State of the Art in RoboCup

Oberseminar TAMS

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Technische Aspekte Multimodaler Systeme

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RoboCup

- Official Goal
  - Win against the soccer world champion with a team of robots in 2050
- Actual Goals
  - Accelerate research in robotics
  - Test approaches under realistic conditions
  - Make different approaches comparable
  - Promote robotics research to the public
- Organization
  - Yearly world championship and symposium
  - Multiple other competitions, workshops and summer schools
  - Different Leagues for different purposes

@Home

- Tasks
  - Service robots
  - Communication with humans (speech/face/gesture recognition)
  - Grasping
  - Navigation
- Current state
  - Adaption to new environment with preparation
  - Error handling by communication
  - Single robot
  - Grasping/navigation/understanding works sometimes
- Future
  - Into the real world
  - Robustness / repeatability

Rescue

- Tasks
  - Search and rescue in disaster scenarios
  - Teleoperated or autonomous
- Current state
  - Locomotion in difficult terrain
  - Wheels and tracks
  - Simple manipulation tasks
  - Some autonomy
- Future
  - Drones
  - Outdoor
  - Direction legged/humanoid

Small Size

- Tasks
  - Soccer with simple robots
  - Controlled with external sensors and computer
- Current state
  - Fast games
  - Complex team tactics
- Future
  - Optimization
  - Not many new challenges

Middle Size

- Tasks
  - First league to play against humans
  - Realistic soccer without walking problematic
- Current state
  - Relatively fast games between robots
  - Forced passing
  - Big fields
  - Weak games against humans
- Future
  - More team play
  - Artificial grass
  - Hexapods
  - Referee
  - Getting closer to FIFA rules

Humanoid Soccer League Field

- Tasks
  - Be as close to human soccer as possible
  - Research in hardware
- Current state
  - Walking on artificial grass
  - Positioning on the field
  - Almost no tactics
  - ROS
  - FIFA rules
- Future
  - Mixed teams
  - Bigger robots/fields
  - Standard situations
  - Referee

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Previous Work

- Open Source
- Keeping up with the rule changes
- Stack machine
- Cooperation in the league
- ROS standards
- Ball detection in neural networks
- Imagetagger

Current Work

- Improve walking on artificial grass
- Bigger robots
- Improvements and publication of Imagetagger
- Improvements in ROS standards
- Using neural net ball detection on robot
- More neural net approaches (object recognition, walking)

