Real-Time Bridge Monitoring Requirements Specification

Version 0.01

Revision History

Date	Version	Description	Author
2013-11-06	0.01	Initial Version	Dev. Team

Table of Contents

1. Introduction

1.1 Purpose of this document

The purpose of this document is to state all gathered requirements and to explain system in more details. This document will be used to proof that development team and customer have the same view of what the system is supposed to do and how. The document will also be helpful to the developing team in the design and implementation phase in order to implement the desired functional and non-functional requirements. Finally, document will also be object of supervision from the supervisor of the project.

1.2 Scope

The document is split into five major parts: Description of the system, Requirements description, Requirements definition, Future development and Appendix.

In the part “Description of the system”, at the beginning brief recall of the background of the existing system is given. After that the functions of each actor from use case diagram is explained. The constraints and assumptions are also covered in this part.

The second part of this document is “Requirement description”. All requirements, regarding Sensor data presentation, engineer functionality, administrator functionality, external user functionality and calculations are described in details in this section.

The purpose of the third section, “Requirement definition”, is to give a priority to each requirement described in Requirement description section. This is done by putting all the requirements in a table along with their priorities.

In the fourth section, “Future development”, some of the extra features that can be developed later are given.

At the end, table of parameters used in document is given, this way it is easier to understand the document and meaning of the requirements.

1.3 Definitions and acronyms

1.3.1 Definitions

Keyword	Definitions
Labview Encode	Number of seconds that have elapsed since 1st January 1904, on the Greenwich meridian
Debris	Obstacle stuck on the pillar 30 of the bridge

1.3.2 Acronyms and abbreviations

Acronym or abbreviation	Definitions
ANE1	Mean wind speed in 10 minutes
ANE2	Maximum wind speed in 10 minutes
ANE3	Mean wind direction in 10 minutes
ANE4	Direction of the maximum wind speed in 10 minutes
IDRO1	Mean water depth/water height in 10 minutes
IDRO2	Variance of the sample in 10 minutes
Data of type ①	Parsed sonar height value, with format Rxx.xx
Data of type ②	Parsed sonar height value, with format Rxx.xxE
Data of type ③	Parsed sonar height value, with format xx.xx
Data of type ④	Parsed sonar height value, with format R99.99E
Data of type ⑤	Parsed sonar height value, E1 or missing data
SONAR1	Mean value of the height of the bottom (only with data of type ① and ②), in 10 minutes
SONAR2	Variance of the sample (only with data of type ① and ②)
SONAR3	Percentage of data of type "① + ②" used compared to the 600 elements of the sample data, in 10 minutes
SONAR4	Percentage of data of type "③" there are in the sample data, in 10 minutes
SONAR5	Percentage of data of type "④" there are in the sample data, in 10 minutes
SONAR6	Percentage of data of type "⑤" there are in the sample data, in 10 minutes
SONAR7	Percentage of data of type "②" there are, considering as sample the "① + ②" set of data (so not all the 600 data), in 10 minutes
S_{Vplank}	The push of the wind on the planking
S_{Vtraf}	The push of wind on the traffic.
$V_{EFFwind}$	Effective value of the wind speed
C_{Dwi}	Drag planking
ρ	Air density
A_{PLANK}	Planking area
$S_V(A1\,traf)$	Traffic combination A1
$S_V(A2\,traf)$	Traffic combination A2
$S_V(A3\,traf)$	Traffic combination A3
h_{water}	IDRO1
Q	Flow rate value
V_{water}	Relative value of water speed
$h_{MAXwater}$	Maximum water height. If $h_{water} > h_{MAXwater}$, the river has overflowed.
$PP_{structure}$	Portion of palking

1.4 References

It is necessary to read through the following documentation in order to fully understand the system that is being developed.

[1] Project plan and description document of the project Real-Time Bridge Monitoring
[2] Real-Time Assessment of Bridge Vulnerability, Gianluca C., Francesco B. et al.
[3] Sistema di monitoraggio di Borgoforte, Francesco B., Alfredo C, Gianluca C. et al.

2. Description of the system

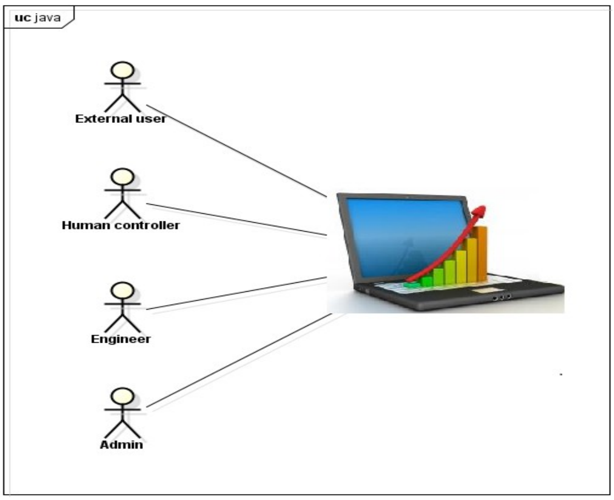
2.1 Background

The bridge, we are monitoring, named "Borgoforte" is situated on the Po river. On the bridge some of the piles are enforced but there is one pile which is week and needs to be monitored. On this pile there is a number of sensors measuring physical force that different sources make on bridge. Moreover, two cameras are providing pictures from both sides of the bridge. All data from sensors and pictures from cameras are stored in files and send to the server in packages each hour.

