



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



LEG MECHANISM

Studio e comparazione di 4 meccanismi di locomozione

RELATORE

Prof. Paolo Boscariol

CORRELATORE

Prof. Tamellin

LAUREANDI

Berradi Anass

Dalle Fusine Luca

Lofoco Gregorio

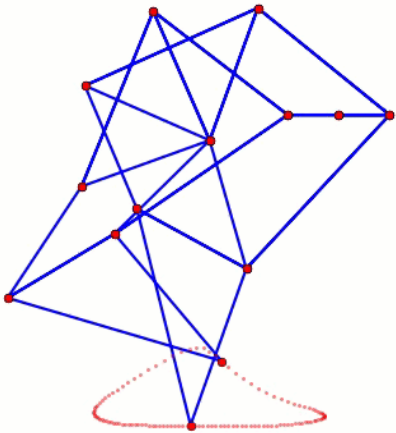
Zheli Arlind



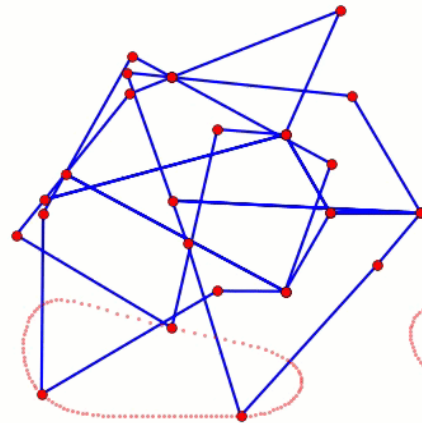
Leg Mechanism

COSA SONO?

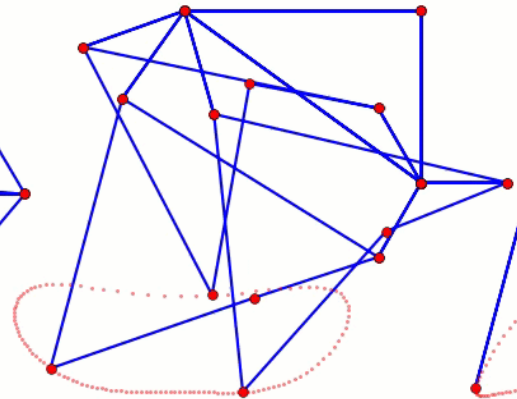
Strandbeest



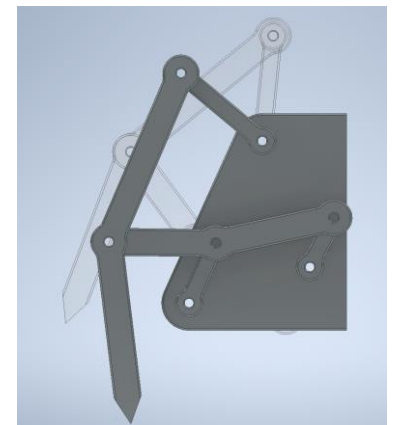
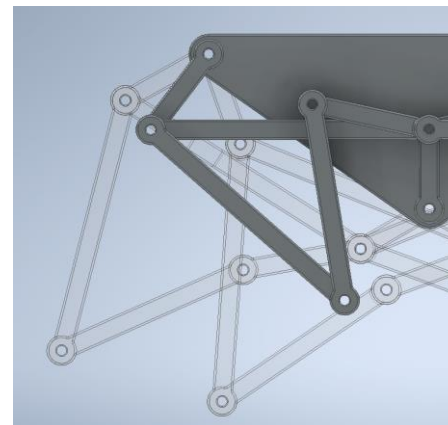
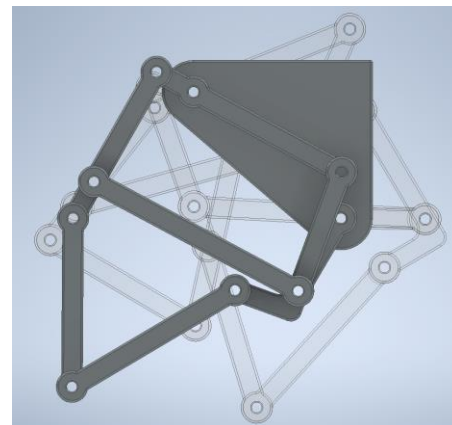
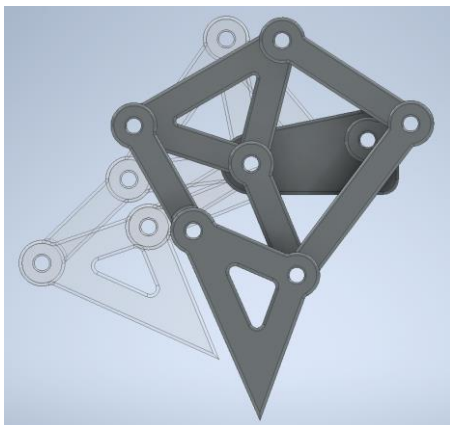
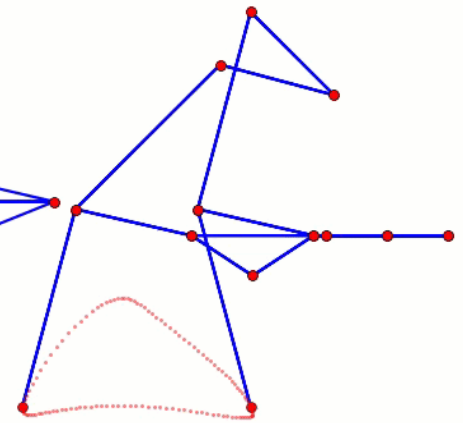
TrotBot



Strider



Klann





Comparazione Meccanismi

PARAMETRI STUDIATI

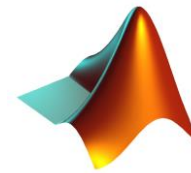
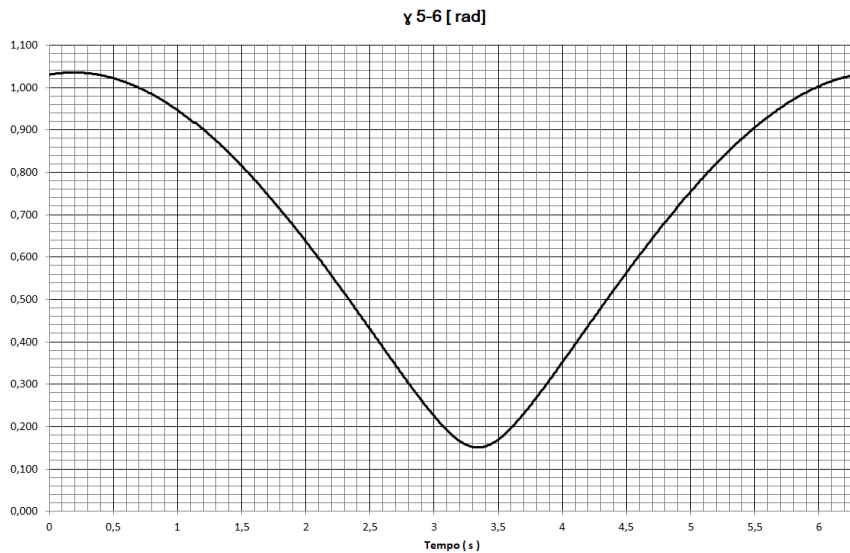
- ***Altezza Passo***
- ***Velocità Meccanismo***
- ***Varianza Velocità***
- ***Costo Energetico***
- ***Stabilità Centro di Massa***