Current Walking Approaches

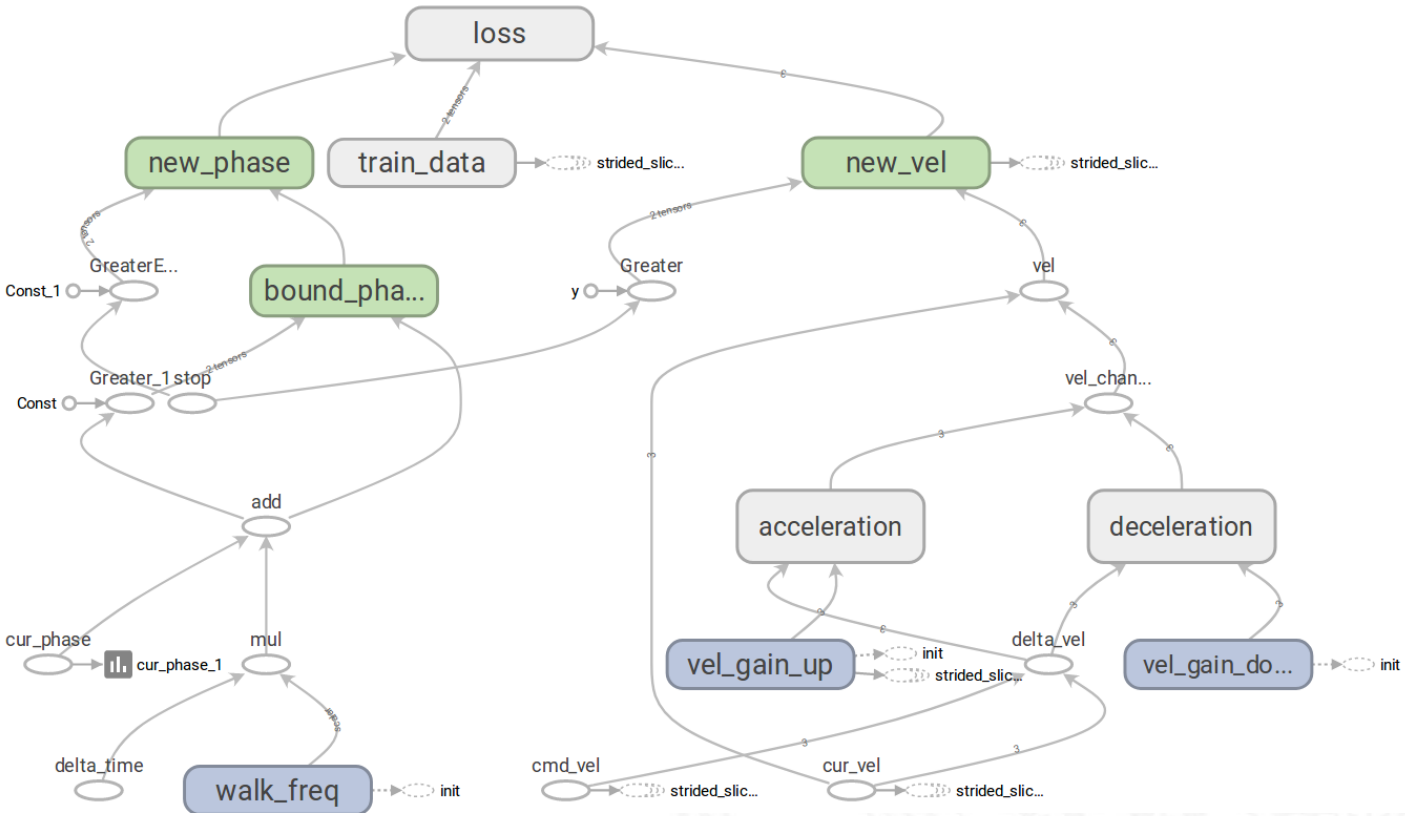
- Coding by hand
- Parameter optimization through machine learning
- Learning in simulator
- Closing the loop with upper body motions

My Approach

- Tensorflow
- Splitting the task for transparency
- Three parts
  - Speed control
  - Feet position in Cartesian space
  - Inverse kinematics
- Using current open loop walking as seed
- Integrating IMU and foot pressure

Speed control

- Acceleration is a critical phase
- Learning can be blocked if speed is constant