Our goal is to make a system for storing, calculating and presenting all relevant data of the bridge. We have to extract data from .txt files and store them to database. After that calculations has to be done according to parameters. The calculated level of danger of the bridge is also stored in a database. Finally, both current and history data along with pictures can be presented to the user.

2.2 User Characteristics

Four types of actors have been identified: the Administrator, the Human Controller, the Engineer and the External User. The way of interacting with the system depends on the type of the user. The users are presented in the following illustration.

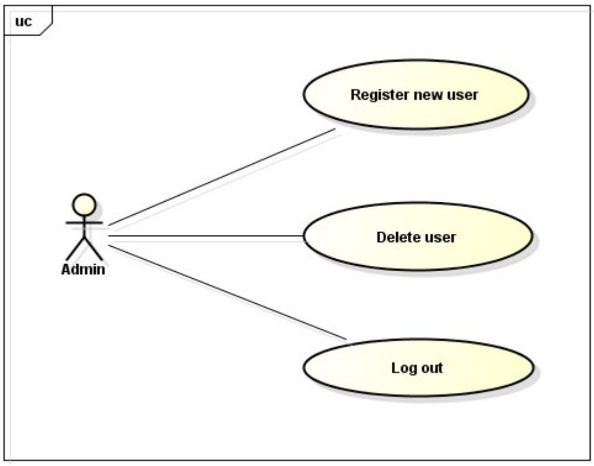


The Administrator manages the users accounts , the human controller monitor the bridge and reacte by giving inputs, the Engineer is the one who has all knowledge about equations and is aloud to change parameters, and the external user doesn't need to have any knowledge of the system since he is only allowed to see reduced set of current state and history status of the bridge.

2.3 Product functions

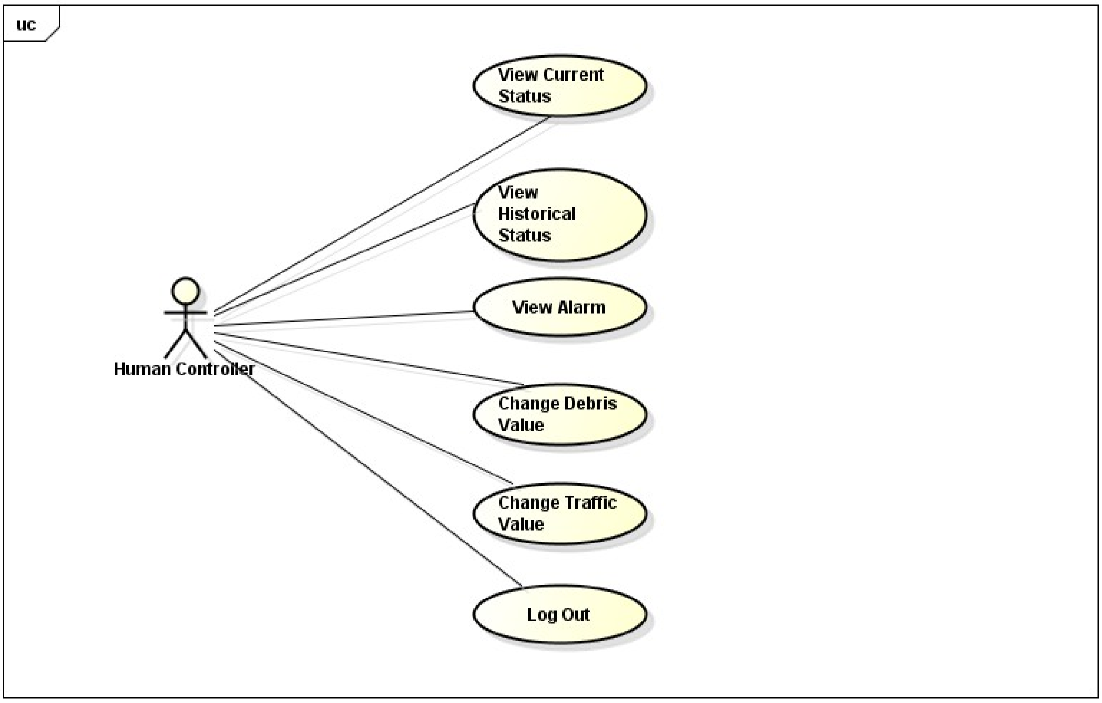
2.3.1 Administrator functions

The Administrator can only manage the users and does not have authorization to change any system parameters. He can register a new user, delete a current user and logs out. The administrator does not need to have knowledge about the calculations or how the system works at all.