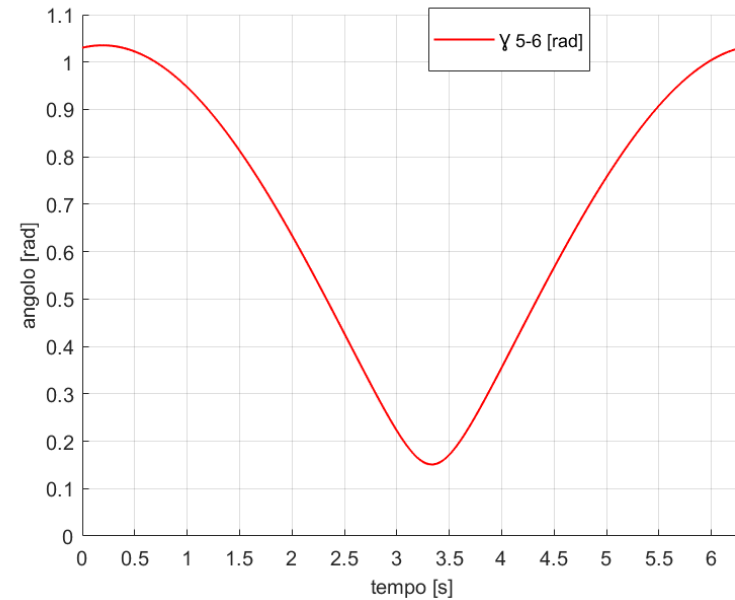
Comparazione Meccanismi

STRUMENTI UTILIZZATI

Inventor



Matlab

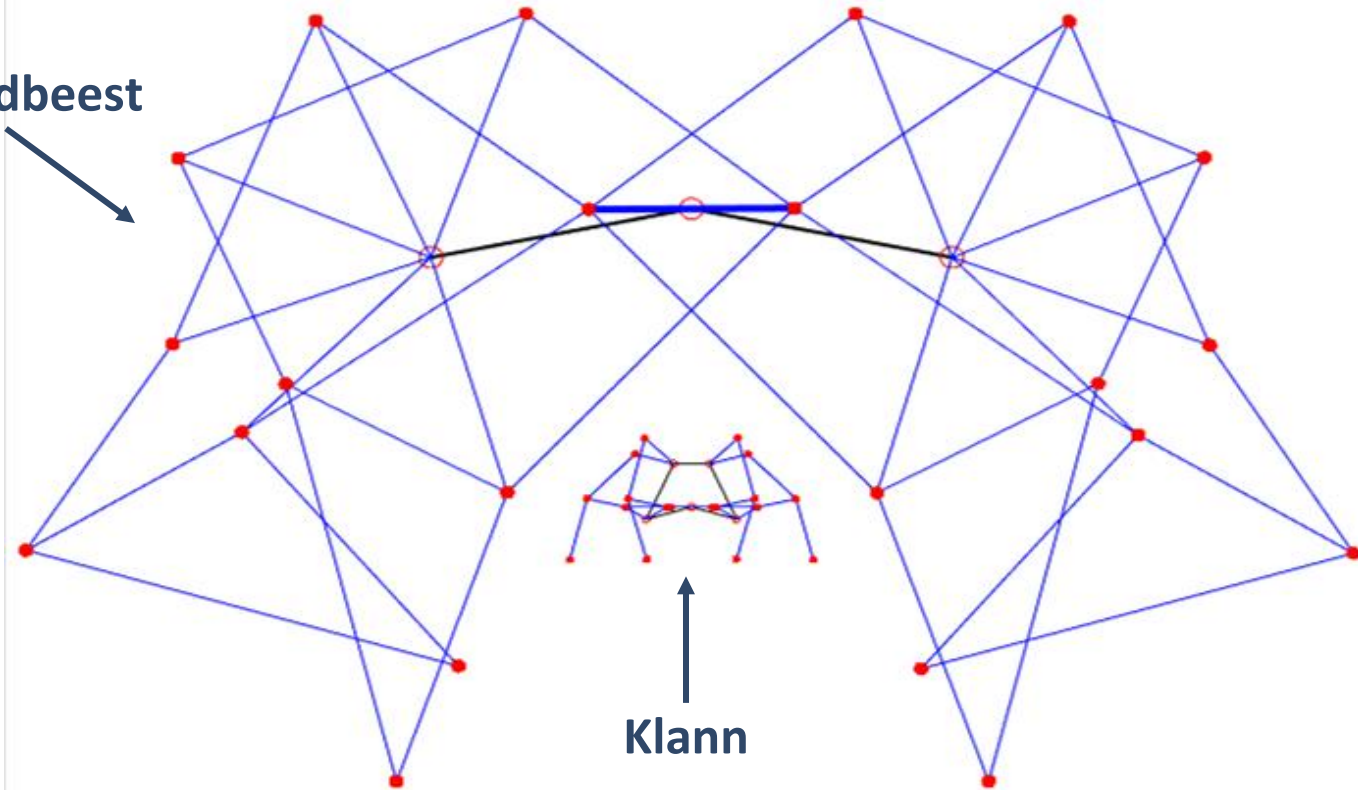




Comparazione Meccanismi

PROBLEMA COMPARABILITÀ

Strandbeest

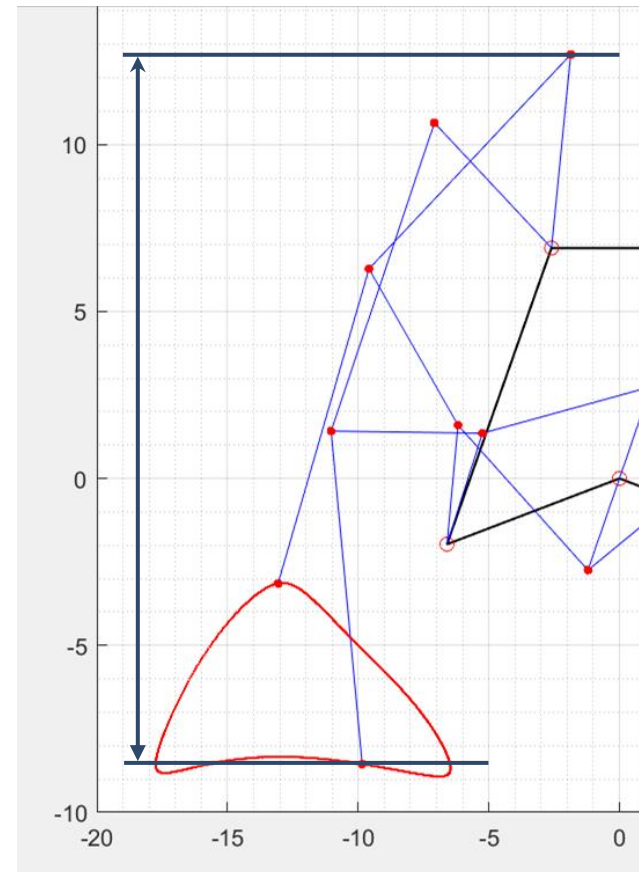
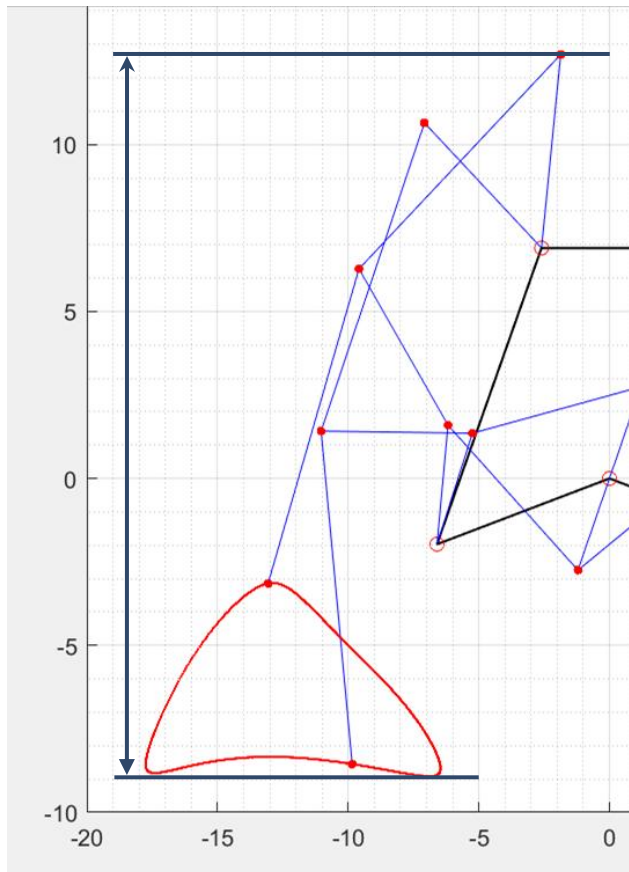


