

Output Selection

Introduction

Passivity

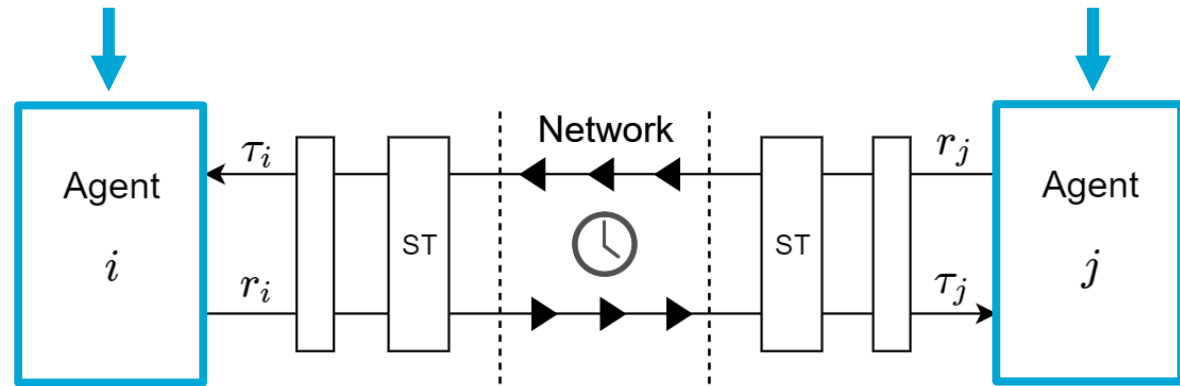
Cooperative rPBC

Experimental Results

Conclusions

- Outputs
 - Fulfil our objectives with **coordinates**
 - Are passive with **velocities**
- Encode **velocities** and **coordinates** into the output r
- $r = \dot{z} + \lambda z$
- If $\dot{z} \rightarrow \mathbf{0}$, then $r \rightarrow \lambda z$

r-Passive Agents



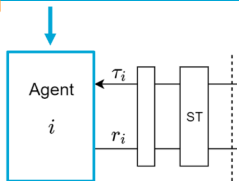
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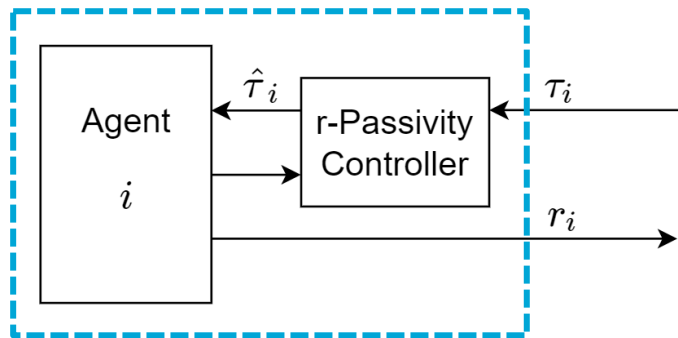
Conclusions



r-Passive Agents

- Find a control function $\hat{\tau}_i(\boldsymbol{\tau}_i)$ such that

$$S_i = \boldsymbol{\tau}_{c,i}^T \mathbf{r}_i - \dot{V}_i \quad (\text{r-passivity})$$



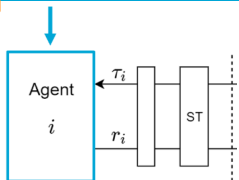
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- Find a control function $\hat{\boldsymbol{\tau}}_i(\boldsymbol{\tau}_i)$ such that

$$S_i = \boldsymbol{\tau}_{c,i}^T \mathbf{r}_i - \dot{V}_i \quad (\text{r-passivity})$$

$$V_i = \frac{1}{2} \mathbf{r}_i^T \mathbf{r}_i + \frac{1}{2} \gamma_i \lambda \mathbf{z}_i^T \mathbf{z}_i, \quad S_i = \gamma_i \dot{\mathbf{z}}_i^T \dot{\mathbf{z}}_i.$$



$$\boldsymbol{\tau}_{c,i} = \dot{\mathbf{r}}_i + \gamma_i \dot{\mathbf{z}}_i = \ddot{\mathbf{z}}_i + (\lambda + \gamma_i) \dot{\mathbf{z}}_i$$

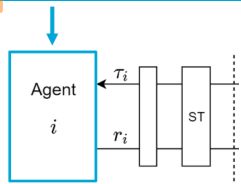
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r-Passive Agents

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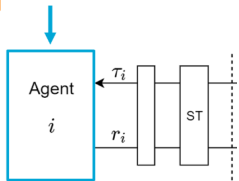
Conclusions

