Software Architecture Document

Web platform WillyWeb

Studenten:
- Jonathan ten Hove : S1082167

Schoolbegeleider:
- Mischa Mol : mc.mol@windesheim.nl

Opdrachtgever Art of the Robotics:
- Ruud van den Berg : rvdb@art-of-robotics.nl

Datum: 27-05-2018
Versie: BETA

Table of contents

Preface

In this document the web platform of Willy is fully described in a functional manner as well as a technical manner. The technical parts are visualised in various UML diagrams to make the application structure as clear as possible. Besides this the design choices made during development are listed and reasoned. Also some more information about the framework used to talk to ROS is described in this document.

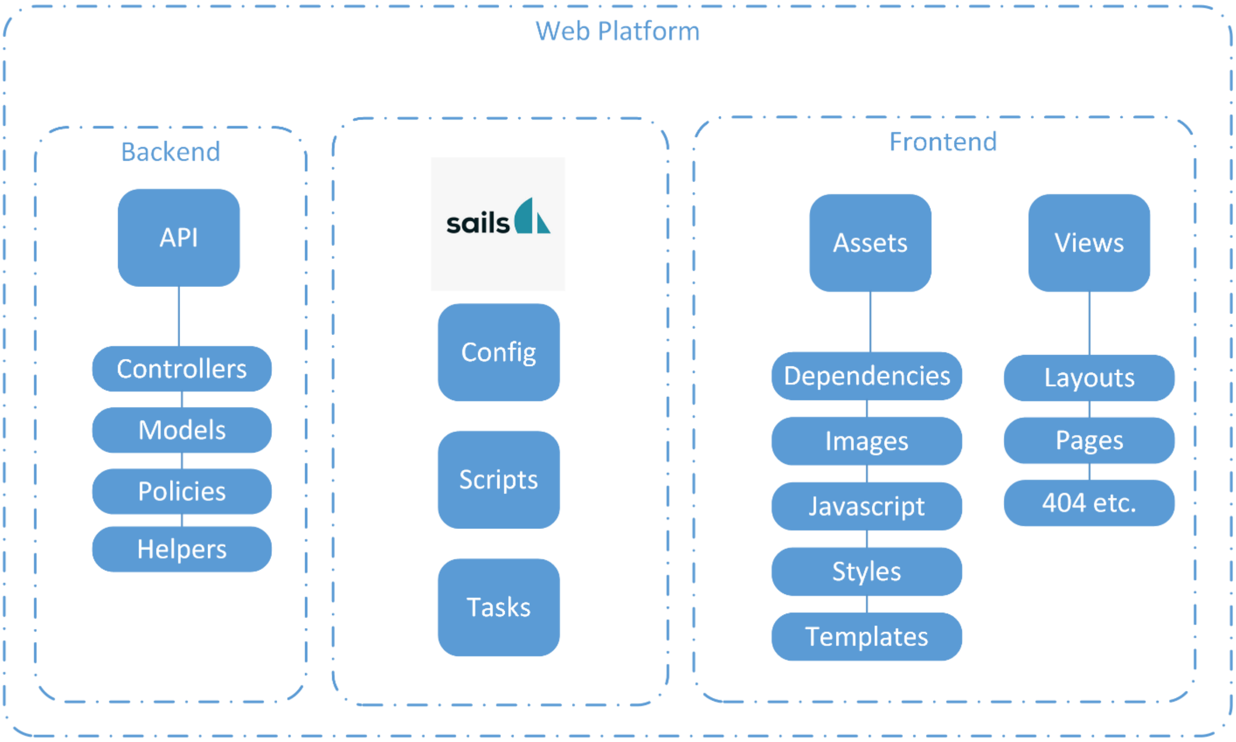
For more information you can consult the Wiki, specificly the WEB section which can be found at https://artofrobotics.github.io/WillyWiki/WEB/. The social interaction part is also described on the Wiki and not in this document because it is in very early stages and is not part of the design yet. You can find documentation about social interaction at https://artofrobotics.github.io/WillyWiki/WEB/#_interaction.

Disclaimer

At the time of writing the application is still in its early development stages what could be called an alpha product. So many of the designs might change in the future when more suitable solutions or better alternatives are found.

System Overview

Sails JS



SailsJs
In the above schematic you can see how SailsJs is setup. At the left the backend and frontend at the right. In the middle you see the global config and other files which are used by the backend as well as the frontend.

Backend
The backend consist out of the so called API which contain controllers and models. Each controller contains actions which are called by the frontend.

Frontend
The frontend is divided into views and assets, the views contain html which generates the view. The assets contain all the front-end dependencies and for each page a separate JavaScript file which handles all the API calls and displays the data.

