openPASS / OSI World

Overview OSI objects and OSI world implementation

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Contents

1 Introduction

This document shall provide an overview of the proposed implementation of an openPASS world representation based on OSI (open simulation interface) [1]. It's focused on the required entities for our proposal of the "OSI world".

2 World requirements

The World holds the data for the simulated entities and provides methods for queries on these entities via the WorldInterface.

In our proposal we will implement a representation of the environment with a road-based coordinate system (s-t-coordinates). The road is described by an aggregation of lanes. Each lane is defined by a reference line and various properties. The s coordinate of a location specifies the distance along the reference line from the start of the road. The t coordinate describes the offset from the lane's reference line. In order to locate a point, s- and t-coordinates, as well as a lane identifier are required.

In Addition, the global x-y-coordinates will be available.

3 Architectural overview

Our OSI world implementation will be just another implementation of the openPASS WorldInterface. OSI is actively being developed, a switch from protobuf to another underlying structure has already been mentioned. Thus, we decided to split the base data container (OSI) from the actual implementation by introducing another layer.

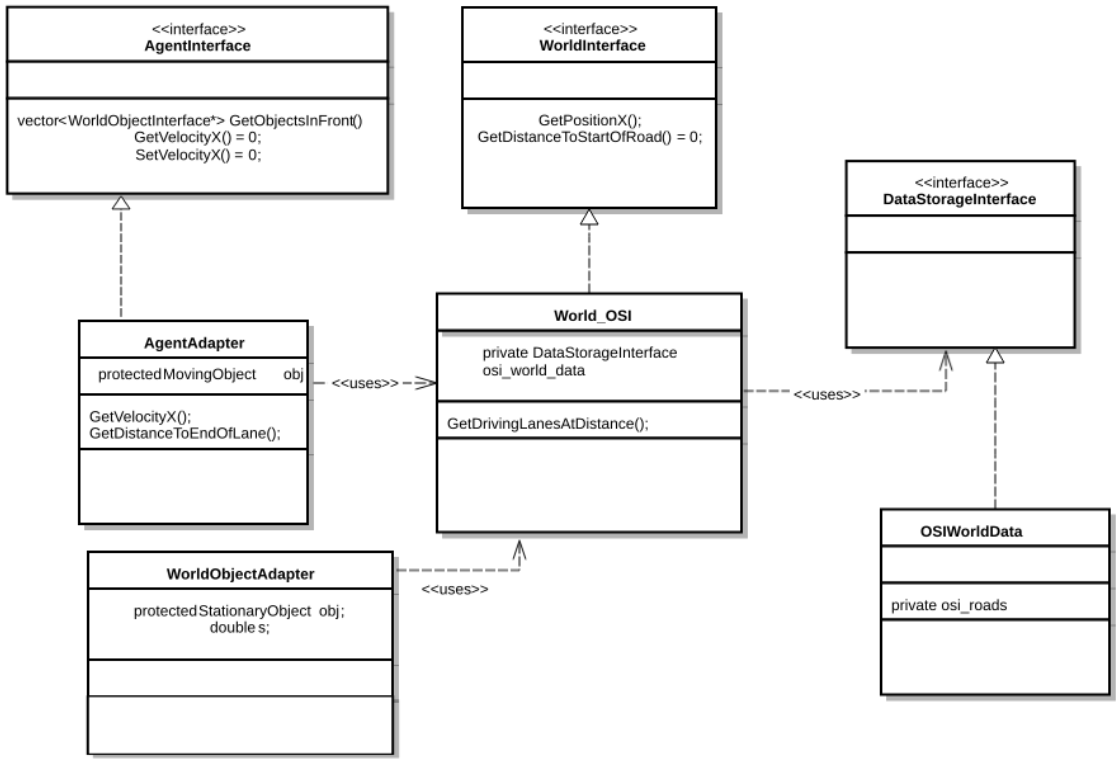

Figure 1: World_OSI class diagram (wip, suspect to change)

4 OSI messages

OSI provides data containers for various types of entities, currently based on protobuf [2]. Apart from methods for setting and getting the data, no means of manipulation are specified or implemented in OSI.