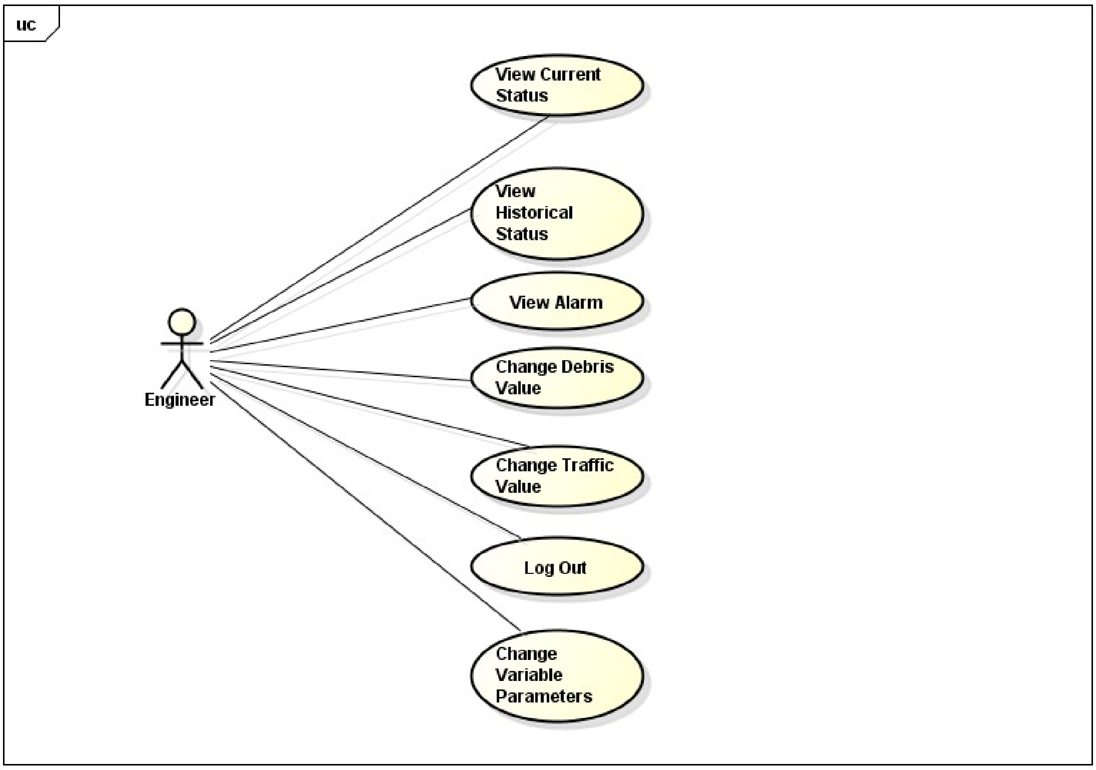
2.3.2 Human Controller functions

The purpose of Human Controller is only to monitor the condition of the bridge and input the information if there is debris on the bridge or not. This input is basically a radio button and can be active or inactive. According to his input and all the parameters calculation are made. The human control can see the current status of the bridge and the historical status of the bridge. This information includes also the safety factor and alarm state. The safety factor is product of calculations. The alarm state represents the level of current danger of bridge to collapse. The Human Controller can log out and then interacts with the system as an external user.



