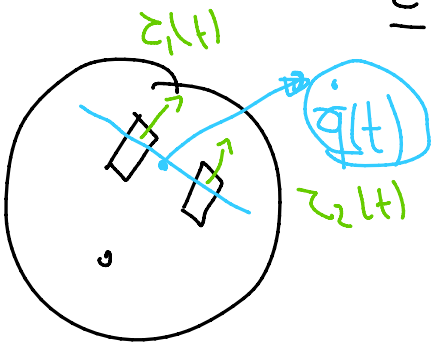
t_N
q_N

$$\underline{q}_k(t) = \underline{A}_k \begin{bmatrix} t^3 \\ t^2 \\ t \\ 1 \end{bmatrix}$$

ΒΡΗΚΑ ΤΟ $\underline{q}(t)$ → ΠΟΙΟ ΕΙΝΑΙ ΤΟ $\underline{z}(t)$?

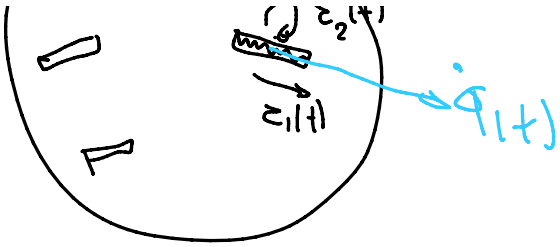
$$\underline{z}(t) = \begin{bmatrix} z_1(t) \\ z_2(t) \end{bmatrix}$$

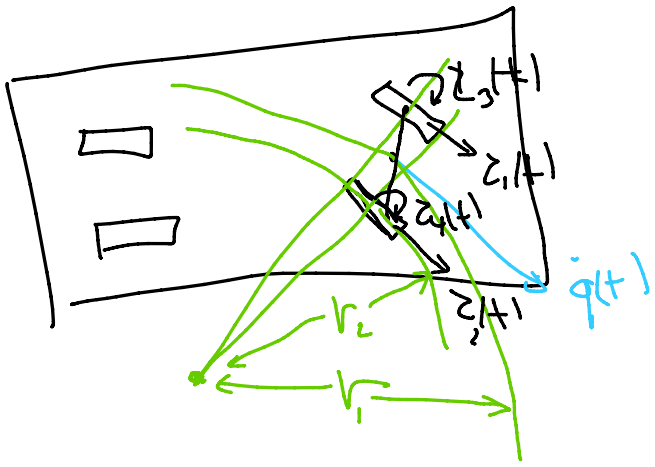
Π.Χ.



ΕΞΑΡΤΑΤΑΙ ΑΠΟ ΤΟ ΣΧΗΜΑ !!!

$$z(t) = \begin{pmatrix} z_1(t) \\ z_2(t) \end{pmatrix}$$





$$\dot{q}(t) \rightarrow \begin{bmatrix} z_1(t) \\ z_2(t) \\ z_3(t) \\ z_4(t) \end{bmatrix}$$

ΣΥΣΤΗΜΑ ΑΥΤΟΚΙΝΗΤΑ

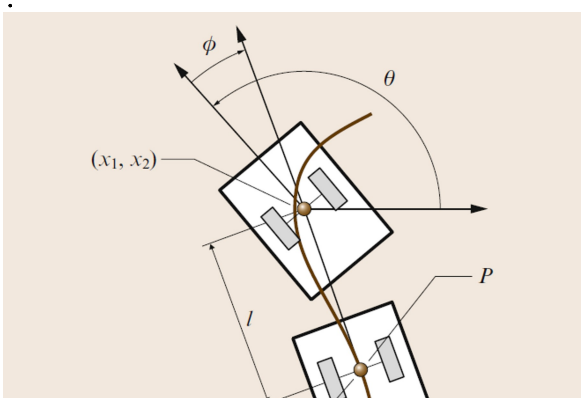
$$q(t) \rightarrow \begin{pmatrix} z_1(t) \\ z_2(t) \\ \vdots \\ z_3(t) \end{pmatrix}$$

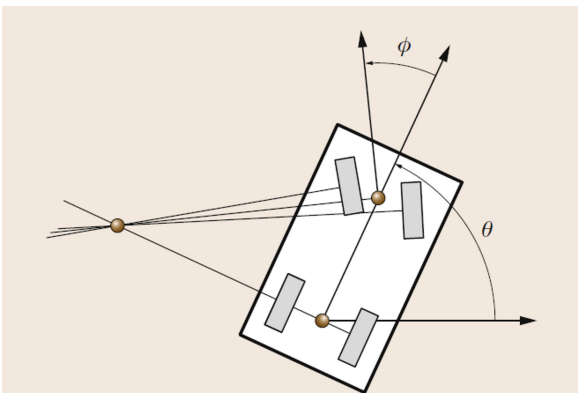
$z_1(t)$ ← ΓΚΑΖΙ

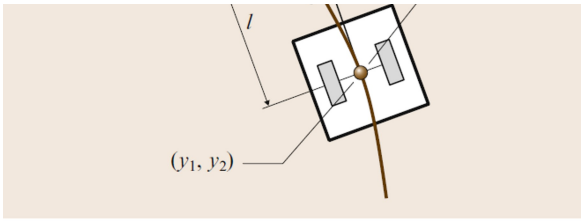
$z_2(t)$ ← ΤΙΜΟΝΙ

ΤΡΟΧΙΑΣΤΙΚΟ

ΧΕΙΡΟΒΡΕΧΙΟ






l
(y_1, y_2)