LiSuM: Design and Development of a Middleware to couple Virtual LISA+ TLS Controller and SUMO Simulation

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Agenda

• 1. Motivation
• 2. LiSuM Software Concept
• 3. Use case scenario with LiSuM
• 4. Short video to demonstrate LiSuM
• 5. Conclusion and outlook
Motivation (1)

Virtual Traffic Light Controller (TLC)
- standalone
- Appropriate for complex control algorithm
- Close to the reality

Traffic light control program designed and planned for a signalized intersection

Real World

Available strategy control
- Local control
- Fixed time control
- Vehicle adaptive control
- Coordinate control
- S. activated Plan Selection (SAPS)
- Co-operative control (e.g. AGLOSA)

Real TLC

Traffic road intersection equipped with:
Real TLC : Traffic Light Controller
TLS: Traffic Light Signals
D: Vehicle detection equipment

Traffic simulation vs. Traffic controller

Microscopic Traffic Simulation (MTS)
- standalone
- appropriate for simple control algorithm

Interface

Switch commands

Detector data

Real World

Virtual World

ImFlow (PEEK)
Sitraffic Office (Siemens)
VS-Plus (Verkehrssysteme AG)
TRANSYT (TRL)
LISA+
Schlothauer&Wauer

VISSIM (PTV)
Paramics (Quadstone)
AIMSUN (TSS)
MatSim (TU-Berlin)
SUMO (DLR)

...
Motivation (2)

• In DLR TLC Laboratory new methods for TLC are investigated.

• For this purpose different tools like Sitraffic Office VISSIM SUMO and LISA+ to design, plan and simulate new methods for traffic light control.

• The simulated control logic algorithms can be tested into the real controller available in the DLR Laboratory.

• Fact:
  • Interface between LISA+ and VISSIM exists.

• Problem:
  • no open SUMO interface to LISA+ was available at the beginning this project.
  • Complex control logic programs designed with professional tools like cannot be executed with SUMO.
DLR Solution: LiSuM Middleware Interface

- LiSuM = LISA SUMO Middleware
- LiSuM realizes the **communication** interface between SUMO and LISA+ controller
  - LiSuM communicates with LISA+ through a **RESTful** API
  - LiSuM communicates with SUMO using **TraCl4J**
  - LiSuM sends LISA+ induction loops detection data (read from SUMO)
  - LiSuM sends SUMO traffic light states (received from LISA+)
- LiSuM provides GUI, which allows the **user interaction** between LISA+ and SUMO during the simulation
- LiSuM supports the simulation of multiple TLC Units
- LiSuM provides two sample TLC simulation projects as part of the distribution
What is LISA+?

• LISA+ is a traffic engineering software toolsuite developed by the German company Schlothauer & Wauer
  • LISA+ is a commercial product → it is recommended to purchase the software license to use the LISA+ products
  • The tools consist of:
    • LISA+ OTMC (Open Method of Traffic Control) GUI is a design and planning tool for traffic light control etc…
    • Virtual LISA+ traffic light controller (TLC) to simulate the traffic control logic
    • …etc
  • LISA+ products are mostly used in Germany and in some countries in Europe and in South America
• LISA+ products target groups are
  • Transportation engineers and planners
  • Local government officials
  • Lecturers - for teaching and research
  • Etc...

supported strategy control
- Local control
- Fixed time control
- Vehicle adaptive control
- Coordinate control
- Co-operative control
LiSuM Communication Interface

Virtual LISA+ Controller RestFul Service

PDSProtocol
PutMessage

PDSMapping
SetDataDir
GetDataDir
GetObjectList
GetTaskList
RemoveTaskList
SetTask
GetTask
...

LiSuM Middleware

LiSuM Configuration

Detectors data (Traffic demand)

SUMO

Method Call
getTrafficLightRepository()
getInductionLoopRepository()
getVehicleRepository()
inductionLoop.getLastStepVehicleData().getInformationPackets()
trafficLight.changeLightsState(new TLState())
...