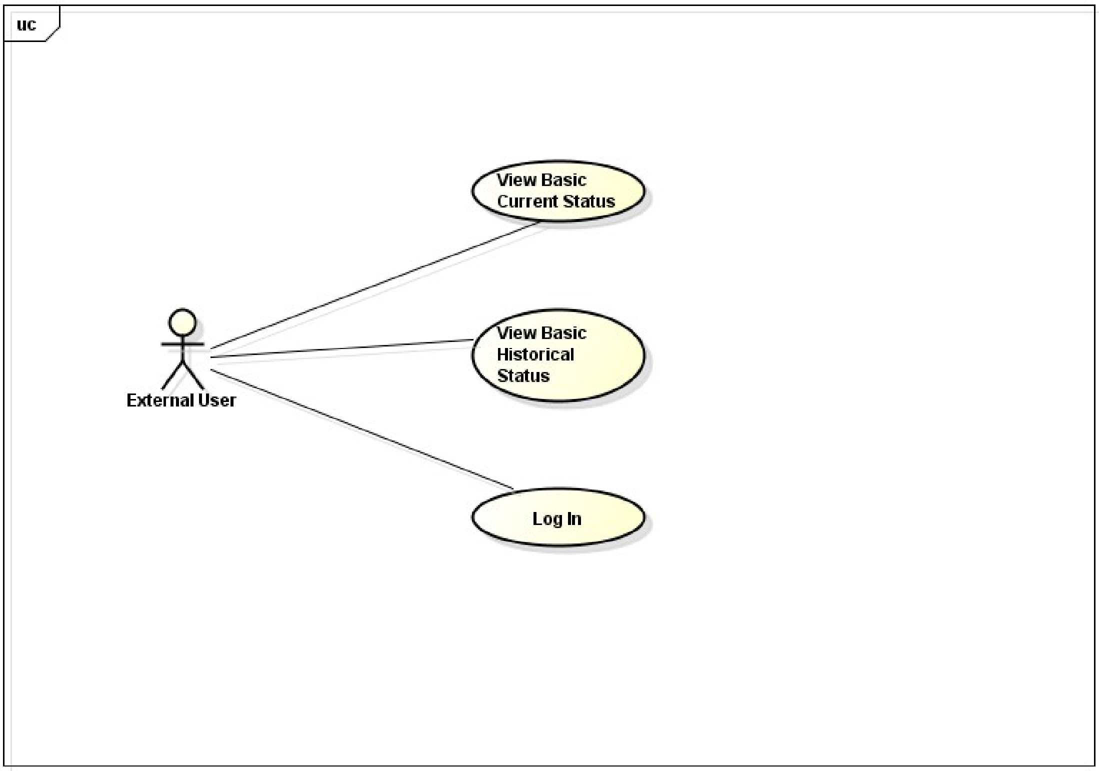
2.3.3 *Engineer functions*

The Engineer has the same functions as the Human Controller and the additional ones. The Engineer can change all variable parameters. He also can change the boundary values of each state of the alarm. Moreover, engineer can log out and then interacts with the system as an external user.



2.3.4 External User functions

The External User doesn't need to have any knowledge of the system since he is just a guest. The External User can see just a basic information of the Bridge. These information are current status of the bridge and basic historical information about the status of the bridge. The external user can see the same data as the human controller except the safety factor and alarm. He can log in and then interacts with the system as a registered user.



2.4 Use Cases

2.4.1 Register New User

Goal: To add a new registered user.
Participating Actors: Administrator
Related Use Cases: none
Precondition: The user must be logged in as an administrator
Main flow of events:

1. The user enters all the information of the new user
2. The user defines the permission level of the new user.
3. The user clicks on "Save" button.
4. The system checks all the entered information.
5. The system shows the message "Added new registered user".

Alternatives

5. a. The system shows the message "Incorrect entered information".
   b. Resume at 1.

1.

2.4.2 Delete User

Goal: To delete a current registered user.
Participating Actors: Administrator
Related Use Cases: Register User

Precondition: The user must be logged in as an administrator
Main flow of events:
6. The admin. selects a user.
7. The admin. clicks on “Delete” button.
8. The system shows a confirmation window.
9. The admin. clicks on “yes”
10. The system shows the message “ xxx user is deleted” where “xxx” is the username of the user.

Alternatives
4. a. The admin. clicks on “no”.
   b. The system closes the confirmation window.
   c. Resume at 1.

2.4.3 Log out

Goal: To log out a registered user.
Participating Actors: Administrator, Human Controller, Engineer
Related Use Cases: Log In
Precondition: The user must be logged in as a registered user
Main flow of events:
11. The user clicks on “Log Out” button.
12. The system logs out the user.
13. The system redirects the user to the home page.

2.4.4 View Current Status

Goal: To let the user see the current status of the bridge.
Participating Actors: Human Controller, Engineer
Related Use Cases: none
Precondition: The user must be logged in as a Human Controller or as an Engineer
Main flow of events:
14. The user clicks on “Current Status” button.
15. The system shows the information about the current status of the bridge.
16. The user views the information of the current status.

2.4.5 View Historical Status

Goal: To let the user see the historical status of the bridge.
Participating Actors: Human Controller, Engineer
Related Use Cases: none
Precondition: The user must be logged in as a Human Controller or as an Engineer
Main flow of events:
17. The user clicks on “Historical Status” button.
18. The system shows the page with information about the historical status of the bridge.
19. The user chooses the “Start Date” and the “End Date”.
20. The system shows the historical status of the bridge between the selected dates.
21. The user views the information of the historical status.

2.4.6 View Alarm

Goal: To let the user see the current status of alarm.

Participating Actors: Human Controller, Engineer
Related Use Cases: none
Precondition: The user must be logged in as a Human Controller or as an Engineer
Main flow of events:
22. The system shows the level of alarm.
23. The user views the level of alarm.

2.4.7 Change Debris Value

Goal: To let the user change the debris parameter.
Participating Actors: Human Controller, Engineer
Related Use Cases: none
Precondition: The user must be logged in as a Human Controller, Engineer
Main flow of events:
24. The user change the Debris Parameter by checking a check box.
25. The system updates the database.
26. The user views the change of the safety factor in the next calculations.

2.4.8 Change Variable Parameters

Goal: To let the user change the boundary values of different levels of alarm.
Participating Actors: Engineer
Related Use Cases: none
Precondition: The user must be logged in as an Engineer
Main flow of events:
27. The user changes the variable parameters.
28. The user clicks on “Save” button.
29. The system shows a confirmation window.
30. The user clicks on “yes”.
31. The system shows the message “variable parameters are updated”.