- For fully actuated systems, solvable:

$$\boldsymbol{\tau}_i = \mathbf{M}_i \mathbf{J}_i^\dagger (\boldsymbol{\tau}_{c,i} - \mathbf{K}_{z,i} \dot{\mathbf{q}}_i) + \frac{\partial H_i}{\partial \mathbf{q}_i},$$

$$\mathbf{K}_{z,i} = \mathbf{J}_i \left((\lambda + \gamma_i) \mathbf{I}_{n,i} - \mathbf{M}_i^{-1} \dot{\mathbf{M}}_i \right) + \dot{\mathbf{J}}_i$$

- Dimensionality of cooperative tasks



Local Dynamics

- Subtask optimisation

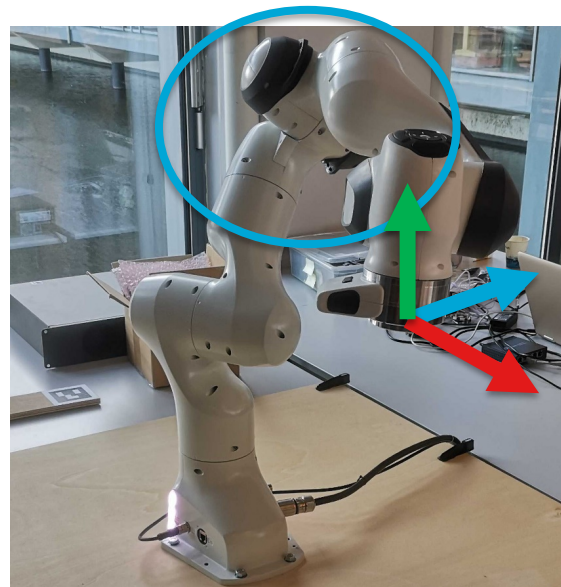
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Cooperative Controls

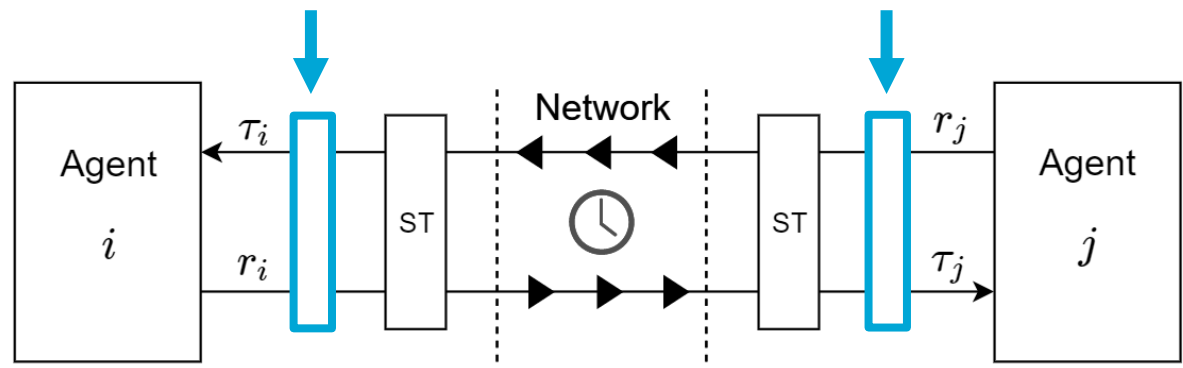
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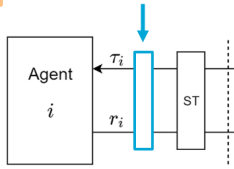
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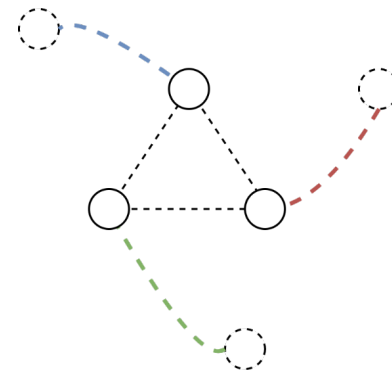
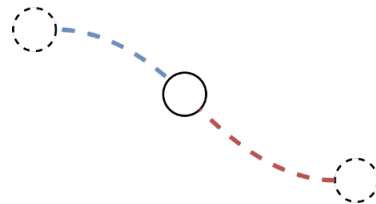
Conclusions