LiSuM GUI
LiSuM Graphical User Interface (GUI)
LiSuM Graphical User Interface (GUI)

System Preference Panel

Control Unit Management Panel
LiSuM Configuration File (lisum.xml)

- XML file which contains all necessary information used to control the way that LISA+ communicates with SUMO
- Difference in the representation and naming between LISA and SUMO
- Mapping of signal group and detector between LISA+ and SUMO to resolve the difference in the naming and representation convention
- Configuration of multiple control units for different signalized intersections is possible

```xml
<?xml version="1.0" encoding="UTF-8"?>
<simulation>
  <input>
    <lisa>lisaDirectory</lisa>
  </input>
  <controlUnits>
    <controlUnit lisa="z1_fg1" sumo="gneJ1">
      <signalGroups>
        <signalGroup lisa="K1" sumo="0" />
        <signalGroup lisa="K2" sumo="1" />
        <signalGroup lisa="K3" sumo="2" />
        <signalGroup lisa="K4" sumo="3" />
      </signalGroups>
      <detectors>
        <detector lisa="D1" sumo="myLoop1" />
      </detectors>
    </controlUnit>
    <controlUnit lisa="z1_fg2" sumo="gneJ2">
      <signalGroups>
        <signalGroup lisa="K1" sumo="0,1,2" />
        <signalGroup lisa="K2" sumo="3" />
        <signalGroup lisa="K3" sumo="5,6,7" />
        <signalGroup lisa="K4" sumo="8" main="K3" />
      </signalGroups>
    </controlUnit>
  </controlUnits>
</simulation>
```
Recommended Steps to using LiSuM

1. Design & plan the road intersection traffic signal control logic with **LISA+ OMTC Tool**
2. Design & plan the road intersection and the traffic light for **SUMO**
3. Installation of the **virtual LISA+ TC** (RESTFull Server)
4. Installation of **SUMO** (+GUI)
5. Installation of **LiSuM Middleware**
6. **Lisum.xml configuration**
7. **TLC Simulation mit LiSuM (Video)**

**LISA+ control logic files**

**SUMO files**

**LISA+ executable Jar**

**Sumo**
version 0.29.0 or later

**LiSuM Java Software**
(java, JRE version 8 or later)
Design and plan the Example Intersection with LISA+ OMTC

**Signal phases**

**Detectors**

**Signal group**

**Control logic**

**Intersection**
Generated Control Logic from LISA+ OMTC

- Control logic created with LISA+ OMTC consists of a serie of files containing the control logic program and its parameters.

- Control logic created with LISA+ OMTC is uploaded to the virtual LISA+ controller and can be directly simulated with the SUMO using LiSuM.

LISA+ control logic files
Design and Planning the Sample Intersection for SUMO

- demo.sumocfg
  ```xml
  <configuration>
    <input>
      <net-file value="lsa.net.xml"/>
      <route-files value="lsa.rou.xml"/>
      <additional-files value="lsa.add.xml"/>
    </input>
    <time>
      <step-length value="1"/>
    </time>
  </configuration>
  ```

- SUMO net file
  - lsa.net.xml

- SUMO route / vehicle demand / TLS file
  - lsa.rou.xml

- SUMO detector config. file
  - lsa.add.xml
Virtual LISA+ Controller Installation

LISA+ executable Jar

LISA+ virtual controller acts als RESTfull Server
SUMO Installation

Installation of SUMO (+GUI)

- Bin folder
  - Makefile.am
  - Makefile.in
  - SUMOTrafficModeler.jar
  - TrasS.jar
  - emissionsDrivingCycle.exe
  - emissionsMap.exe
  - netedit.exe
  - activitygen.exe
  - sumo-gui.exe
  - marouter.exe
  - dfrouter.exe
  - sumo.exe
  - netconvert.exe
  - TracTestClient.exe
  - jtrrouter.exe
  - netgenerate.exe
  - duarouter.exe
  - polyconvert.exe
  - od2trips.exe
  - FOXL1-1.6.dll
  - xerces-c_3_1.dll

Sumo
Version 0.29.0 or later
Short video to demonstrate LiSuM

Simulation of traffic-actuated control scenario for a sample signalized intersection
**Configuration of the Sample Intersection**

**Detection type**
- 2 Induction loops
- 4 Infra red detectors
- 1 Radar detectors

**Signal group**
- 4 (LISA)
- 6 (SUMO)

Sample intersection to simulate traffic-actuated control
Conclusion and Outlook

• First step:
  • Technical realization of a LiSuM Middleware that provides
    • communication interface between LISA+ TLC and SUMO
    • GUI to support the user interaction by the simulation process
  • The LiSuM tool has been used to test a traffic-actuated signal control
    on an selected example intersection

• Next step:
  • Simulation of traffic light control scenario for complex/multiple
    intersections (scalability and performance evaluation)
  • Comparison of the simulation between VISSIM, SUMO and LISA+ controller
  • Optimization of the current LiSuM software version
  • Make the LiSuM (source + distribution) available for download to the
    community (as part of SUMO distribution. come soon)
Thank you for your attention

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