Requirements

Functional

- A user must be able to identify himself by entering a name
- A user must be able to see who else is using the platform and on what page
- A user must be able to use the platform without knowledge of Ros or underlying systems
- A user must be able to read Ultrasonic sensor data
- A user should be able to set and change variables
- A user should be able to show a visualisation of the 2d map made by RVIS
- A user should be able to control Willy using touch or a mouse
- A user should easily be able to start Willy with a single click and some instructions
- A user must be able to see the location of Willy based on GPS data

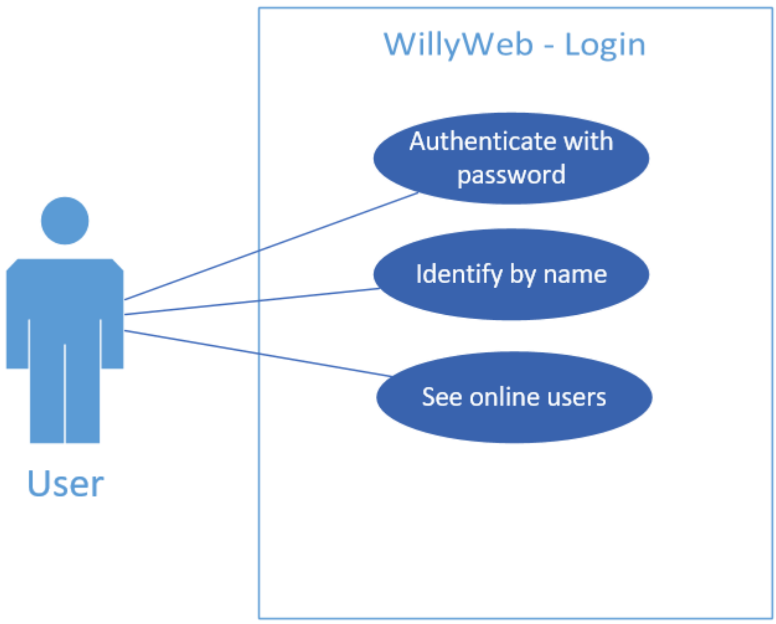
Non-functional

- The platform must communicate via ROS
- The platform is password protected
- The platform is multiplatform and usable on a mobile phone
- The platform runs on Willy's PC using Ubuntu