Klann



Comparazione Meccanismi

VERSIONI CALCOLO INGOMBRO





Altezza Passo

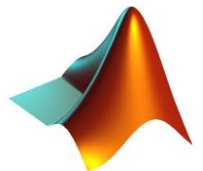
Velocità Meccanismo

Varianza Velocità

Costo Energetico

Stabilità CM

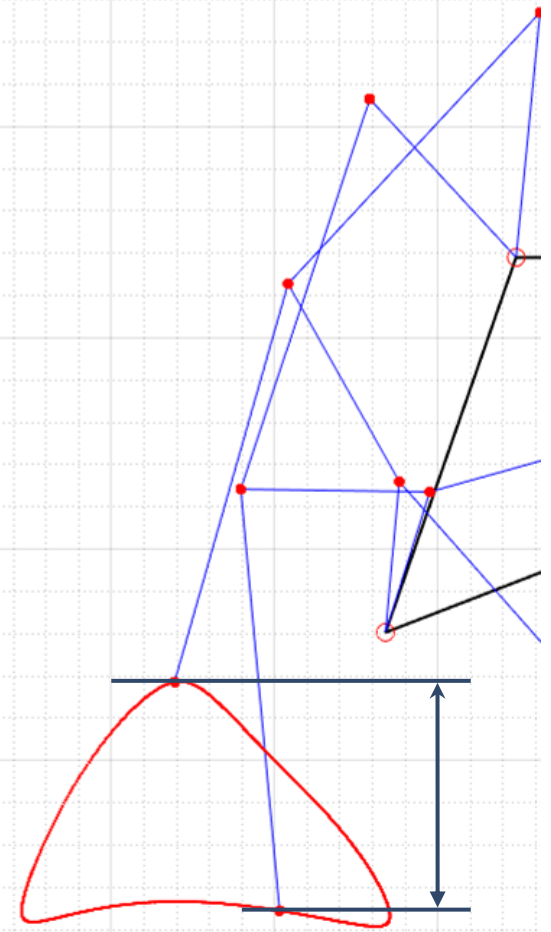
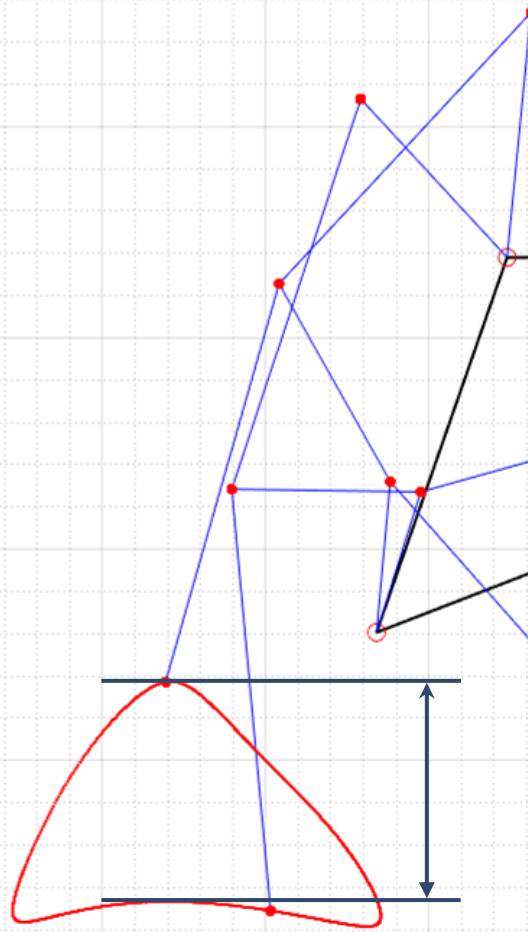
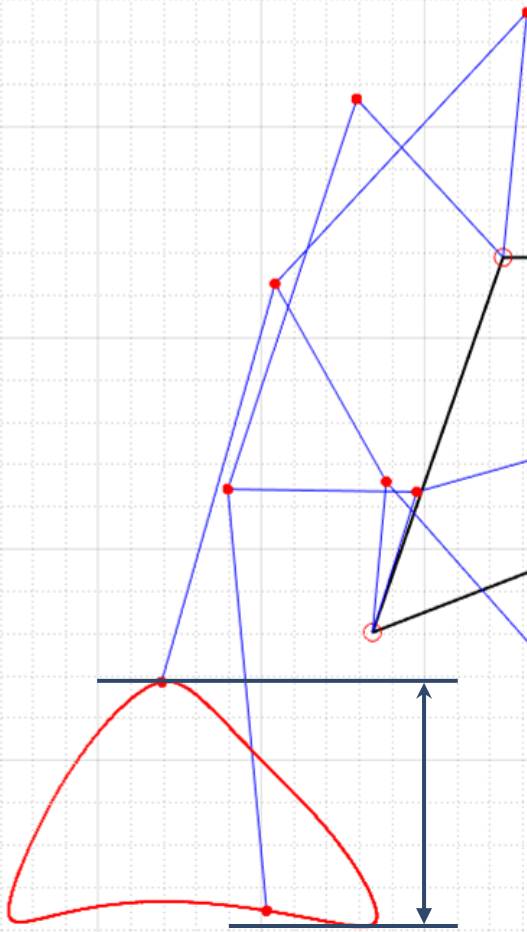
*Valutare quale meccanismo è il migliore
per superare un ostacolo*





Altezza Passo

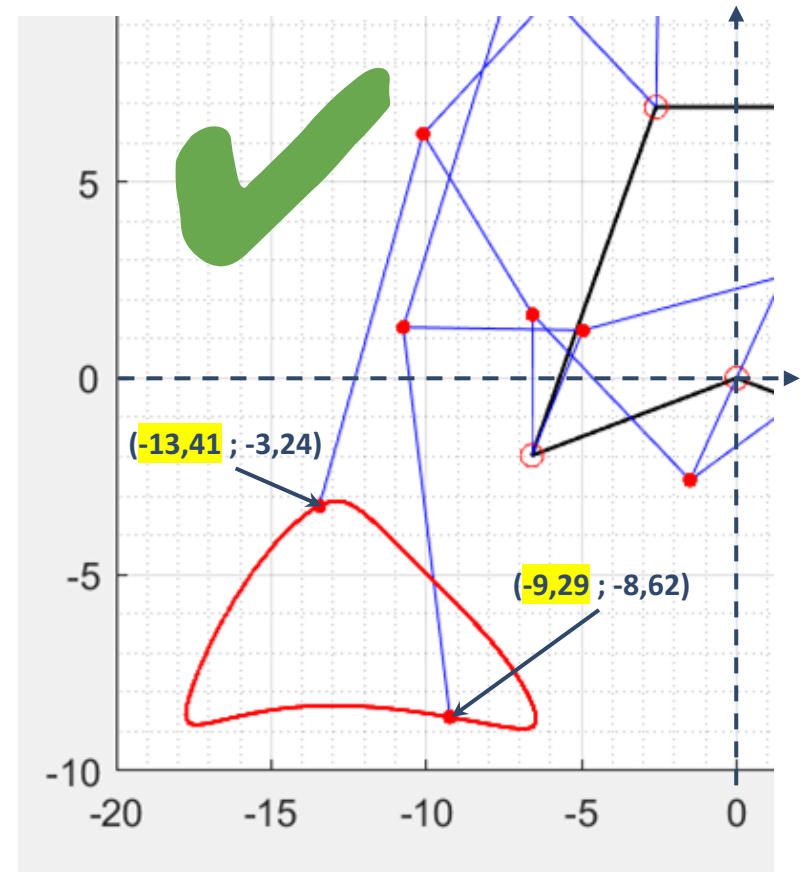
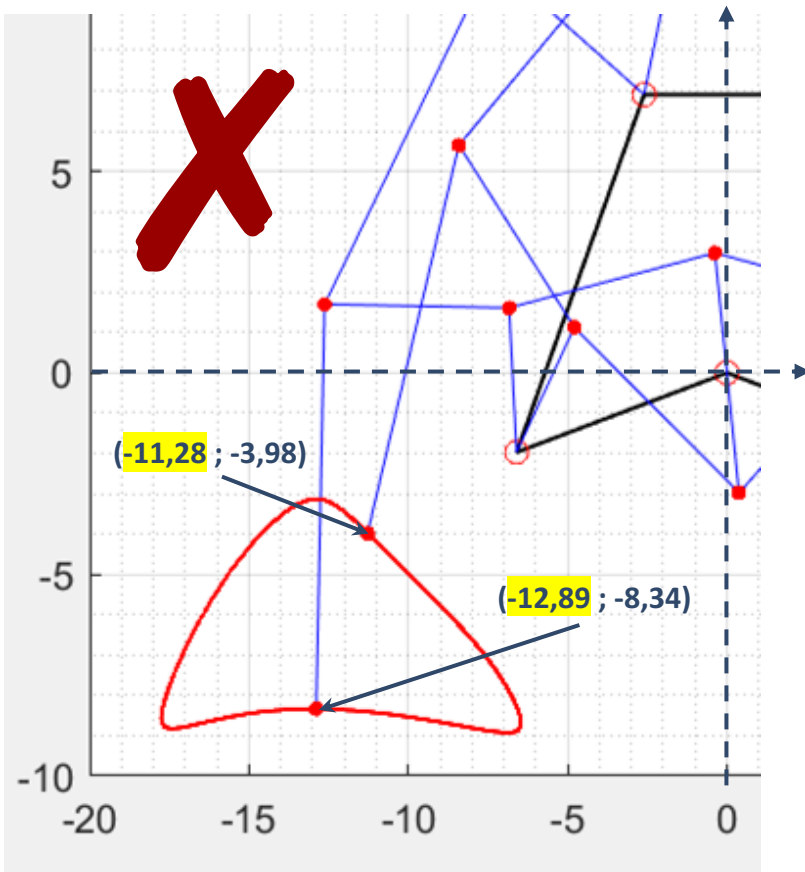
VERSIONI DI CALCOLO