Alternatives
4. a. The user clicks on “no”.
   b. The system closes the confirmation window.

2.4.9 View Basic Current Status

Goal: To let the user see the basic current status of the bridge.
Participating Actors: External User
Related Use Cases: none
Precondition: The user must be logged out.
Main flow of events:
32. The user clicks on “Current Status” button.
33. The system shows the information about the current status of the bridge without displaying information regarding the safety factor.
34. The user views the information of the current status.

2.4.10 View Basic Historical Status

Goal: To let the user see the basic historical status of the bridge.
Participating Actors: External User
Related Use Cases: none

Precondition: The user must be logged out.
Main flow of events:

35. The user clicks on “Historical Status” button.
36. The system shows the page with information about the historical status of the bridge without displaying information regarding the safety factor.
37. The user chooses the “Start Date” and the “End Date”.
38. The system shows the basic historical status of the bridge between the selected dates without the information regarding the safety factor.
39. The user views the information of the basic historical status.

2.4.11 Log in

Goal: To log in an external user.
Participating Actors: External User
Related Use Cases: Log Out
Precondition: The user must be logged out
Main flow of events:

40. The user enters the username and password.
41. The user clicks on “Log In” button.
42. The system logs in the user with his predefined permission level from the administrator.

2.5 Constraints

The main constraint of this project are the incomplete requirements because of the poor communication with the costumer. There is documentation which explains the requirements, which is only in Italian language so it is being translated.

2.6 Assumptions

Since the pictures of the camera do not provide information about the traffic above the bridge, we have to take into account all possible scenarios and possibilities of this parameter for the final calculations.

3. Requirements Description

In this part, all the functional and non-functional requirements will be defined along with a unique identification.

3.1 Functional requirements

3.1.1 External User functionalities

EU1. The external user must be able to see the current value of the Wind speed level.

EU2. The external user should be able to see the latest pictures of the both sides of the bridge.

EU3. The external user should be able to see the graph showing the change of value of wind speed in last 24h.

EU4. The external user should be able to see the diagram showing the change of value of wind direction in last 24h.

EU5. The external user should be able to see the diagram showing the change of water level in last 24h.

EU6. The external user should be able to see the diagram showing the change of depth of river bed in last 24h.

EU7. The external user should be able to see a diagram showing force on each pillar in the last 24h.

EU8. The external user should be able to see diagram showing force on each pillar during period of last 24h.

EU9. The external user should be able to see history diagram showing force on each pillar during chosen period of time.

EU10. The external user should be able to see history diagram showing depth of river bed during chosen period of time.

EU11. The external user should be able to see history diagram showing water level during chosen period of time.

EU12. The external user should be able to see history diagram showing wind speed during chosen period of time.

EU13. The external user should be able to see history diagram showing wind direction during chosen period of time.

EU14. The external user must be able to see current value of the Wind Direction.

EU15. The external user must be able to see current value of the Water level.

EU16. The external user must be able to see current value of the River Bed level.

3.1.2 Human controller functionalities

HC1. The human controller must be able to log into the system with username and password.

HC2. The human controller must be able to see current value of the Wind speed level.

HC3. The human controller should be able to see the latest pictures of the both side of the bridge.

HC4. The human controller should be able to see the graph showing the change of value of wind speed in last 24h.

HC5. The human controller should be able to see the diagram showing the change of value of wind direction in last 24h.

HC6. The human controller should be able to see the diagram showing the change of water level in last 24h.

HC7. The human controller should be able to see the diagram showing the change of depth of river bed in last 24h.

HC8. The human controller should be able to see diagram showing force on each pillar during period of last 24h.

HC9. The human controller should be able to see history diagram showing force on each pillar during chosen period of time.

HC10. The human controller should be able to see history diagram showing depth of river bed during chosen period of time.

HC11. The human controller should be able to see history diagram showing water level during chosen period of time.

HC12. The human controller should be able to see history diagram showing wind speed during chosen period of time.

HC13. human controller should be able to see history diagram showing wind direction during chosen period of time.

HC14. The human controller must be able to view the safety factor value.

HC15. The human controller must be able to view the graph showing the change of the value of the safety factor in the last 24h.

HC16. The human controller must be able to view the history graph showing the safety factor during chosen period of time.

HC17. The human controller must be able to change the debris value in real time. The debris value is a boolean.

HC18. The human controller must be able to see current value of the Wind Direction.

HC19. The human controller must be able to see current value of the Water level.

HC20. The human controller must be able to see current value of the River Bed level.

HC21: The human controller must be able to log out of the system.

3.1.3 Engineer functionalities

E1. The engineer must be able to log into the system with username and password.

E2. The engineer must be able to see current value of the Wind speed level.

E3. The engineer must be able to see the latest pictures of the both side of the bridge.

E4. The engineer should be able to see the graph showing the change of value of wind speed in last 24h.

E5. The engineer should be able to see the diagram showing the change of value of wind direction in last 24h.

E6. The engineer should be able to see the diagram showing the change of water level in last 24h.