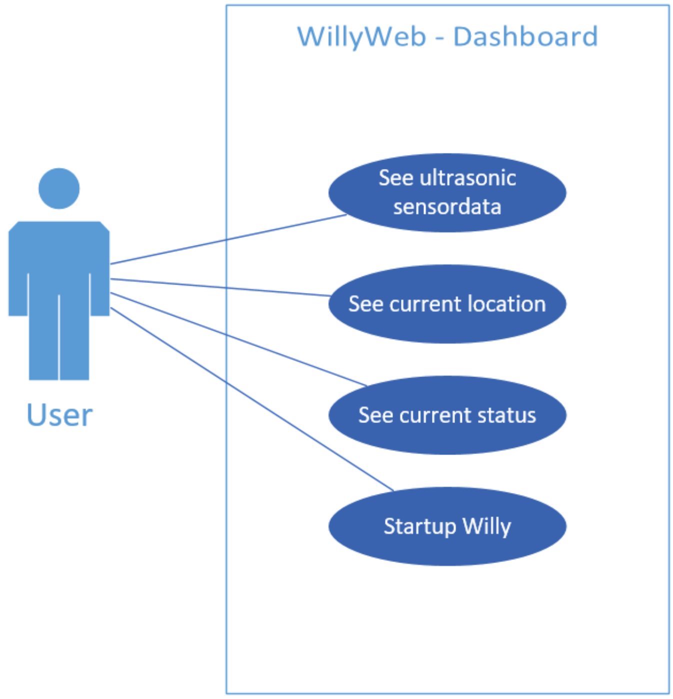
Use Cases

Use Case Diagrams

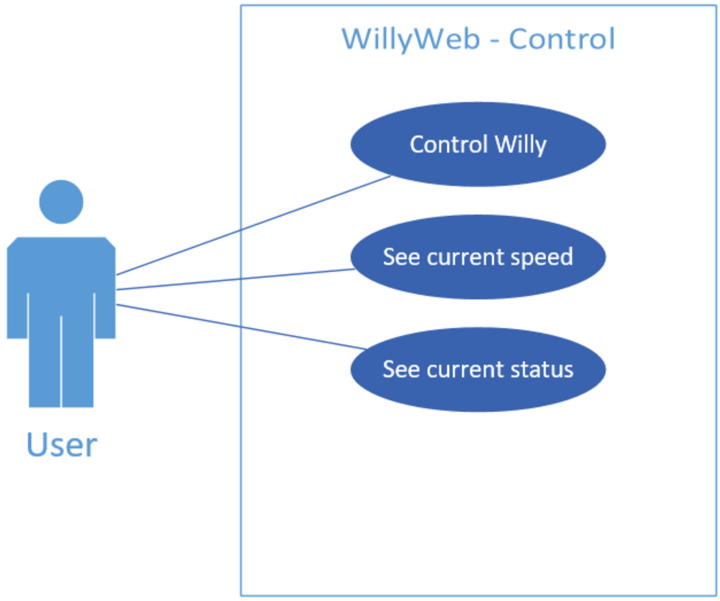
Login



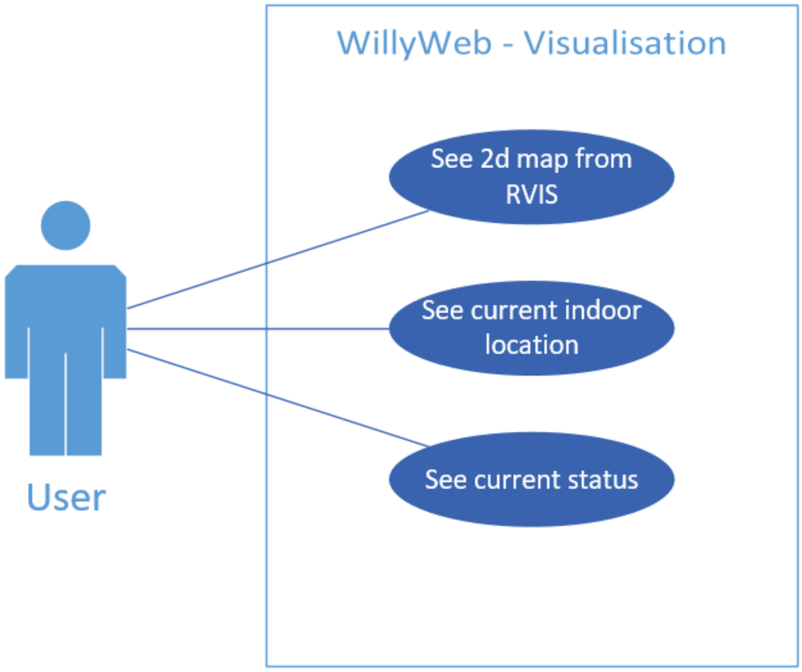
Dashboard



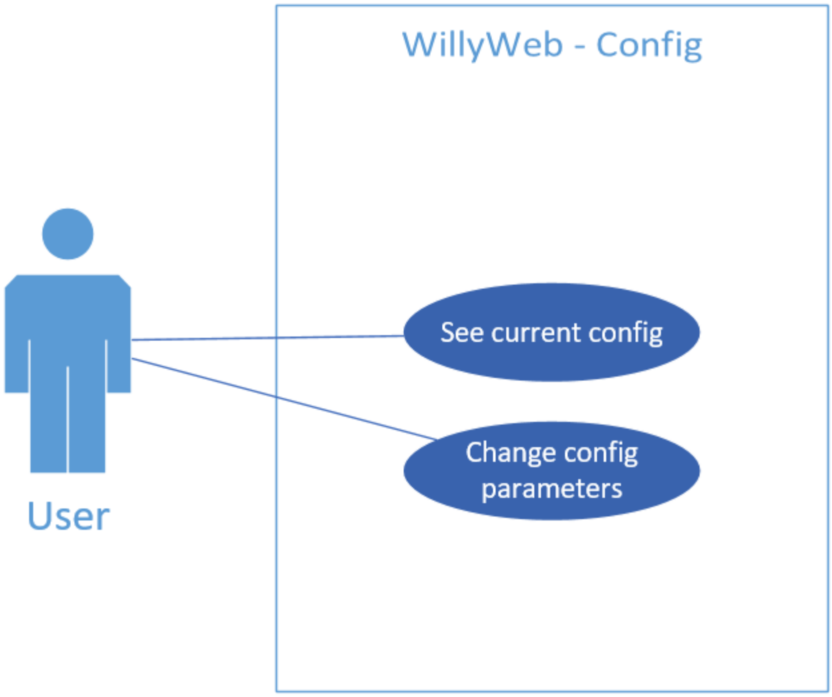
Control



Visualisation



Config



Use Case descriptions

Login

Authenticate with password

A user must enter a password to authenticate.

Identify by name

A user must identify by entering a name

See online users

After authentication and identification a user must be able to see who else is using the platform and on which page they are or what they are doing.

Dashboard

See ultrasonic senordata

A user must be able to readout the sensordata from ultrasonic sensors to check a certain distance between an object.

See current location

A user should be able to see the current location of Willy, indoors and outdoors if possible else it should display its latest position and time updated.

See current status

A user must be able to see Willy's current status, which modules are correctly started and connected and which modules failed to start for example.

Startup Willy

With a press of a button a user should be able to turn Willy on, when doing this a user instruction should be presented.

Control

Control Willy

A user should be able to control Willy manually. This can come in handy when Willy needs to be moved in specific directions or in spaces it normally wouldn't operate such as on a fair.

See current speed

A user should be able to see the current speed of Willy while driving manually

See current status

A user should be able to see Willy's current status, for example show senor data to avoid collisions.

Visualization

See 2d map from RVIS

A user should be able to see the 2d map generated from the sensor input using RVIS. This is to be able to remotely monitor the space around Willy and for debugging purposes.

See current indoor location

On this 2d map the location of Willy should be shown.

See current status

A user should be able to see Willy's current status, for example show senor data to avoid collisions.