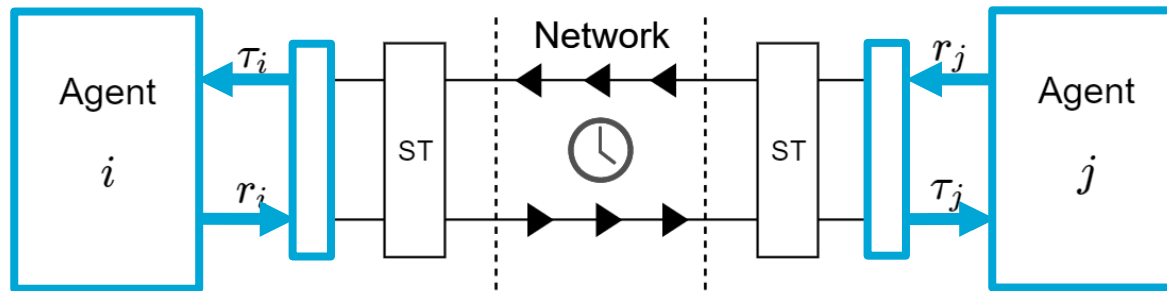
Cooperative Controls

- Gradient descend
- Objectives
 - Consensus
 - Formations
 - Leader-Follower Control



Summarizing Remarks

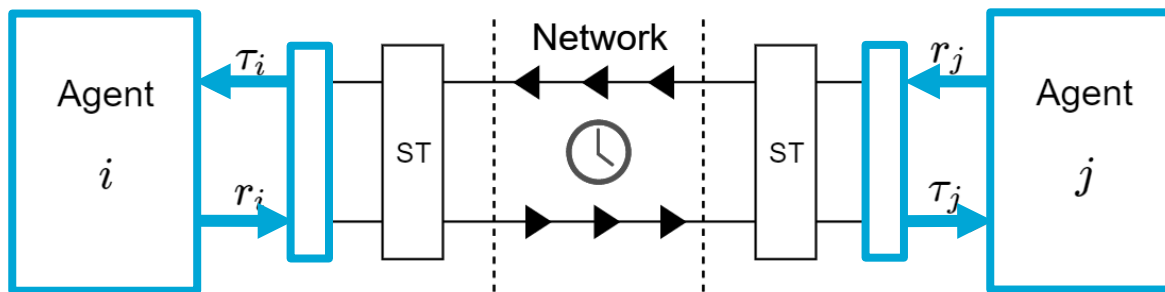
- We developed
 - A scheme for synchronisation with r-passive systems
 - A controller that renders agents r-passive





Summarizing Remarks

- No knowledge required of other agent dynamics
- Interconnection becomes trivial