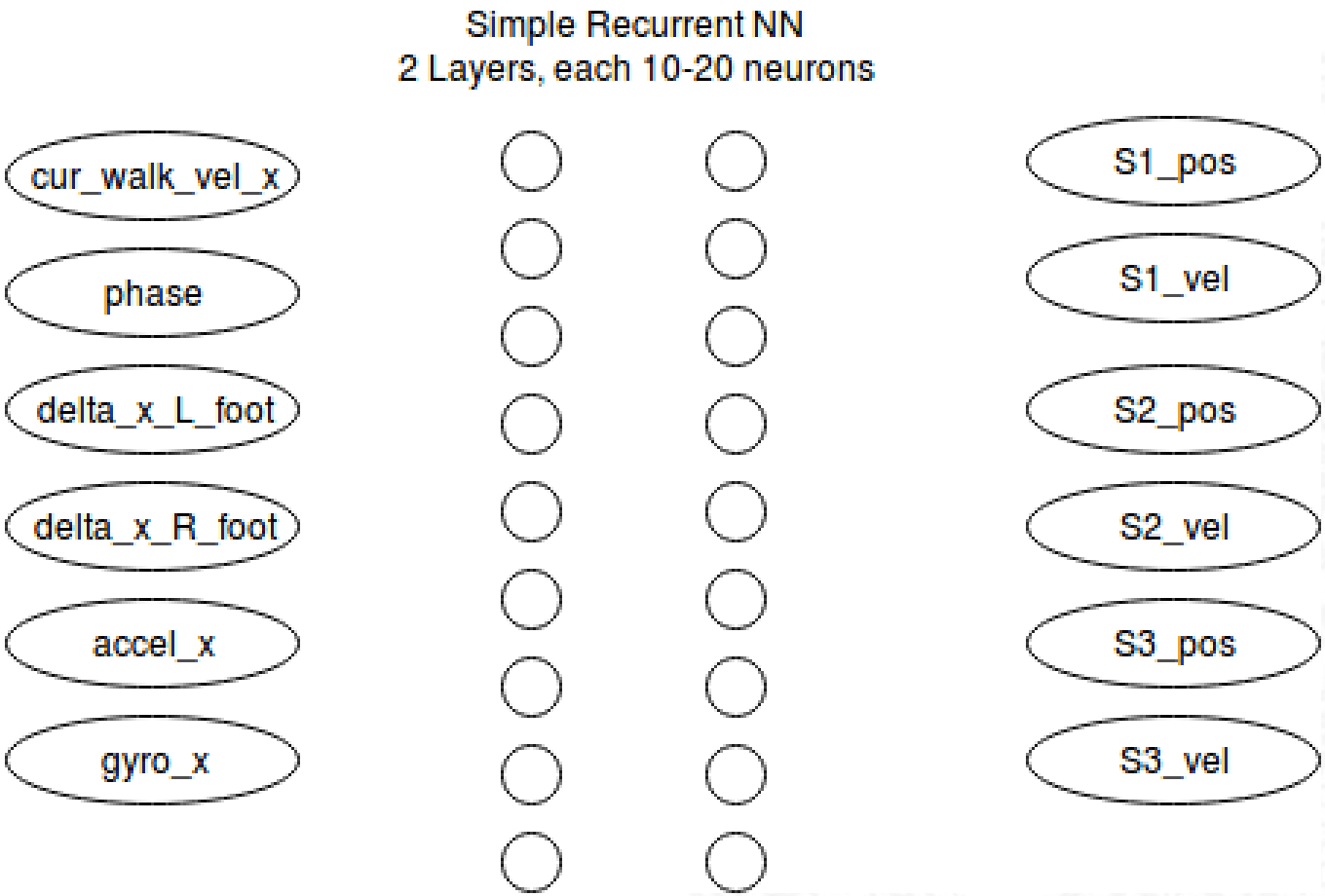
Feet Position

- Cubic splines
- Using a fixed phase
- Splitting in x, y, z, a
- Not using current feet positions
- Use IMU and foot pressure