Config

See current config

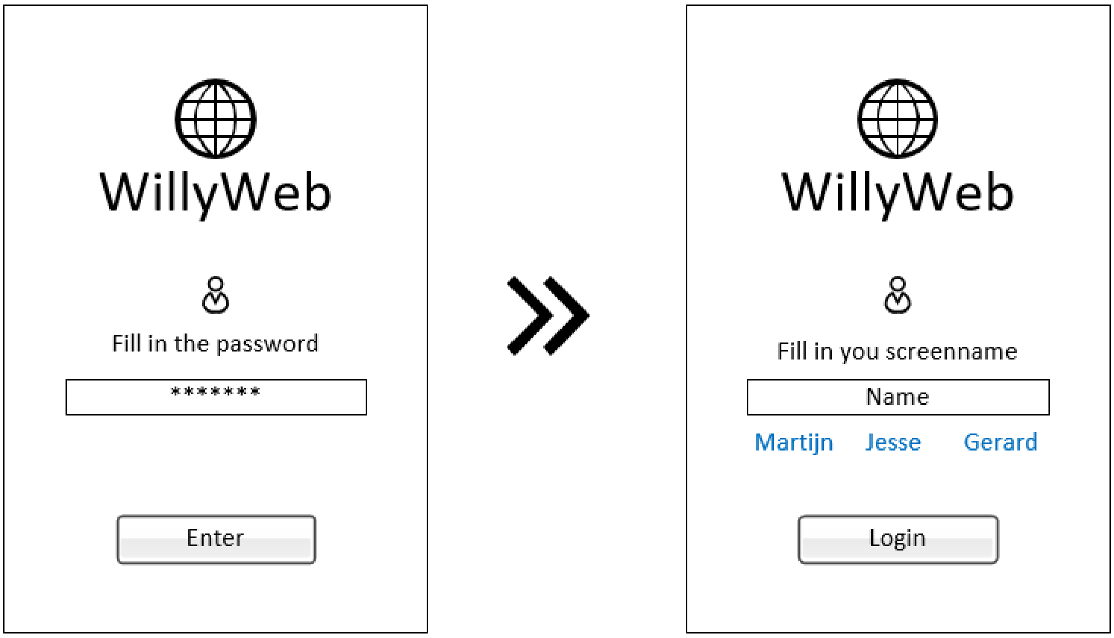
A user should be able to see the current parameters set in the config

Change config parameters

A user should be able to change these parameters, without being able to enter wrong input values.

Wireframes

Login



Login

The login screen is split up into two actions first authentication and then identification.

Authentication

On the left side the wireframe for authentication. It contains the following elements:

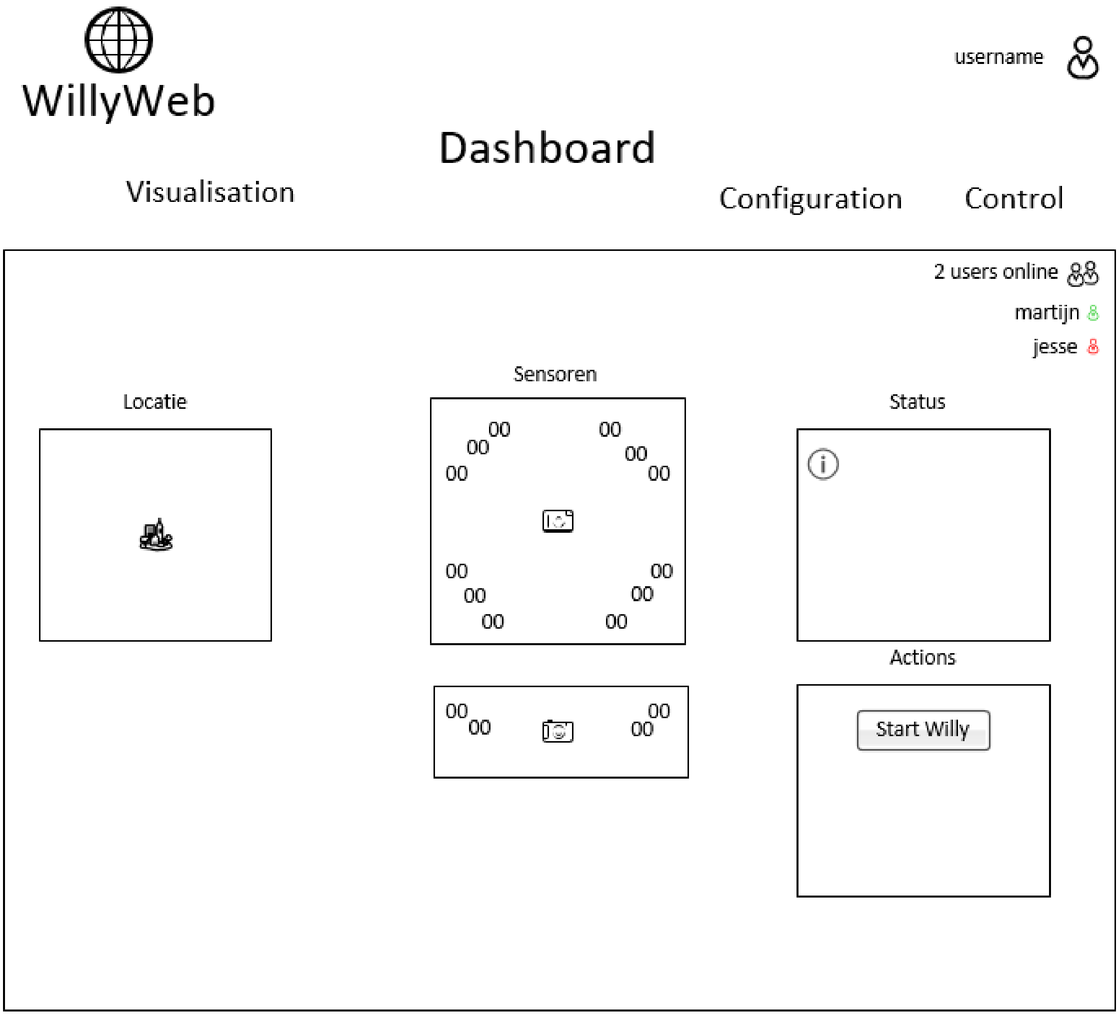
Type	Description	Purpose	Action
Image	Logo	Informative	None
Label	Fill in the password	Instruction	None
Password field	Password	Authentication	Enter password
Button	Authenticate	Authentication	Authenticate