E7. The engineer should be able to see the diagram showing the change of depth of river bed in last 24h.

E8. The engineer should be able to see diagram showing force on each pillar during period of last 24h.

E9. The engineer should be able to see history diagram showing force on each pillar during chosen period of time.

E10. The engineer should be able to see history diagram showing depth of river bed during chosen period of time.

E11. The engineer should be able to see history diagram showing water level during chosen period of time.

E12. The engineer should be able to see history diagram showing wind speed during chosen period of time.

E13. The engineer should be able to see history diagram showing wind direction during chosen period of time.

E14. The engineer must be able to view the safety factor value.

E15. The engineer must be able to view the graph showing the change of the value of the safety factor in the last 24h.

E16. The engineer must be able to view the history graph showing the safety factor during chosen period of time.

E17. The engineer must be able to see current value of the Wind Direction.

E18. The engineer must be able to see current value of the Water level.

E19. The engineer must be able to see current value of the River Bed level.

E20. The engineer must be able to change bounds of the each risk range.

E21. The engineer must be able to change the debris value in real time. The debris value is a boolean.

E22. The engineer must be able to change the value of each variable parameter that is used for calculations.

E23. The engineer must be able to log out of the system.

3.1.4 Administrator functionalities

A1. The administrator must be able to log into the system with username and password.

A2. The administrator must be able to register a new user by entering information about the user: first name, last name, username, email and permission level (Engineer or Human Controller).

A3. The administrator should be able to delete a registered user from the system.

A4. The administrator must be able to log out of the system.

3.1.5 Parsing

P1. Each received package must be parsed into the database in the following way. Every hour the system receives a packet in which there are an analog file, a sonar file both with 3600 values and two images, one for camera. All these values are to be converted from the parser into the db, in the table of Raw_data(1sec). Each values has to fill one row of the table.

P2. For the analog and sonar sensors, the name of the files should be parsed in the following way. In the file names, analog*********.txt and sonar**********.txt, the ID (**...) represents the number of seconds that have elapsed since 1st January 1904 (using Labview encode), on the Greenwich meridian.

P3. For the picture files, the ID of the name Modean[Mantova]********.jpg should represent the exact time and date when the picture was taken.

P4. The first column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the wind speed (measured in mA). It should be converted to [m / s] by using the following formula: V [m / s] = (((V [mA] * 1000) − 4) * 3,75).

P5. The second column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the distance between the hydrometer and the level of water (measured in mA). The actual distance [m] should be parsed by using the following formula: h [m] = 20 + (((h [mA] * 1000) − 4) * (−1,25)). The water height should be parsed by using the following formula: h_{water}[m] = 29,86 − h [m].

P6. The third column of the analog*********.txt file should be parsed in the following way. Each row in the column represents the wind direction (measured in mA). It should be converted to [°] by using the following formula: dir [°] = (((dir [mA] * 1000) − 4) * 22,5).

P7. The fourth column of the analog*********.txt file should be parsed in the following way. Each row in the timestamp of the detection of the sample (Labview encode). The decimals for the timestamp are allowed to be dropped.

P8. The first column from the sonar**********.txt file should be parsed in the following way. The first column is the distance between sonar and the bottom of the river (measured in meters). The height of the bottom [m] should be parsed by using the following formula: hBottom[m] = 12,3 − xx.xx [m].

P9. The second column from the sonar**********.txt file is the timestamp of the detection of the sample and should be parsed by using the Labview encode: the number represents the number of seconds that have elapsed since 1st January 1904, on the Greenwich meridian.

3.1.6 Calculations

C1. All calculations should be preformed after each parse of the data.

C2. The push of the wind on the planking should be calculated by the formula: $S_{Vplank}=\frac{1}{2}*C_{Dwi}*\rho_{air}*A_{traf}*V^2_{EFFwind}$

C3. The push of the wind on the traffic for traffic combination A1 should be calculated by the formula: $S_{V(A1\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_1*A_{traf})*V^2_{EFFwind}$

C4. The push of the wind on the traffic for traffic combination A2 should be calculated by the formula:

$$S_{V(A2\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_1*A_{traf})*V^2_{EFFwind}$$

C5. The push of the wind on the traffic for traffic combination A3 should be calculated by the formula:

$$S_{V(A3\,traf)}=\frac{1}{2}*C_{Dwi}*\rho_{air}*(\beta_2*A_{traf})*V^2_{EFFwind}$$

C6. The parameters a_i , b_i , c_i should be calculated using the table below.

Scale of estimate flow rates with fixed section				
Parameters	h_{water} < 17m	17m < h_{water} < 22m	22m < h_{water} < $h_{MAXwater}$	$h_{MAXwater}$ = 25,3m
a_i	46	60	96	96

b_i	-902	-1350	-2800	-2800
c_i	4658	8000	22500	22500

C7. The flow rate should be calculated using the formula: $Q = a_i * h^2_{water} + b_i * h_{water} + c_i$.