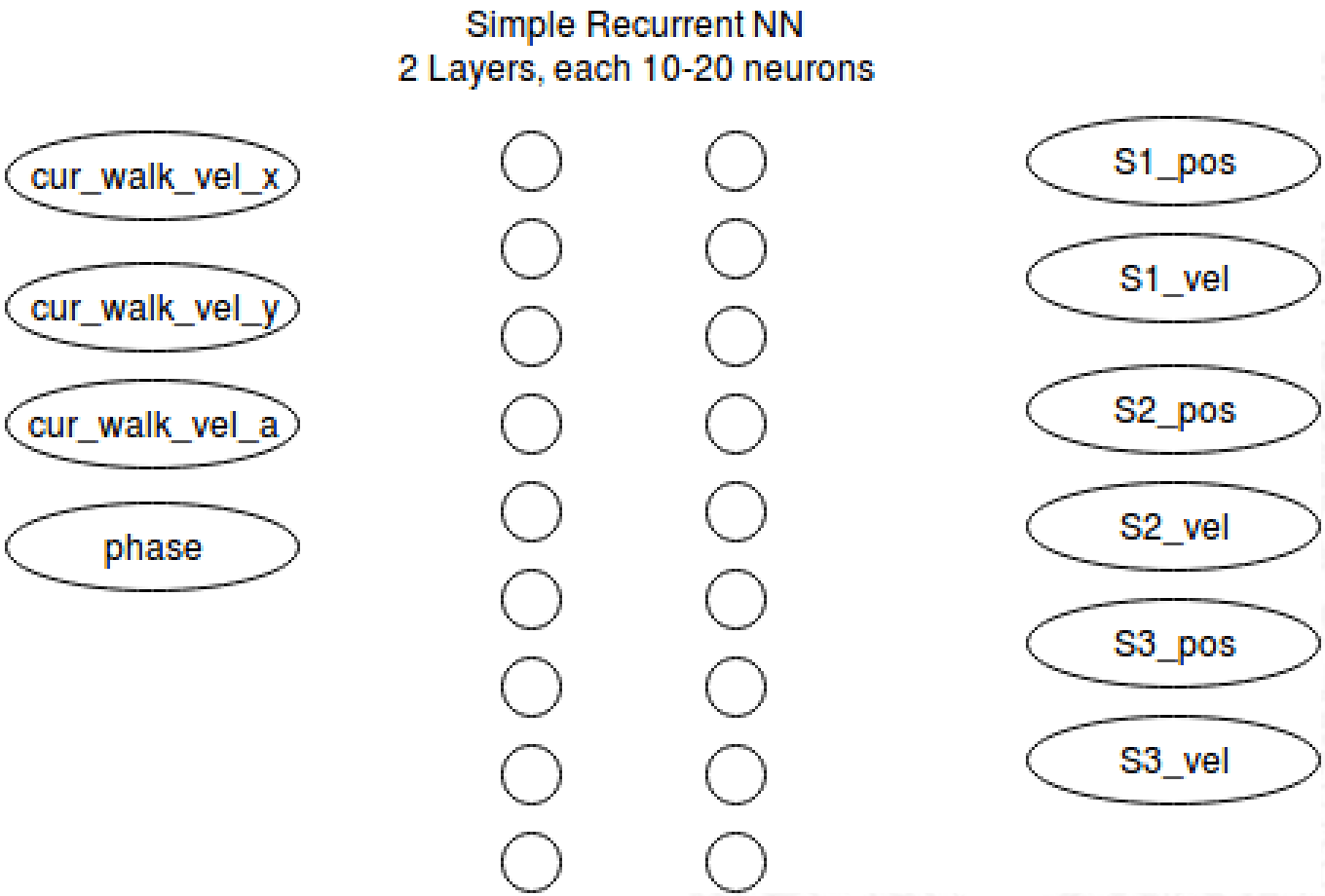
[1]

Feet position

Feet position

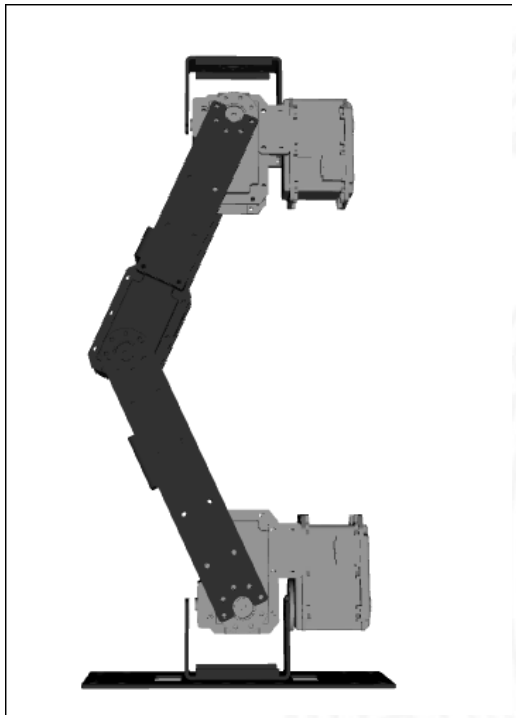


Feet position



Inverse Kinematics

- Movements are very restricted - simple IK
- Using existing IK



What I've done so far

- Research on related work
- Understanding the Rhoban walking algorithm
- Porting the algorithm to a roscpp node
- Minor improvements and debugging data
- Understanding Tensorflow
- Prototyp for a speed control Tensorgraph

Future Work

- Build physical learning setup
- Removing fixed phase length
- Using current feet positions
- Moving arms and upper body
- Learning from demonstration

References

[1] https://de.wikipedia.org/wiki/Spline-Interpolation.

Questions

Questions?