Simulation

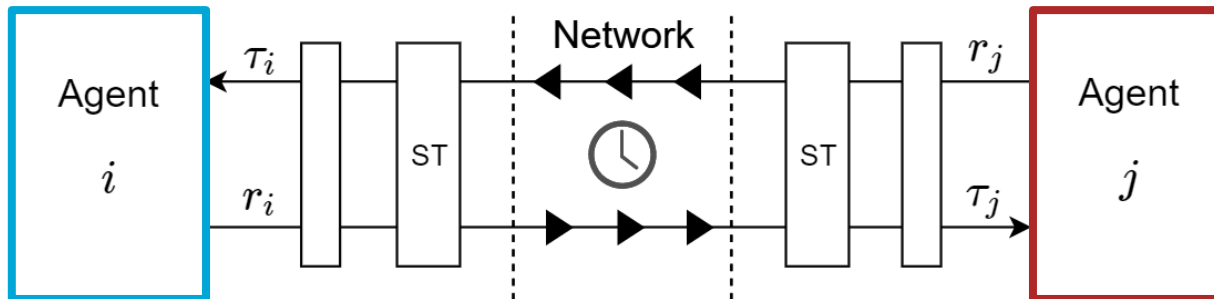
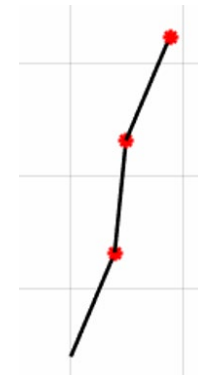
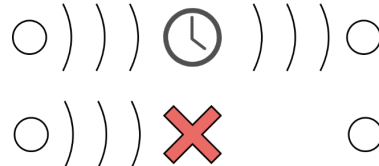
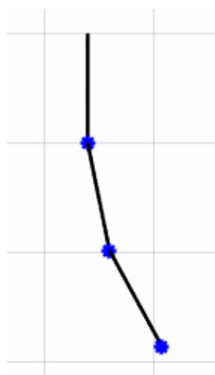
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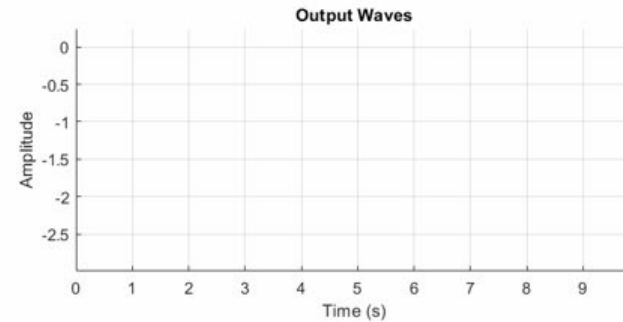
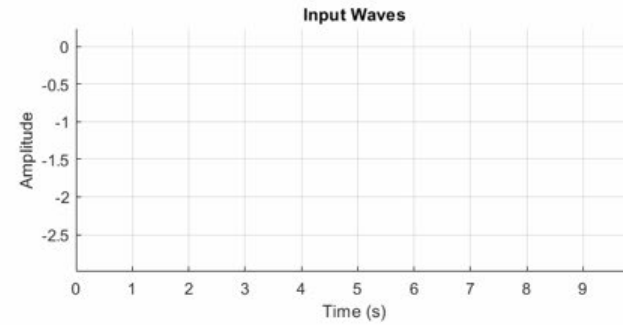
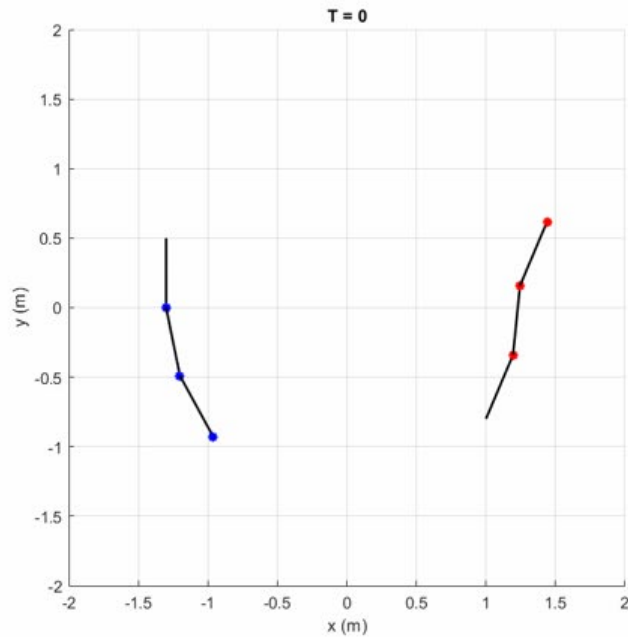
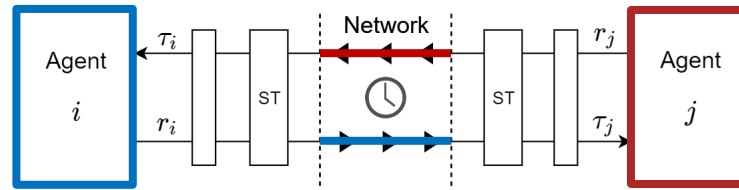
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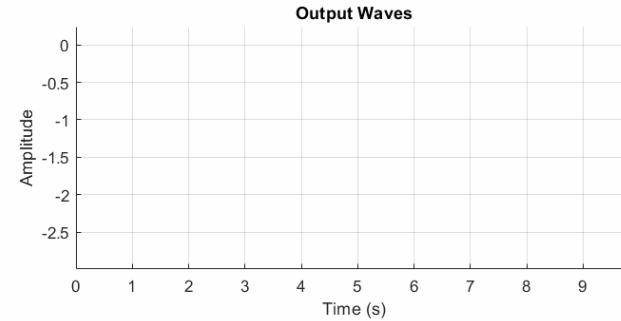
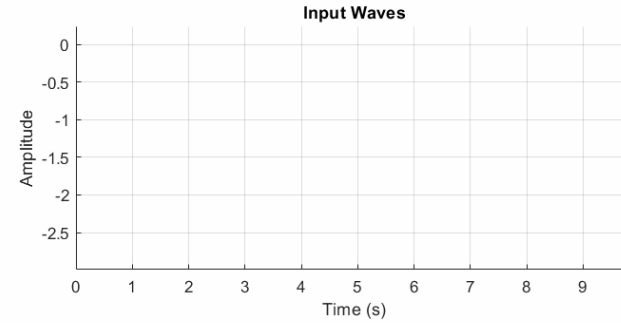
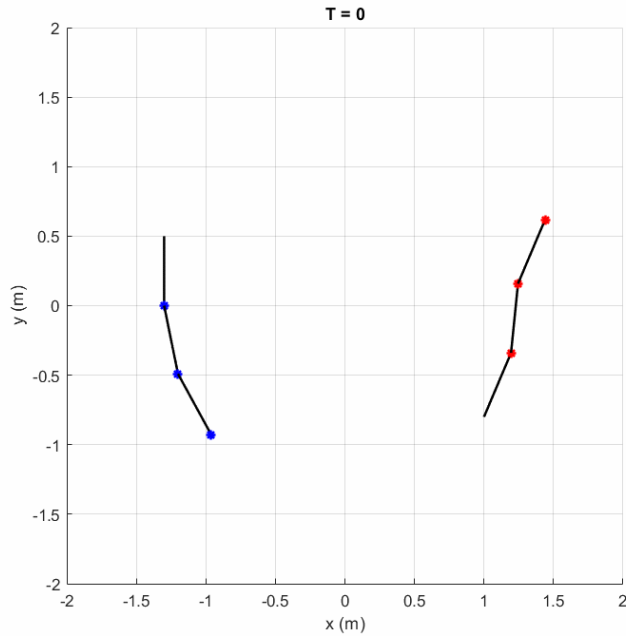
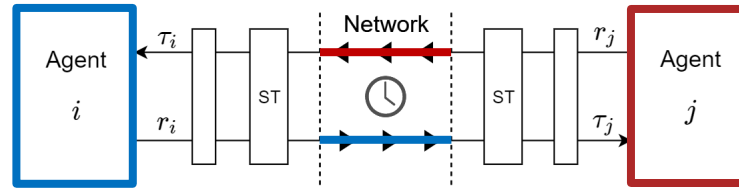
Cooperative rPBC