Altezza Passo

VERIFICA SUPERAMENTO OSTACOLI





Altezza Passo

Velocità Meccanismo

Varianza Velocità

Costo Energetico

Stabilità CM

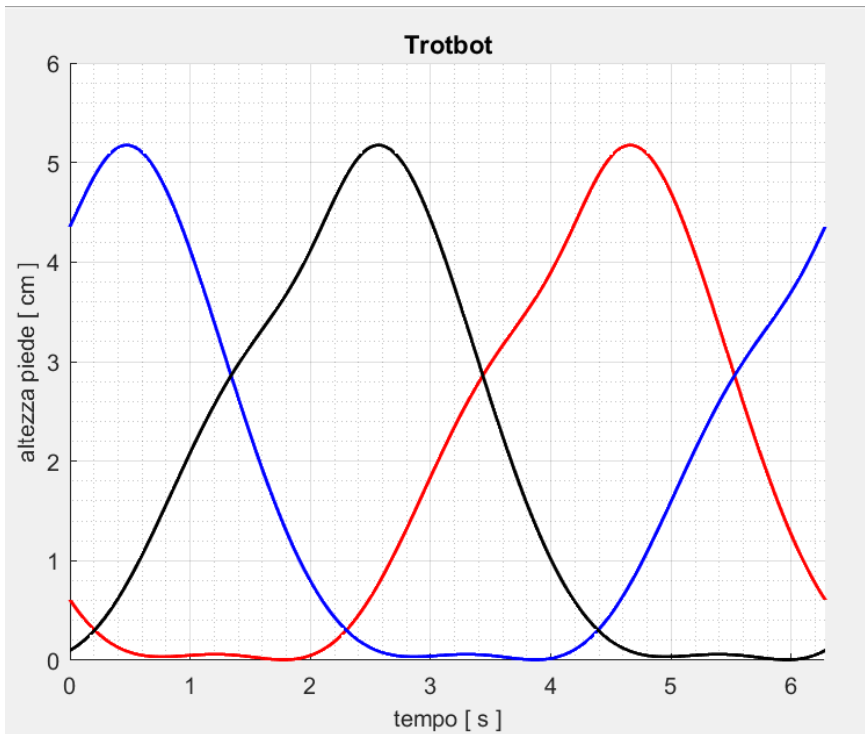
***Valutare quale meccanismo è il più veloce
a parità di velocità di rotazione
della manovella***





Velocità Meccanismo

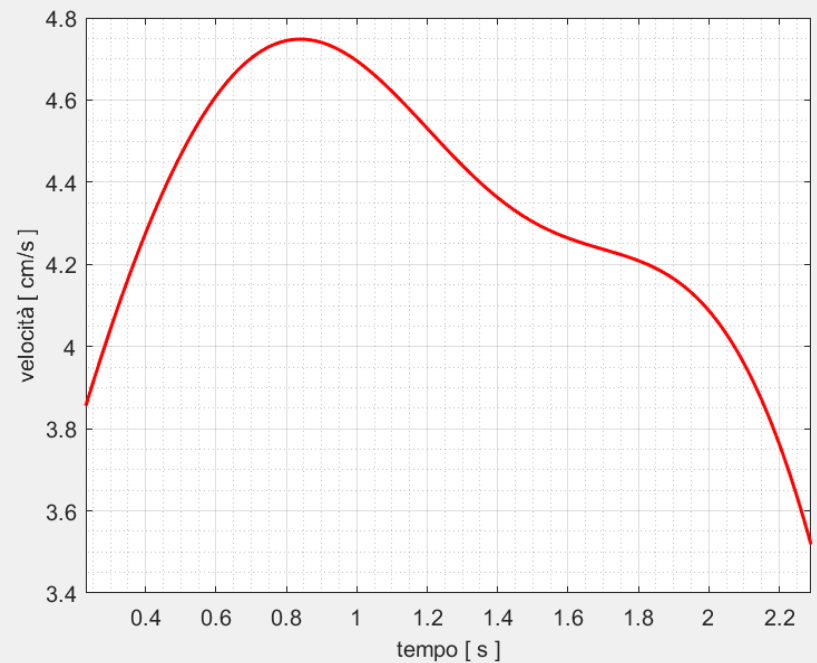
METODO DI CALCOLO



Analisi velocità piede durante contatto terra



← **Rilevazione piede contatto terra**





Altezza Passo

Velocità Meccanismo

Varianza Velocità

Costo Energetico

Stabilità CM

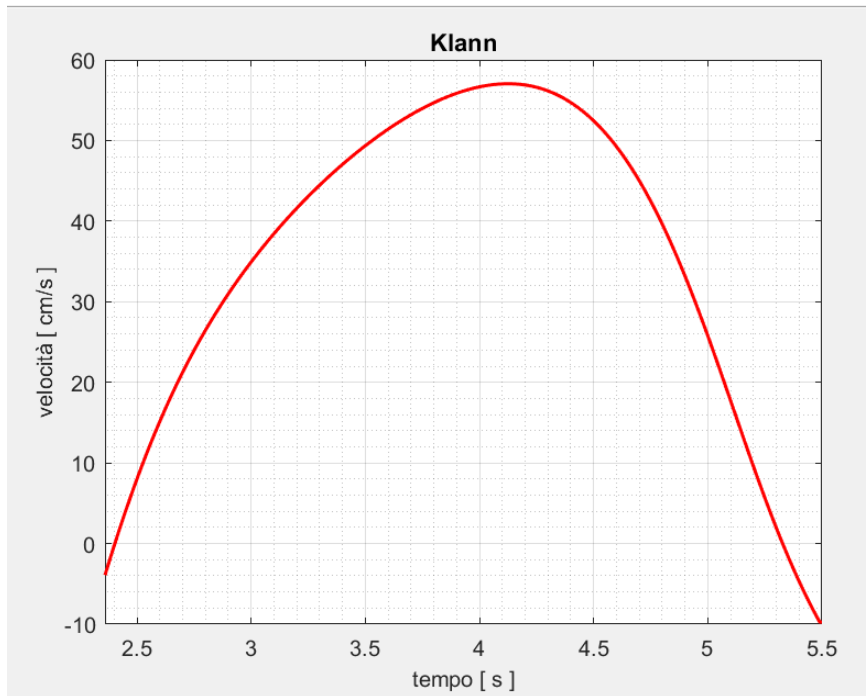
***Valutare quale meccanismo ha la velocità
di movimento più costante***