C8. The speed of water should be calculated using the formulas:

$$V_{water} = a * h^3_{water} + b * h^2_{water} + c * h_{water}$$

2D analysis – fixed bottom		
h_{water} [m]	Q [m^3/s]	V_{water} [m/s]
3	510	0,24
10,5	5400	2,73
14	10000	3,54

C9. The area of stack should be calculated using the formula: $A_s = B_s * h_s$.

with

a. if [SONAR1] < bottom_ref → **h_s = [IDRO2] – bottom_ref**
b. if [SONAR1] > bottom_ref → **h_s = [IDRO2] – [SONAR1]**

and

a. if D = 0 → $B_s = B_{s0} = c$
b. if D = 1 → $B_s = B_{s1} = 2*D_{pylon}$

C10. The Area Stack and Swater should be calculated using the formulas:

(D = 0)	**(D = 1)**
$A_s = B_{s0} * h_s$ $S_{water} = \frac{1}{2} * C_{D0} * \rho_{water} * A_s * V^2_{water}$	$A_s = B_{s1} * h_s$ $S_{water} = \frac{1}{2} * C_{D1} * \rho_{water} * (A_s * \beta_A) * V^2_{water}$

C11. The portion of palking should be calculated with the formula:

$$PP_{structure} = P_s + [(2 * P_{pu} + 6 * P_{tp} + 2 * P_b) + 6 * (P_p * (h_{beam} - [SONAR1]))]$$

3.1.7 External interfaces

EI1. The current risk factor must be visualized by displaying the color associated with the current risk range the risk factor value is in. Each risk range is associated with a specific color. "Alarm": red, "Alert": orange, "Pre-alert": yellow.

EI2: A Google Earth picture of the bridge and an icon of a wind rose should be visible on each page.

EI3: A link to external webpages which show the measurements of river Po should be present on each page.

EI3: A film of the day, the week and month based on the pictures should be visible to the human controller, in order to see if there has been some debris in the river.

3.1.8 Warning messages

WM1: A warning message "Are you sure you want to delete this user?" should appear if the administrator chooses to delete a registered user.

WM2: A warning message "Are you sure you want to change the range of risk factors" should appear if the engineer chooses to change ranges of risk factors.

3.2 Non-Functional requirements

3.2.1 Performance

PE1: The system should parse the data from the sensors and perform calculations every one hour.

PE2. The loading time for each page should be less than 20 seconds.

3.2.2 Usability

U1: Each new user of the system should be able to learn how to operate with the system within one day of tutorial.

3.2.3 Extensibility

Ex1. It should be able to add new sensors to the system in the future.

3.2.4 Security

S1. A log in is required to sign into the system and view internal data.

3.3 Requirements for the future

FD1. Create an Android application of the system.

FD2. Have a local and remote Database. Local with 'current' data (last X years). Remote with 'historical data (older than X years ago).

4. Requirements Definitions

The table below shows the priorities and status of each requirement. In the future, the requirements will be sorted by priority.

Identity	Requirement Group	Requirement source	Priority	Status
EU1	EU	Customer	3	I
EU2	EU	Customer	3	I
EU3	EU	Customer	3	I
EU4	EU	Customer	3	I
EU5	EU	Customer	3	I
EU6	EU	Customer	3	I
EU7	EU	Customer	3	I
EU8	EU	Customer	3	I
EU9	EU	Customer	3	I
EU10	EU	Customer	3	I
EU11	EU	Customer	3	I
EU12	EU	Customer	3	I
EU13	EU	Customer	3	I
EU14	EU	Customer	3	I
EU15	EU	Customer	3	I
EU16	EU	Customer	3	I
HC1	HC	Customer	4	I
HC2	HC	Customer	1	I
HC3	HC	Customer	2	I

HC4	HC	Customer	1	I
HC5	HC	Customer	1	I
HC6	HC	Customer	1	I
HC7	HC	Customer	1	I
HC8	HC	Customer	1	I
HC9	HC	Customer	2	I
HC10	HC	Customer	2	I
HC11	HC	Customer	2	I
HC12	HC	Customer	2	I
HC13	HC	Customer	2	I
HC14	HC	Customer	1	I
HC15	HC	Customer	1	I
HC16	HC	Customer	2	I
HC17	HC	Customer	2	I
HC18	HC	Customer	1	I
HC19	HC	Customer	1	I
HC20	HC	Customer	1	I
HC21	HC	Customer	4	I
E1	E	Customer	4	I
E2	E	Customer	2	I
E3	E	Customer	2	I
E6	E	Customer	2	I
E7	E	Customer	2	I
E8	E	Customer	2	I
E9	E	Customer	3	I
E10	E	Customer	3	I
E11	E	Customer	3	I
E12	E	Customer	3	I
E13	E	Customer	3	I