Identification

On the right side the wireframe for identification. It contains the following elements:

Type	Description	Purpose	Action
Image	Logo	Informative	None
Label	Fill in your screenname	Instruction	None
Text field	Name	Identification	Enter a name
Button	Identify	Identification	Identify

Dashboard



Dashboard

The dashboard is split into 4 different sections one of which is the header at the top. The other 3 sections on the bottom of the page are location information, sensor information and information about the status including a few quick actions.

Header

The header located at the top of the wireframe contains the following elements:

Type	Description	Purpose	Action
Image	Logo	Informative	Go to Dashboard
Label	Username	Informative	None
Menu	Menu items	Navigation	Navigate to page
Text	Shows online users	Informative	None

Location information

At the far left of the wireframe the 'location' section contains the following elements:

Type	Description	Purpose	Action
Title	Location	Informative	None
Image	Map, shows surroundings	Informative	None
Image	Willy, Shows current location	Informative	None

Senor information

In the middle the sensor section contains the following elements:

Type	Description	Purpose	Action
Title	Sensors	Informative	None
Image	A image of Willy's top view	Informative	None
Image	A image of Willy's side view	Informative	None
Text	Sensor data of sensors around Willy	Informative	None
Text	Sensor data of sensors looking down from Willy	Informative	None

As an extra note, the sensor data is placed according to the sensor placement on Willy itself so the data represented for the real-life situation.

Status information & Actions

The section on the right side with the title 'Status' contains the following elements:

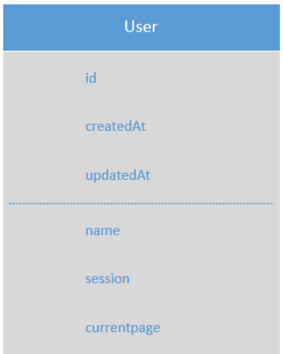
Type	Description	Purpose	Action
Title	Status	Informative	None
Text	Status information	Informative	Show more information
Image	A symbol shows the urge of each status information	Informative	None

The section on the right side with the title 'Status' contains the following elements:

Type	Description	Purpose	Action
Title	Actions	Informative	None
Button	For example: Start Willy	Launch action	Launch specified action

Logical Overview

ERD



Clarification

It might seem quite minimal but the User object is the only model used as of the moment of writing. It is also because most of the objects created are not linked to a user model but rather to a RosNodeJS message type, and these messages are directly send to ROS and not saved in a model of some sort.

User

The user model contains by default an 'id', 'createdAt' and 'updatedAt' attributes. The attributes mainly used in the model are the 'name' attribute, this is the username which the user used to identify. The attribute 'currentpage' keeps track of the page each user is on and the 'session' attribute contains the session id so the application can track the users among API calls.