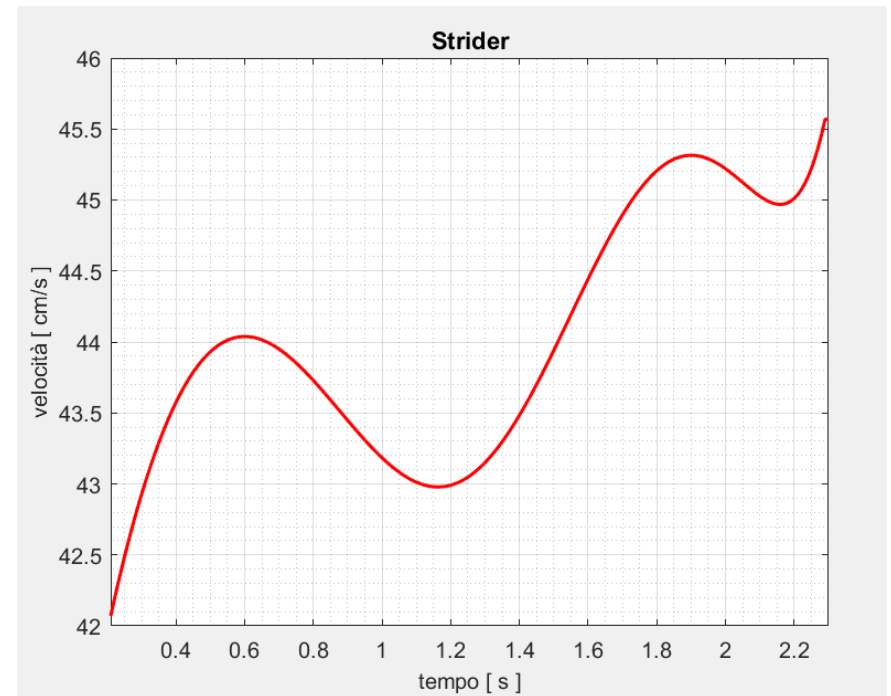


Varianza Velocità

$$\text{Varianza} = \frac{\sum_{i=1}^N (X_i - \bar{X})^2}{N}$$



3,8169 [cm²/s²]



0,007444 [cm²/s²]



Altezza Passo

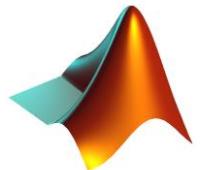
Velocità Meccanismo

Varianza Velocità

Costo Energetico

Stabilità CM

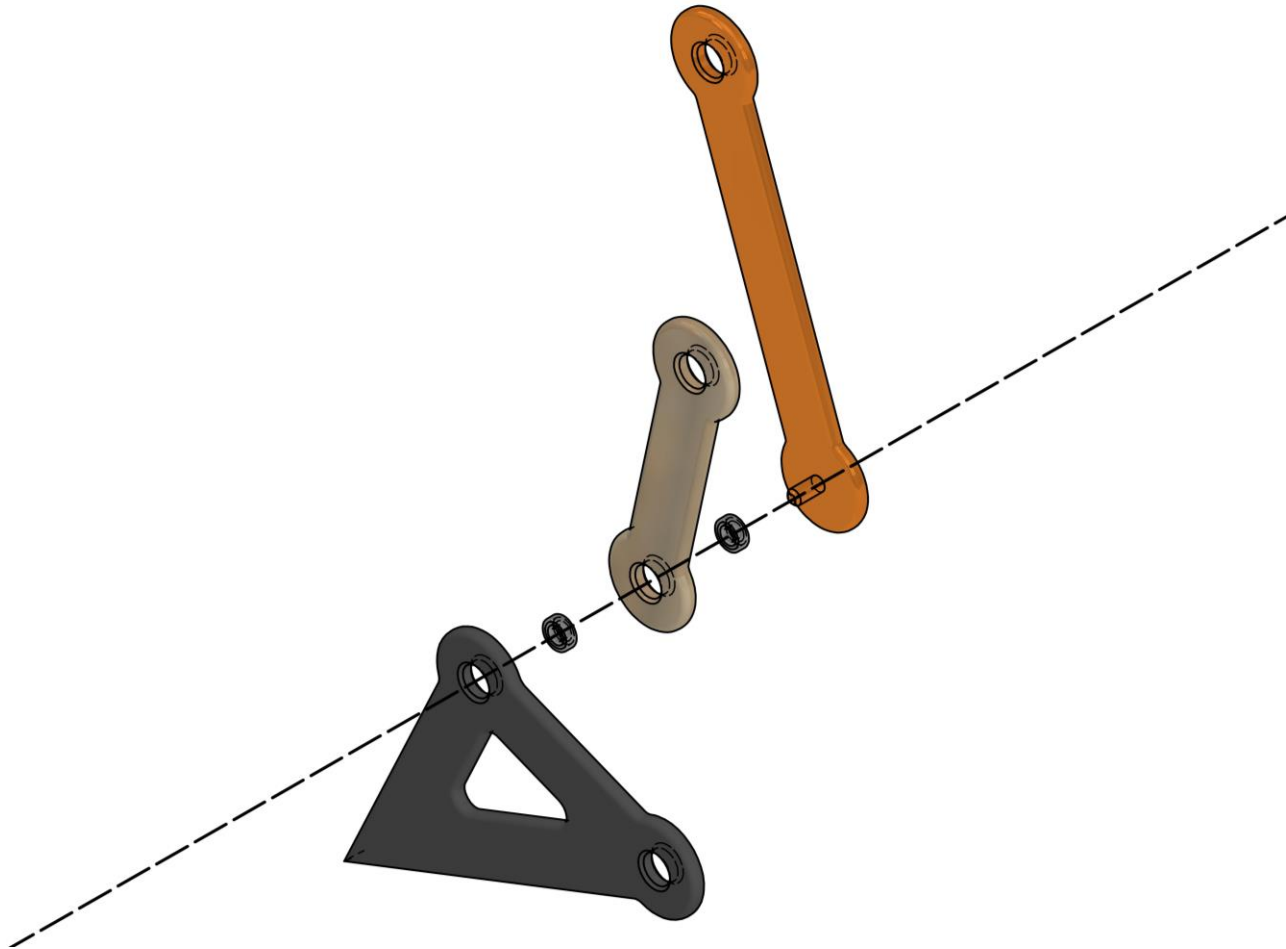
***Valutare quale meccanismo dissipa meno
energia per attrito viscoso***