E14	E	Customer	2	I
E15	E	Customer	2	I
E16	E	Customer	3	I
E17	E	Customer	2	I
E18	E	Customer	2	I
E19	E	Customer	2	I
E20	E	Customer	2	I
E21	E	Customer	3	I
E22	E	Customer	3	I
E13	E	Customer	4	I
A1	A	Customer	4	I
A2	A	Customer	4	I
A3	A	Customer	4	I
A4	A	Customer	4	I
P1	P	Customer	1	I
P2	P	Customer	1	I
P3	P	Customer	1	I
P4	P	Customer	1	I
P5	P	Customer	1	I
P6	P	Customer	1	I
P7	P	Customer	1	I
P8	P	Customer	1	I
P9	P	Customer	1	I
C1	C	Customer	1	I
C2	C	Customer	1	I
C3	C	Customer	1	I
C4	C	Customer	1	I
C5	C	Customer	1	I
C6	C	Customer	1	I

C7	C	Customer	1	I
C8	C	Customer	1	I
C9	C	Customer	1	I
C10	C	Customer	1	I
C11	C	Customer	1	I
EI1	EI	Customer	1	I
EI2	EI	Customer	5	I
EI3	EI	Customer	5	I
EI4	EI	Customer	5	I
WM1	WM	Customer	5	I
WM2	WM	Customer	5	I
PE1	P	Customer	3	I
PE1	P	Customer	4	I
U1	U	Dev. team	4	I
Ex1	Ex	Dev. Team	4	I
S1	S	Dev team	4	I

Requirement status:

I = *initial* (this requirement has been identified at the beginning of the project),
D = *dropped* (this requirement has been deleted from the requirement definitions),
H = *on hold* (decision to be implemented or dropped will be made later),
A = *additional* (this requirement was introduced during the project course).

5. APPENDIX

GEOMETRY OF THE STACK N.30			
D_{pylon}	1.5	m	Diameter of the pylon
c	9.5	m	Distance between two line of pylon
h_{beam}	17.5	m	Height of the lower beam
bottom_ref	10	m	Height of the reference of the bottom of the river
WIND THRUST			
α	6	°	Planimetric inclination of the bridge form the north
C_{Dwi}	2	-	"Drag planking" coefficient
ρ_{air}	1.2	Kg/m^3	Air density
A_{stack}	160	m^2	Planking area exposed to the wind pressure
A_{traf}	177	m^2	Surface of traffic exposed to the wind pressure
β_1	1	-	Coefficient of reduction for A1 and A2 traffic scenarios
β_2	0.5	-	Coefficient of reduction for A3 traffic scenario
r	2.25	m	-
eimp	1.91	m	-
etraf	3.41	m	-
HYDRODYNAMIC THRUST			
C_{D0wa}		-	"Drag planking" coefficient (D=0)
C_{D1wa}		-	"Drag planking" coefficient (D=1)
ρ_{water}		Kg/m^3	Water density
β_A		-	Area reduction for D=1
a		-	Coefficient for the relation $V_{water(}$[IDRO1])
b		-	Coefficient for the relation $V_{water(}$[IDRO1])
c		-	Coefficient for the relation $V_{water(}$[IDRO1])
h_{water1}	17	m	Height limit of the river for parameters a1,b1,c1
a1	46	-	Coefficient for Q(h) when [IDRO1] < h_{water1}
b1	-902	-	Coefficient for Q(h) when [IDRO1] < h_{water1}
c1	4658	-	Coefficient for Q(h) when [IDRO1] < h_{water1}
h_{water2}	22	m	Height limit of the river for parameters a2,b2,c2
a2	60	-	Coefficient for Q(h) when [IDRO1] < h_{water2}
b2	-1350	-	Coefficient for Q(h) when [IDRO1] < h_{water2}
c2	8000	-	Coefficient for Q(h) when [IDRO1] < h_{water2}

h_{max}	25.3	m	Max height level of river and limit for use parameter a3,b3,c3
a3	96		Coefficient for Q(h) when h_{water2} < [IDRO1] < h_{max}
b3	-2800		Coefficient for Q(h) when h_{water2} < [IDRO1] < hmax
c3	22500		Coefficient for Q(h) when h_{water2} < [IDRO1] < hmax
WEIGHT OF THE STACK			
Ps	10710	kN	Plank weight on the stack
Ppu	1680	kN	Weight of single pulvino
Ptp	1601	kN	Weight of the trunk of pylon
Pb	1007	kN	Weight of the single beam
Pp	44	kN/m	Weight per meter of pylon
Mt	9720	kNm	Moment generated asymmetry
SHIFTING WEIGHTS			
N(A1)		kN	Axial load for load combination A1
Mxx(A1)		kNm	Bending moment for load combination A1
Myy(A1)		kNm	Bending moment for load combination A1
N(A2)		kN	Axial load for load combination A2
Mxx(A2)		kNm	Bending moment for load combination A2
Myy(A2)		kNm	Bending moment for load combination A2
N(A3)		kN	Axial load for load combination A3
Mxx(A3)		kNm	Bending moment for load combination A3
Myy(A3)		kNm	Bending moment for load combination A3
Vehicle braking			
F_r	206	kN	Value of the force due to the braking
n	3.3	m	“arm” for the vehicle braking moment