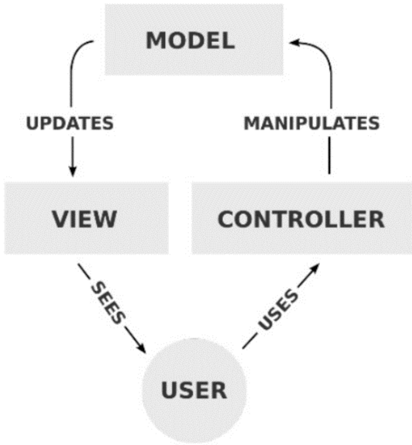
Domain Model

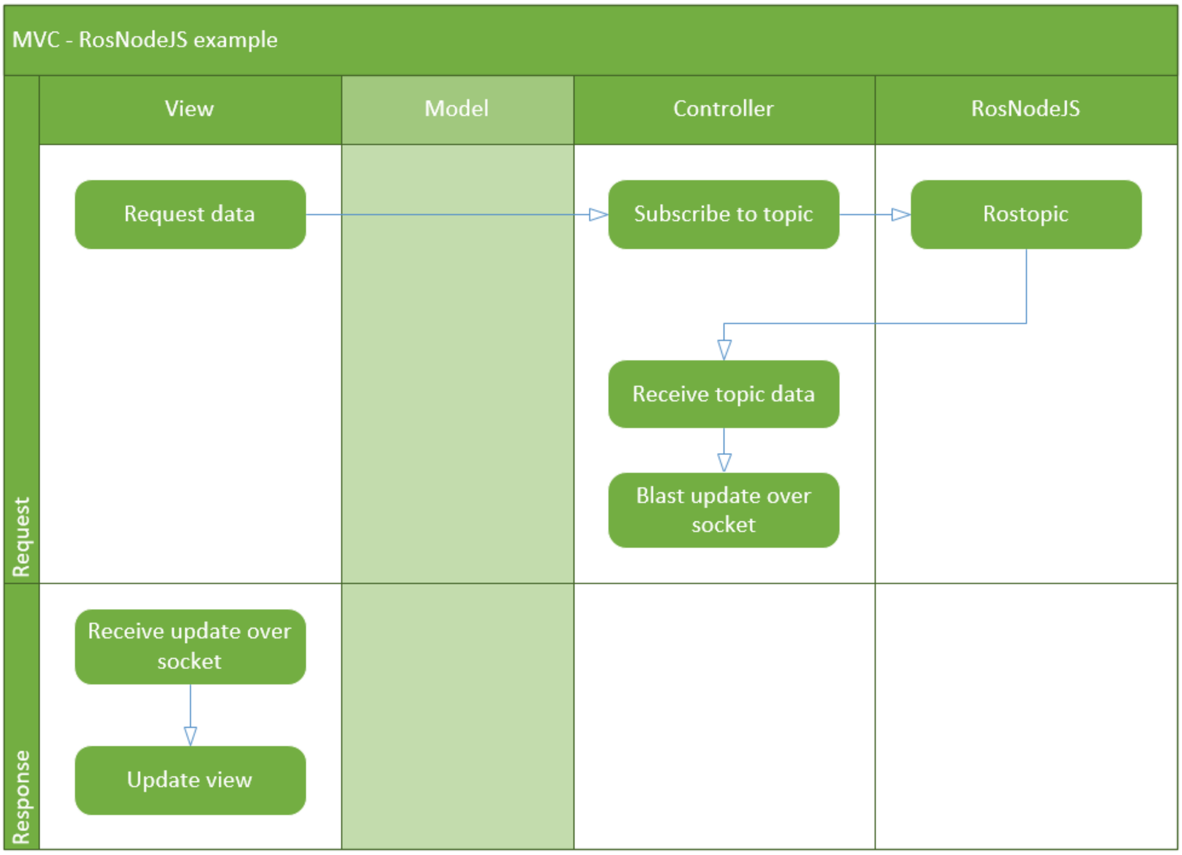
This would be the same as the ERD, see the clarification for more details.

Class Diagram

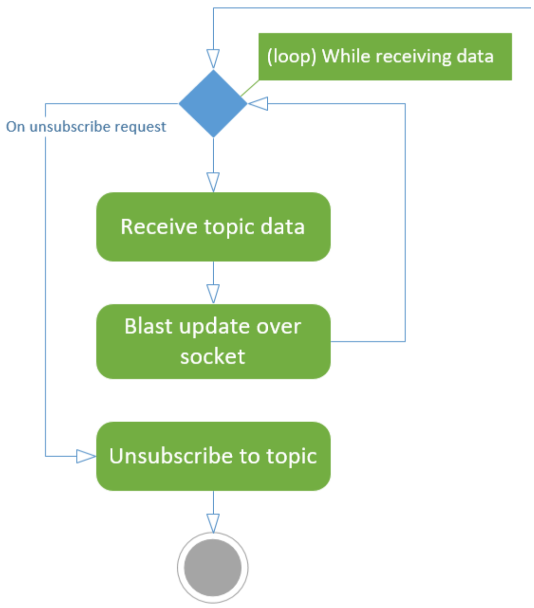
MVC & RosNodeJS

SailsJs is based on the Model – View – Controller framework (MVC) because of this all those parts are separate from each other and it is able to test these individually. But because RosNodeJS is used the Model is often missing in this workflow because ROS uses message objects which are used throughout the application. Often you will see a controller who talks to ROS and this data is directly used in the View, a visualization of this is made in the following activity diagram.