Costo Energetico

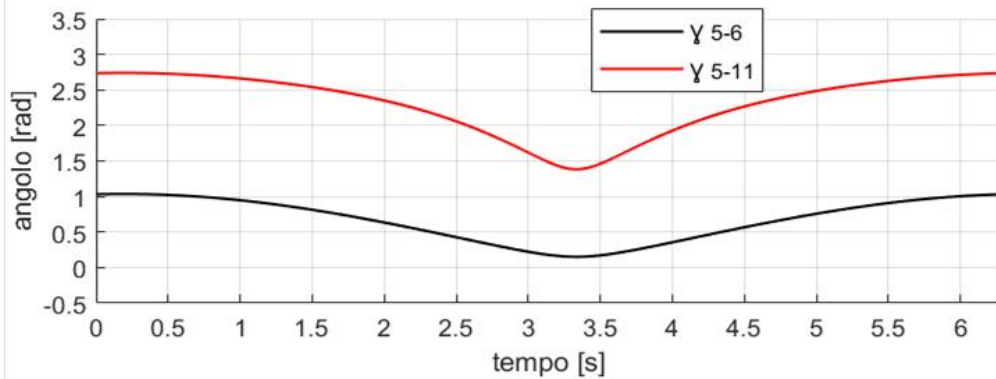
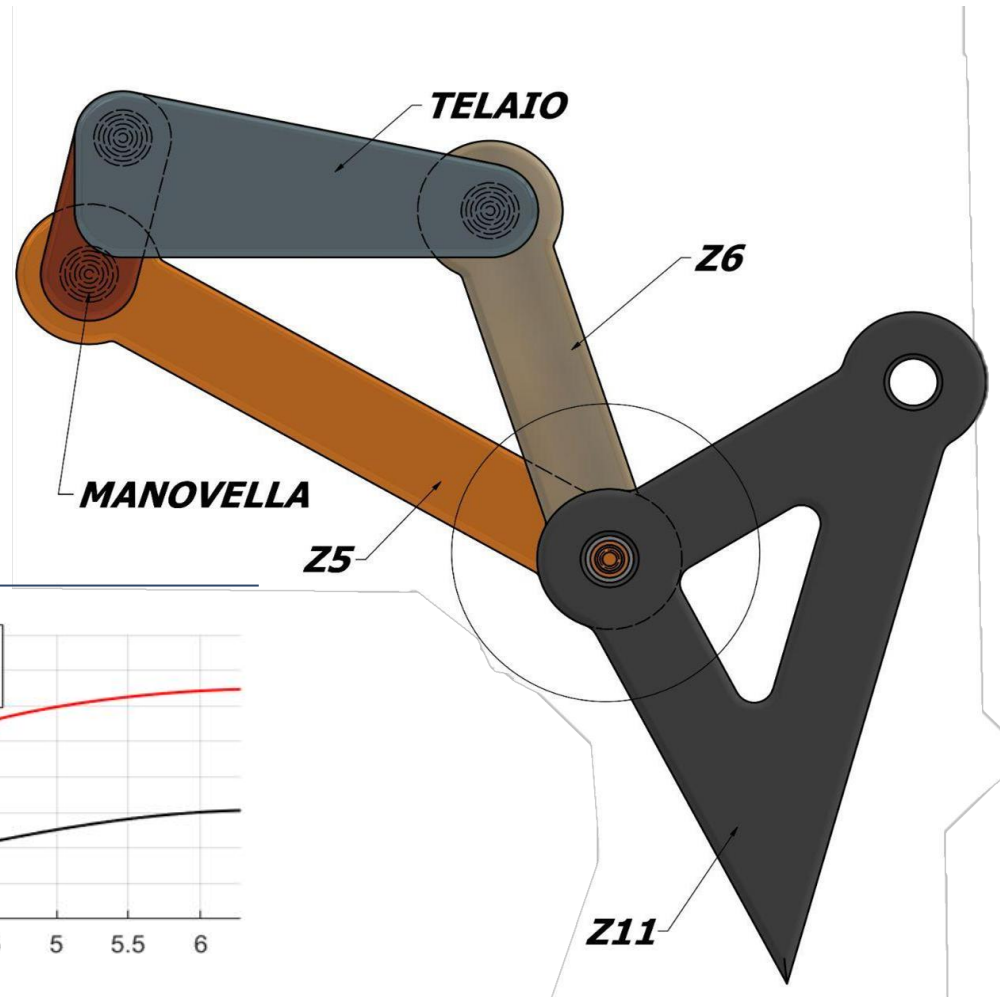
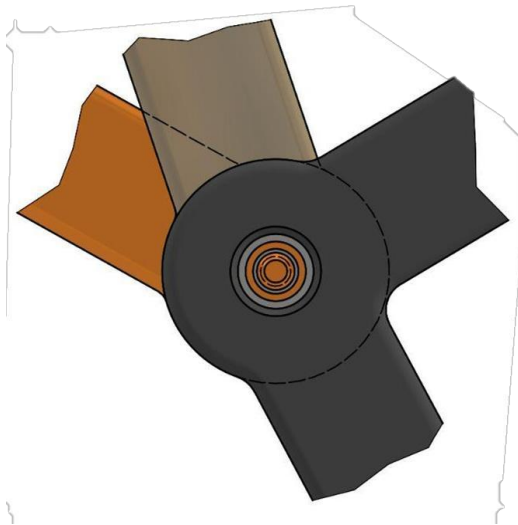
ACCOPPIAMENTO TRA ASTE