4.1 Existing messages

Many OSI objects describe sensor related data for detected objects and corresponding probabilities. These are not covered here.

All currently available coordinate systems in OSI are cartesian and are references to their parent frame (i. e. a sensor's coordinate system origin is moving with the vehicle the sensor is mounted on). Exception: Spherical coordinates for specific sensor data).

Most objects can uniquely be referenced by their Id.

Following overview is based on OSI version 3.0.0.

BaseMoving

Base attributes of an object that is moving (or is able to move).

Properties

Position, orientation, dimension

Velocity, acceleration, orientation rate

Outline (as list of points)

BaseStationary

Base attributes of an immobile object.

Properties

Position, orientation, dimension

Outline (as list of points)

Dimension3d

Dimension of a box.

Properties

Length, width, height

EnvironmentalConditions

Conditions of the environment.

Properties

Time of day, Precipitation, fog, illumination, temperature, humidity, atmospheric pressure

GroundTruth

This is the simulation environment.

Properties

Moving and stationary objects

Lanes, lane boundaries, road markings

Traffic signs, traffic lights

Environmental conditions

Country code

Timestamp

Lane

A lane in the road network.

Properties

Type, road conditions (temperature, water film, freezing point, ice, roughness, texture)

Center line, driving direction, boundaries

Adjacent lanes, lane pairings (logical connection between predecessor and successor lanes)

LaneBoundary

Definition of the border of a lane.

Properties

List of boundary points (position, width, height)

Type, color

Limiting structures (stationary objects)

MovingObject

A mobile object, based on BaseMoving.

Properties

BaseMoving, type, assigned lanes

If type is vehicle: wheel radius, number of wheels, bounding box center to rear/front, ground clearance, type of vehicle, light state, trailer

Orientation3d

Specifies the orientation in Euler-angles.

Properties

Yaw, pitch, roll

RoadMarking

A marking on the road surface (excluding lane boundary markings).

Properties

BaseStationary, type, color, type/value/text of traffic sign, assigned lane

StationaryObject

Objects that are neither MovingObjects nor TrafficLight or TrafficSign.

Properties

BaseStationary, type, material, density, color

TrafficLight

Describes a single bulb of a traffic light.

Properties

BaseStationary

Color, icon, counter, mode (off, constant, flashing, counting)

Assigned lane

TrafficSign

A traffic sign.

Properties

BaseStationary, type, value, unit, direction scope (left, right, ...)

Supplementary information (arrows, distance information, ...), Variability (fixed, temporary, ...)

Assigned lane

Vector2d, Vector3d

Cartesian vector for positions, velocities, accelerations, ...

Properties

x-, y- and z-coordinates

4.2 Messages to be implemented

These messages are currently being specified and may be refactored, modified or extended at any time.

WorldInterface

Container for new OSI world interface messages.

Properties

Roads

Road

A road in the road network.

Properties

Type, framing

Antecessor/successor road connections

RoadSections

RoadSection

A section along a road. Grouping of lanes with same properties.

Properties

s-coordinate of beginning position, length

Antecessor/successor section connections

RoadLanes

RoadLane

A lane inside a road.

Note: Re-use of the existing OSI lane is preferred here (maybe as base-object).

Properties

Type (driving, nondriving, biking, sidewalk, on/off ramp, ...)

Geometry information (list of LaneGeometryJoints), length, reference line orientation

Adjacent lanes, lane pairings (logical connection between predecessor and successor lanes)

Lane boundaries, environmental conditions

LaneObjectAssignments (vehicles, stationary objects, ...)

LaneGeometryJoint

Base element of a lane geometry.

Properties

Reference line, left line, right line (as list of Vector2d)

Curvature, heading

LaneObjectAssignment

Link between objects and the road network location.

Properties

Assigned lane

s-t-coordinates

5 References

[1] Open simulation interface Github repository
https://github.com/OpenSimulationInterface/open-simulation-interface

[2] Google protocol buffers
https://developers.google.com/protocol-buffers