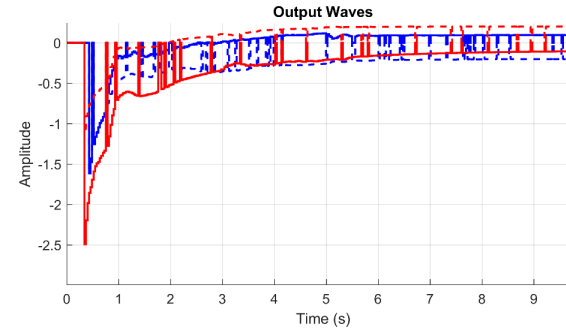
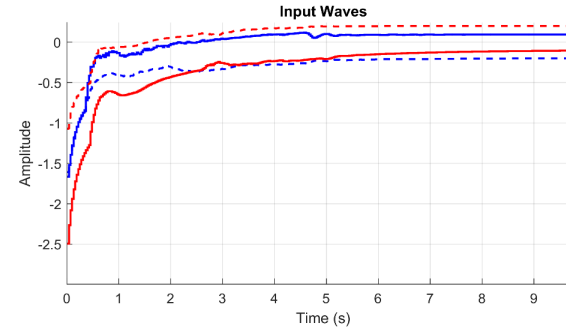
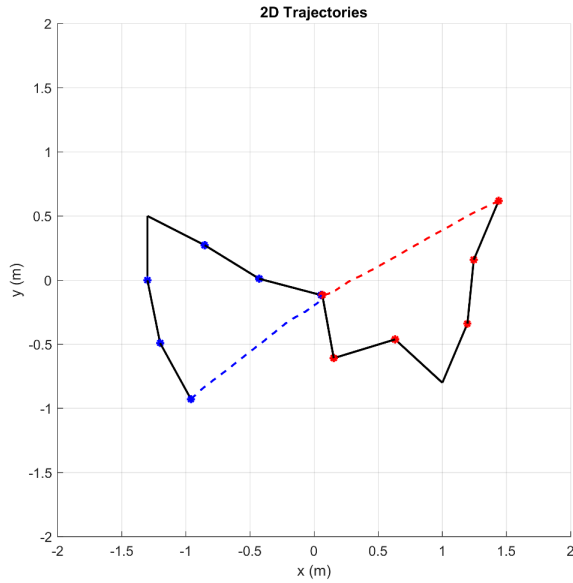
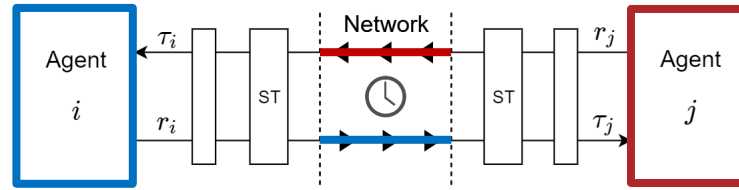
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Experimental Results