Costo Energetico

VARIAZIONE ANGOLI INTERNI





Costo Energetico

VEL. RELATIVE E CALCOLO POTENZA

$$\omega = \frac{d\gamma}{dt} \quad \tau = K \cdot \omega$$

$$P = \tau \cdot \omega$$

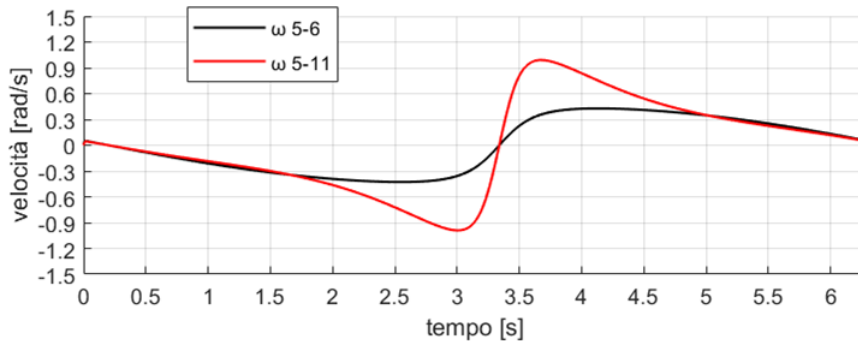


Grafico Variazione Velocità

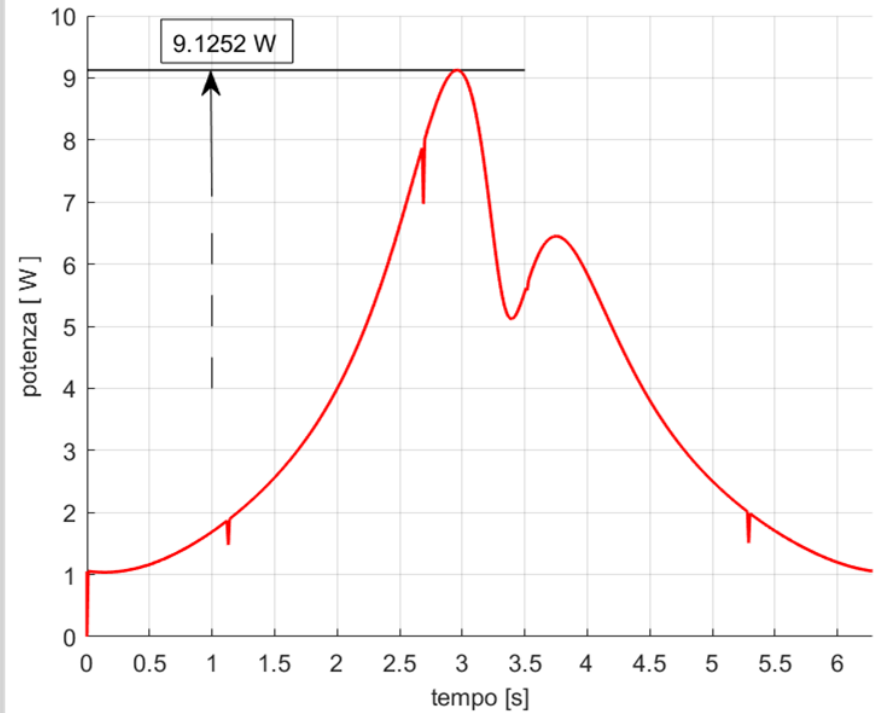


Grafico Potenza dissipata



Altezza Passo

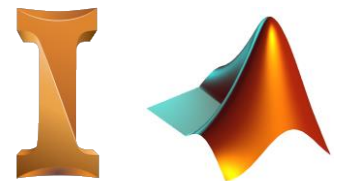
Velocità Meccanismo

Varianza Velocità

Costo Energetico

Stabilità CM

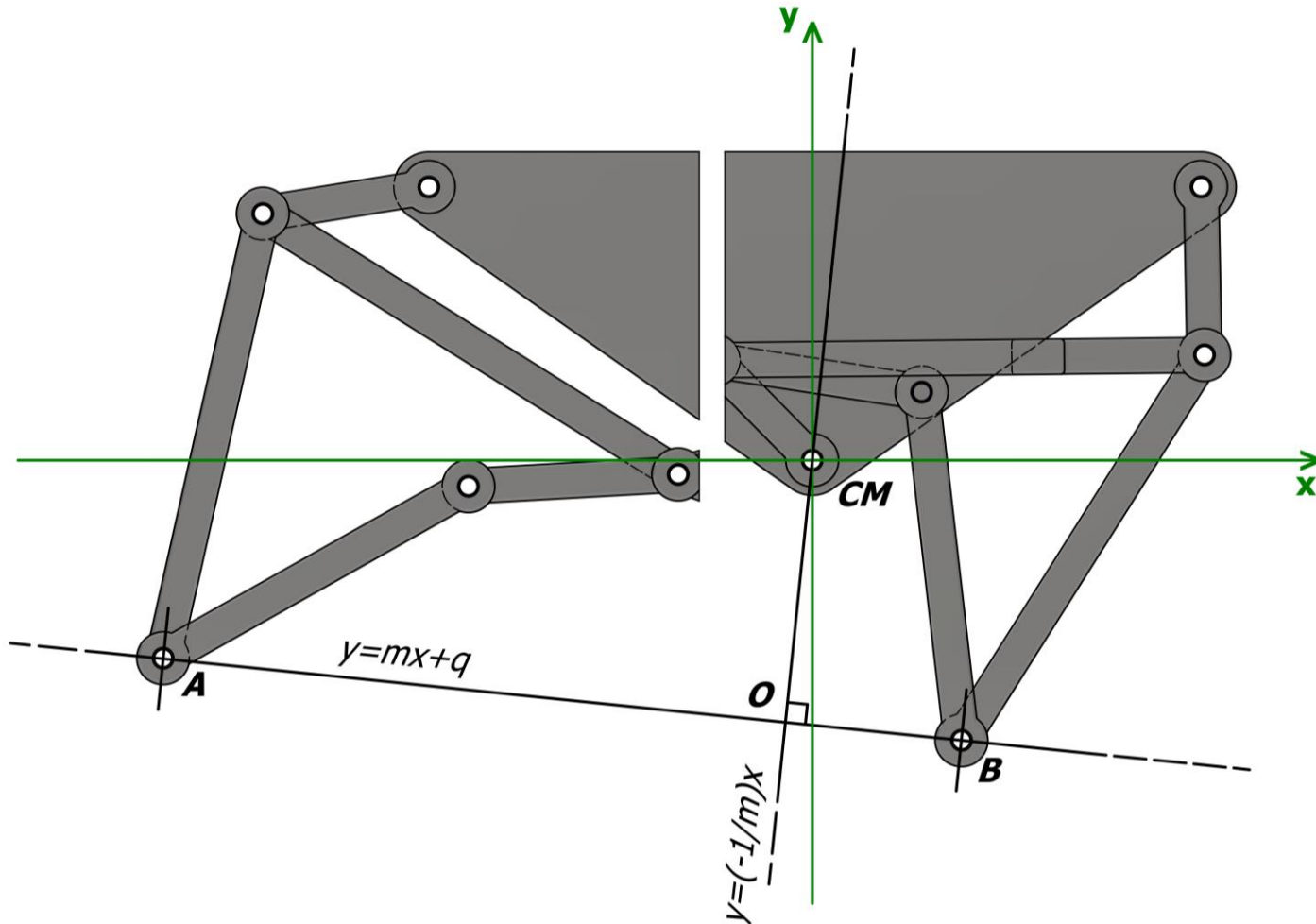
***Valutare quale meccanismo è il più stabile
durante il cammino***





Stabilità CM

METODO DI CALCOLO

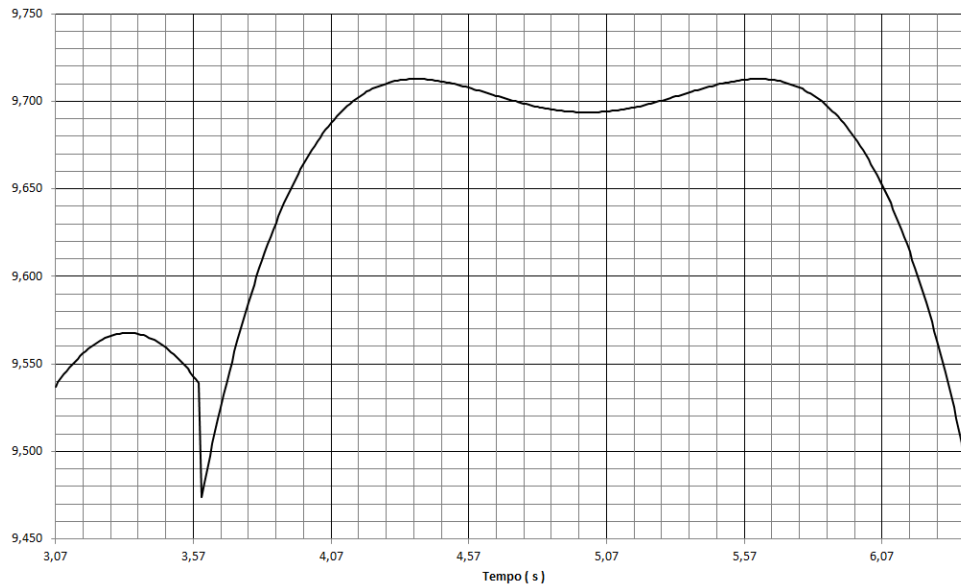




Stabilità CM

RISULTATI FINALI

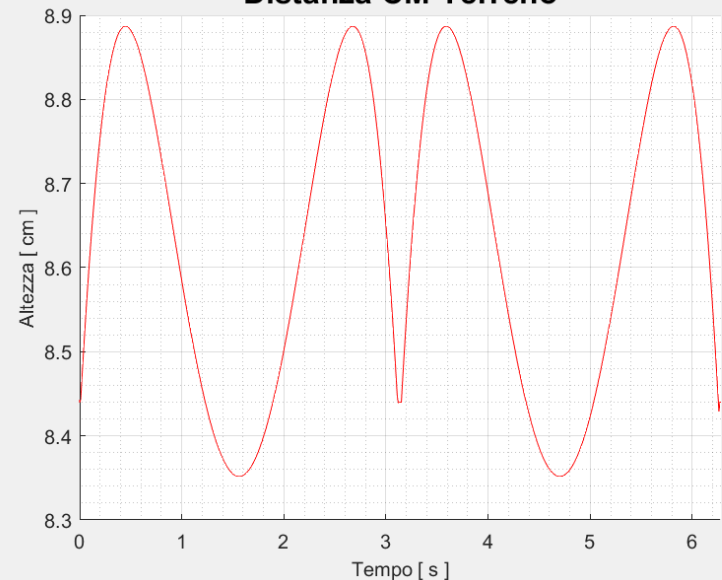
Distanza CM-Terreno



← **Strider**

Klann →

Distanza CM-Terreno



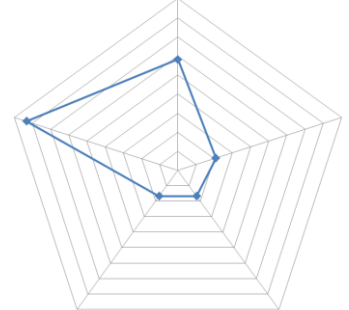
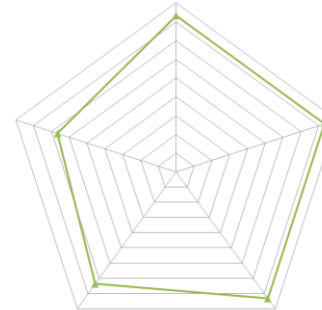
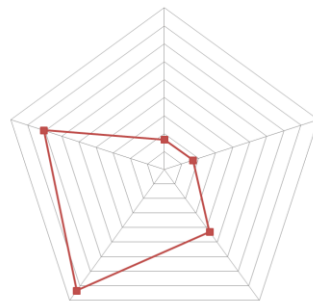
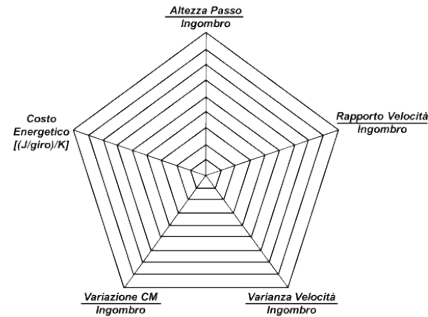