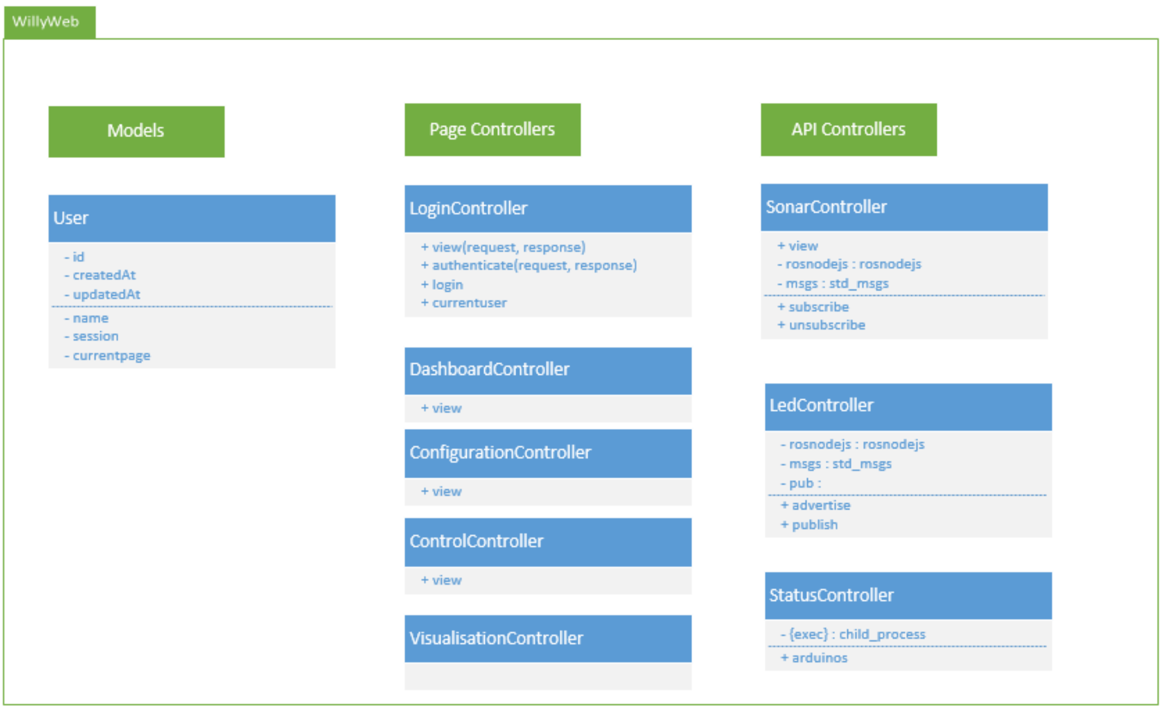


In this example a request for data is send by the user, for example by clicking a button or visiting a page. This request is send via a socket to a controller, this controller subscribes on a Rostopic to receive the data ROS is publishing on the specific topic. When the data is received it is published on a socket with the updated data. Good to know is that this occurs in a loop, and this loop continues until a request for unsubscribing is received. This would more or less look like the following diagram.



Class diagram

A full overview of how a SailsJs environment looks like see https://sailsjs.com/documentation/anatomy. The following diagram focusses on the specifics for WillyWeb.



Models

As described in the ERD section the user is the only model in use at the moment of writing. For a full description read the user section in chapter ERD.

Controllers

Page controllers

The page controllers act as controllers for each page view.

API controllers

The api controllers act as controllers who take care of the ROS communication. An example of this is shown in the previous section about MVC & RosNodeJs. As seen in the diagram above these classes contain RosNodeJS in a variable, this is done using NodeJs require function.

Specific for the 'StatusController' a requirement of the procces is required to execute commands in the operating system.

Views

To complete the diagram as seen above the views should be added. However these are not classes and in such case not shown in a class diagram. The view is rather a html file with But for illustration purposes it would look like the following diagram:

Views

All the .ejs files are embedded Javascipt files, this is the default for SailsJS but could also be html or any other format if you'd like to. Because VueJs is used the use of Embedded Javascript is very limited.

Also the views are separated by folders, to make a difference in files that facilitate the layout and files that are the actual pages.

Assets
This separation is the same for the assets. The assets contain JavaScript files that coordinates all the updates that are done in the view.

Dependencies
In the folder structure of the assets folder you can also find the dependencies.

RosNodeJS

Introduction

RosNodeJs is a framework in which you can create real ROS Nodes. It is good to have basic knowledge about ROS before reading any further. This can be read on the Wiki and at the official website http://www.ros.org/.

RosNodeJs lacks in a proper documentation but the official wiki is available on ROS's own website, see http://wiki.ros.org/rosnodejs/overview.

How to use

RosNodeJs functions as a ROSPackage, the instance of WillyWeb is run as a RosPackage named 'willyweb'. However you are able to run multiple instances of the Rospackage 'willyweb' for example if you run multiple scripts. More on this can be read on the Wiki (https://artofrobotics.github.io/WillyWiki/WEB/).

Implementation

Declaration

Ros is used as a NPM package and is loaded into a controller using the following code:

```
const rosnodejs = require('rosnodejs');
const msg = rosnodejs.require('sensor_msgs').msg;
```

Here in the first line of code RosNodeJs is loaded into the constant variable 'rosnodejs'. In the second line the type of message is defined, in this case 'sensor_msgs'.

Node Handle

In the following section of code these variables are used as following:

```
module.exports = {
    subscribe: async function (req, res) {
        if (!rosnodejs.nh._node) {
            await rosnodejs.initNode('/willyweb');
        }
```

In the third line of code you can see an if statement that checks if a so called Node Handle already exist. A Node Handle is the Node on which the platform operates, you could also see this as the Rospackage 'willyweb' but then in a active node. You would expect that this is not needed because you require the same RosNodeJs module across the application but research found out this does not work as of the moment of writing.

If a Node Handle already exits the node can be accessed using 'rosnodejs.nh'. If this Handle does not yet exist it awaits the creation of it using 'rosnodejs.initnode('/willyweb')'.