Confronto Meccanismi



Confronto Meccanismi

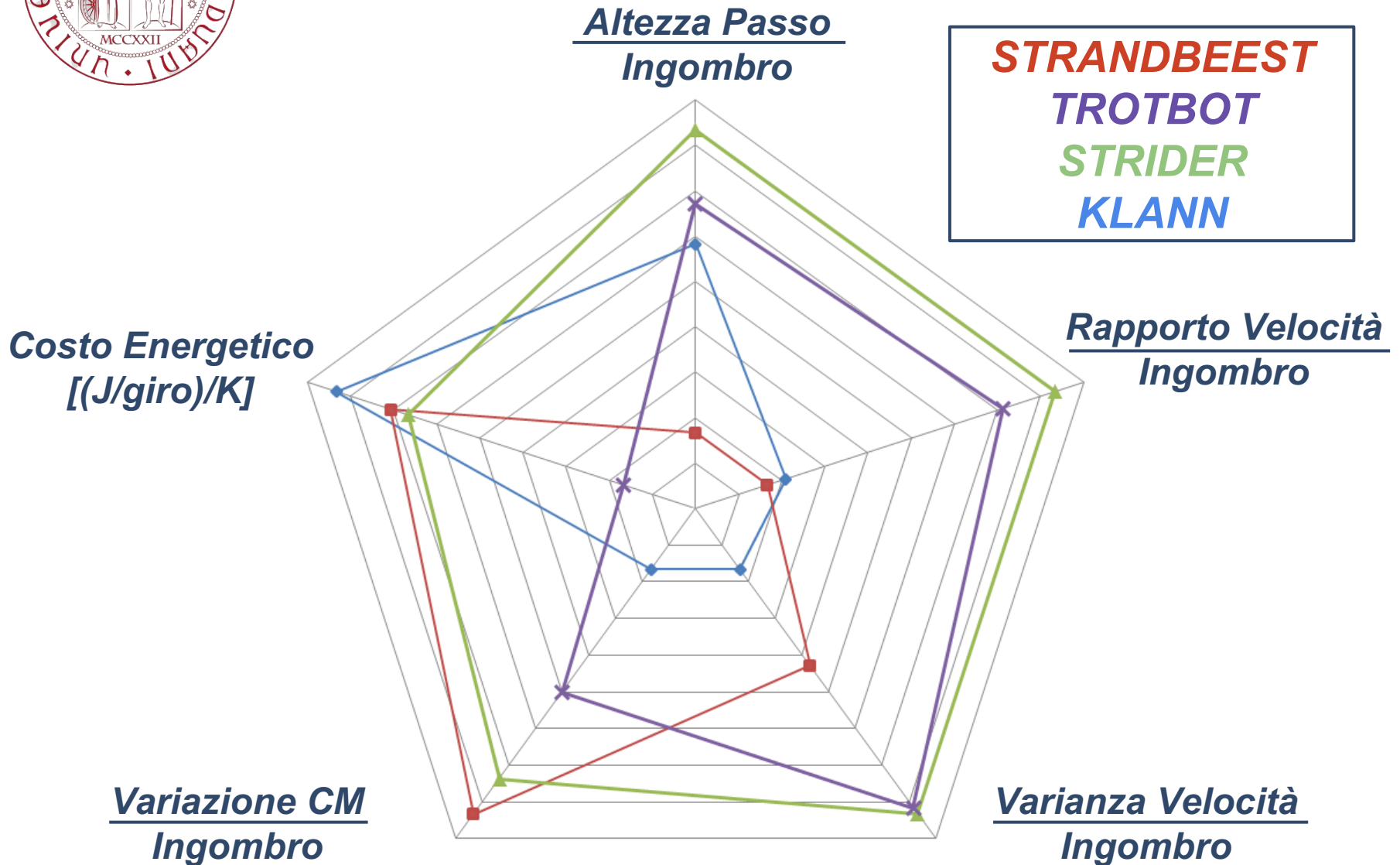
RISULTATI ANALISI PARAMETRI



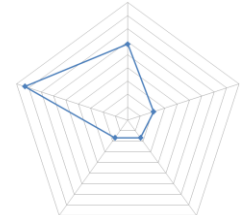
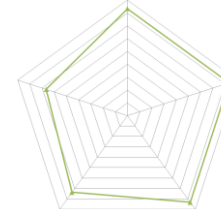
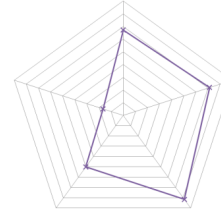
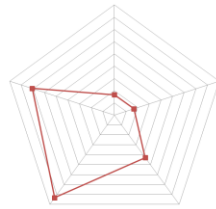
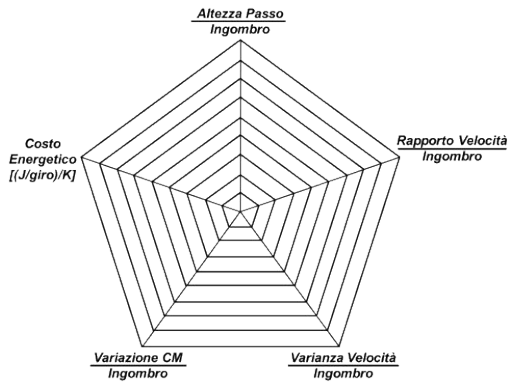
	STRANDBEEST	TROTBOT	STRIDER	KLANN
<u>Altezza Passo Ingombro</u>	17,84%	26,86%	29,75%	25,26%
<u>Rapporto di Velocità Ingombro</u>	16,14%	22,82%	24,30%	16,66%
<u>Varianza Velocità Ingombro</u>	10,85%	0,47%	0,04%	17,85%
<u>Costo Energetico [(J/ giro)/K]</u>	92,08	165,15	97,62	74,92
<u>Variazione CM Ingombro</u>	1,12%	1,81%	1,32%	2,50%



Confronto Meccanismi



Schede Tecniche



	STRANDBEEST	TROTBOT	STRIDER	KLANN
INVENTORE	Theo Jansen	Diy Walkers	Diy Walkers	Joe Klann
PARTICOLARITÀ	Mosso dal vento	Quadrupede	Insetto	Ragno
NUMERO BRACCI PER GAMBA	11	6	9	5
NUMERO GIUNTI PER GAMBA	8	9	10	7
PUNTI A TELAIO	2	2	5	3
NUMERO GAMBE PER LATO	2	3	3	2
TEMPO CONTATTO SINGOLA GAMBA	$\frac{1}{2}$ periodo	$\frac{1}{3}$ periodo	$\frac{1}{3}$ periodo	$\frac{1}{2}$ periodo
SENSO ROTAZIONE MANOVELLA	Antiorario	Antiorario	Antiorario	Orario
ALTEZZA PASSO / INGOMBRO	17,84%	26,86%	29,75%	25,26%
RAPPORTO DI VELOCITÀ / INGOMBRO	16,14%	22,82%	24,30%	16,66%
VARIANZA VELOCITÀ / INGOMBRO	10,85%	0,47%	0,04%	17,85%
COSTO ENERGETICO [(J/ giro)/K]	92,08	165,15	97,62	74,92
VARIAZIONE CM / INGOMBRO	1,12%	1,81%	1,32%	2,50%

GRAZIE PER L'ATTENZIONE

Berradi Anass

Dalle Fusine Luca

Lofoco Gregorio

Zheli Arlind