The main reason this is done each time RosNodeJs is used in the code is because the same instance must be used over the whole application. Multiple Node Handles cannot coexist. The official examples given are also written inside one function, this is not practical for a well designed application. Another solution was therefore to create a RosController in which all communication with Ros would be done. The main disadvantage of this is that you'll have to create a function for each and every message type used throughout the application which violates the Single responsibility principle in the SOLID principles.

Subscribing

If the Node Handle is initialised we can use the various functions ROS uses, for example subscribe:

```
        let sub = rosnodejs.nh.subscribe('/sonar', msg.LaserEcho,
            (data) => {
                sails.sockets.blast('sonarUpdated', data.echoes);
            }
        );
```

In the first line the subscribe method is called with the first parameter being the topic on which it must subscribe '/sonar' and next up the message type 'msg.LaserEcho' after that the function is declared on what to do when data is published on the topic. This data is stored in the local variable 'data', in the current situation it would blast an update over the socket that new data is available. This update also contains the new data received form the topic.

Advertise

Before being able to publish onto a ROS topic we first need to advertise that we are going to publish data. This is done using the advertise function on the Node Handle:

```
let pub = null;
```

First a variable is made so that the advertise topic can be reused inside the controller.

```
        pub = rosnodejs.nh.advertise('/led', msgs.ColorRGBA);
```

After that the variable is filled with a advertise topic, the function advertise consist out of 2 parameters in this case the topic to advertise on '/led' and a message type 'msgs.ColorRGBA'.

Publishing

After the initialisation of the advertise topic the following function is used to publish data onto this ROS topic:

```
pub.publish({ data: req.param('rgb') });
```

In this example the earlier variable 'pub' is reused to call the function publish on the advertise topic. This function contains the data in JSON format that needs to be published onto the topic. Make sure this data is coherent to the official format used by the specific message type which can be found at ROS official wiki: http://wiki.ros.org/common_msgs?distro=kinetic

Design Decisions

NodeJS

The previous web platform used many different languages, C#, Python and NodeJs which made code management a hassle. Because NodeJS was already used in the Front-end the choice was made to do the same for the backend. The original choice to use C# as backend was mainly due to the use of SignalR which, according to the previous group was the only option to send updates from the server to the client. However it is found that this is not true because Socket.IO offers the same functionality in NodeJs. Another benefit of using NodeJs is that the same language can be used for the frontend as well as the backend which makes the code more maintainable. Also a recent publication of a ROS framework for NodeJs made the choice even more argumentative because it eliminates the use of RosBridge. (Socket.io, 2018) (NodeJS, 2018) (Projectgroup, 2018)

RosNodeJS

RosNodeJS is a framework that allows a NodeJS application to talk to ROS as if it was a part of ROS. This eliminates the use of RosBridge, which is a python module and acts as an API for ROS. The main advantage of RosNodeJS is that you are already operating as a rospackage inside the ROS system. This makes it quicker and reliable by sending and receiving messages to various ROS nodes. It also makes it possible to set parameters from within ROS itself without going through an API. Another disadvantage of using ROSBridge is the slow serialization and deserialization of ROS messages. Of course RosNodeJS also needs to serialize these messages but without going through a separate API the speed is substantially increased. (Smith, RosNodeJS talk RosCon 2017, 2017) (Smith, RosNodeJS Github, 2018) (RethinkRobotics, 2017) (Projectgroup, 2018)

SailsJs

After prototyping with different NodeJS platforms, SailsJs was by far the easiest to start with. Due to its ease of API creation you are able to rapidly prototype a real api without the need of extra lines of code to create it. It is also fully customizable in the long run if the generated API does not fulfill the requirements of the application anymore. Sails also has a built-in integration with Socket.IO which makes it easier to use sockets. (SailsJS, 2018)

VueJS

VueJS was chosen, because previously Angular was used as a front-end framework. But Angular requires specific knowledge and has a steep learning curve, VueJs however combines the best of all worlds by being simple and offering standalone usage trough code. This makes for fast development using a Vue instance. SailsJs also offers good support for VueJS. (SailsJS, 2018) (VueJS, 2018)

Bibliografie

NodeJS. (2018). *NodeJS docs*. Opgehaald van https://nodejs.org/en/docs/

Projectgroup, R. 2. (2018). *Inventory Current status of Willy.*

RethinkRobotics. (2017). *RosCon 2017 RosNodeJs sheets*. Opgehaald van https://roscon.ros.org/2017/presentations/ROSCon%202017%20rosnodejs.pdf

SailsJS. (2018). Opgehaald van SailsJS: https://sailsjs.com/

Smith, C. (2017). *RosNodeJS talk RosCon 2017*. Opgehaald van https://vimeo.com/236189788

Smith, C. (2018). *RosNodeJS Github*. Opgehaald van https://github.com/RethinkRobotics-opensource/rosnodejs

Socket.io. (2018). *Socket.io Docs*. Opgehaald van https://socket.io/docs/

VueJS. (2018). *VueJS*. Opgehaald van https://vuejs.org/