FROG

FUN ROBOTIC
OUTDOOR GUIDE

Deliverable: D5.3

FROG Robot Integrated Demonstrator

Consortium

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1. Summary

Deliverable 5.3 is the Frog Robot integrated demonstrator. This small report describes the process of integrating all of the components carried out during the integration meetings that were performed during the Lisbon and Seville integration weeks.

To the date, eight integration/data collection meetings have been held in the Royal Alcázar in Seville and in the Lisbon Zoo.

2. FROG Robot Integration Meetings

Eight Integration/Data Collection meetings were held until July 2014. Three meetings were held at the Lisbon Zoo and five others at the Royal Alcázar in Seville.

The first meeting was held at the Royal Alcázar. This was a meeting for data collection as the partners needed data from a real scenario to start developing their algorithms. The second meeting, also in Seville, was the first time that partners tested their algorithms in the final robot platform.

The next three sessions were performed at the Lisbon Zoo. In those sessions the modules of each partner were integrated to create a simplified demo tour to be performed in the second review meeting.

The last three meetings were held in Seville and used for the final integration of the partners' modules with the goal of creating a 24/7 robot tour.

2.1. Data Collection Meeting Royal Alcázar 29th May 2012

For this data collection meeting the consortium made use of an existing IDM robot platform (see Figure 1). This is a two wheel differential robot with one caster wheel on the back. It uses two 150W Maxon motors with two PI controllers with 250W drivers for locomotion. For navigation it has an on-board computer. The system uses two 12V 20Ah batteries to power the motors and electronics.

Figure 1: Data collection Robot

For the data collection the following equipment was integrated in the platform:

- Six 12V 18Ah batteries;
- Two 600W Power Inverters;
- One desktop from UvA;
- One laptop from ICL;
- One external hard drive Lacie 2TB Minimus USB 3.0 Desktop Hard Drive from ICL;
- One set of stereo cameras from UvA and UPO;
- One stand alone camera from ICL;
- One 22" touch-screen monitor for debugging;
- One Kinetic Xbox camera from ICL
- Three Hokuyo UTM-30LX lasers from UPO
- One inertial sensor XSens MTi-G from UPO

Figure 2 depicts the communication architecture that was been used to synchronize the acquisition of data from the sensors. An Ethernet wireless router provided unique IPs for each computer and enabled a wireless link to an external laptop that was controlling the robot. A Gigabyte Ethernet Switch was used to test the transfer of information between ICL and UVA computers that needed to share camera information.

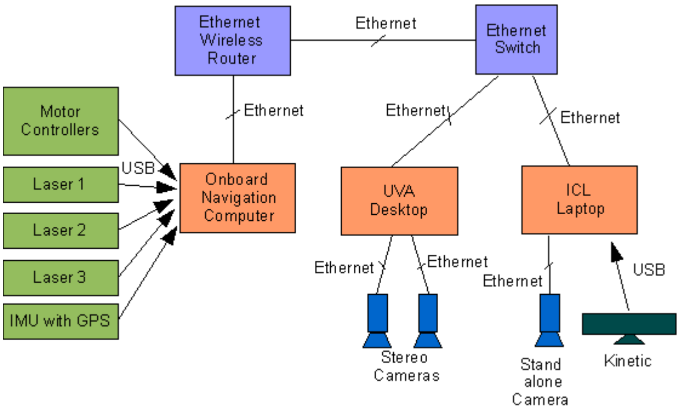

Figure 2: Data collection communication architecture

The onboard navigation computer performed the following tasks:

- sending velocity references to the Motor Controllers;
- collecting raw data from the laser, IMU and motor encoders;
- providing a NTP server to synchronize all the collected data.

The UvA desktop performed the following tasks:

- collecting stereo camera data for future processing and analysis.

The ICL laptop performed the following tasks:

- collecting standalone camera data for future processing and analysis;
- collecting Kinetic data (video and sound) for future processing and analysis.

2.1.1. Data Collection Activities

IDM

Deployment of the data collection robot at Seville. Integration of all partner equipment on the data collection robot (see Figure 3). Data acquisition support. Development of Data acquisition Software, able to read data from the encoder, Inertial Sensor, Lasers and GPS and able to control the robot motors.

Figure 3: Hardware integration on the data collection robot.

UPO

Deployment of a UPO robot with laser to build a map of the Royal Alcázar site. Basic navigation tests with this robot using ROS (see Figure 4). Implementing all of the new algorithms as ROS modules. Sensor data acquisition using the Data collection robot.

Figure 4: Robot Mapping and Navigation.

UvA

Installation of the stereo camera platform on the data acquisition platform. Deployment of video-based person detection and body orientation estimation software algorithms on to the Data collection Robot. Image data acquisition on the end-user site. First tests of the algorithms on site (see Figure 5).

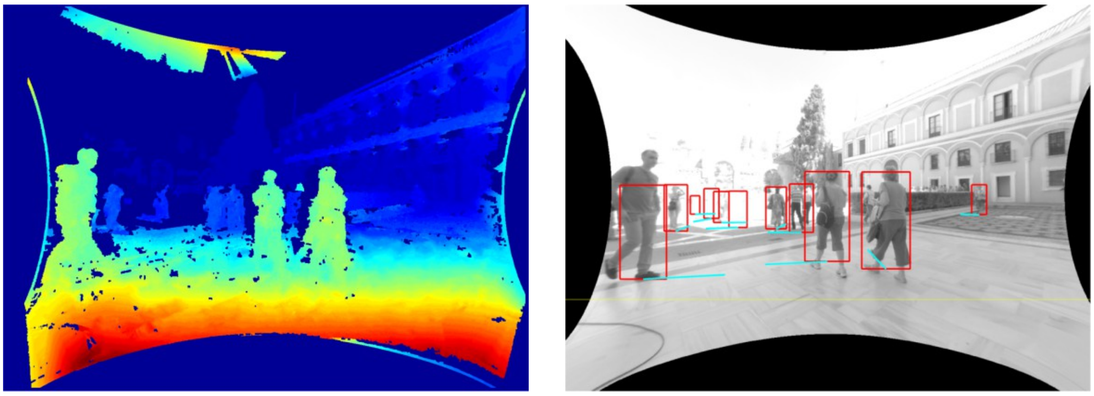

Figure 5: People tracking module

ICL

Installation of the face analysis camera and Kinect on the data acquisition platform (see Figure 6). Image and sound data acquisition at the end-user site.

Figure 6: Face tracking and sound data acquisition

UT

Gathering the user experiences at the sites and making an analysis of human tour guide behaviour. The user experiences of the visitors/end-users at the sites will give insight into the needs of the visitors.

YD

Content research of the Royal Alcázar site. First selection of the POIs (Points Of Interest) and possible respective content. Test of projections on site (see Figure 7).

Figure 7: On Site projection testing

2.1.2 Data Collection Results

The first day of the meeting was dedicated for the integration of equipment and software, from each partner, into the robot (see Figures 8).

On the 30th of May, 2012, the data collection robot was deployed in two scenarios. In the morning the robot collected data in a purely outdoor scenario and in the afternoon in a mixed scenario including both outdoor and indoor routes. In both situations, and for battery power conservation reasons, the robot was placed static in a specific localization while capturing data for UvA and ICL (for future visitor posture and emotion analysis). UvA recorded stereo camera data with different people at different distances and postures. ICL recorded camera data with different people facing the camera while showing different emotional states. Then the robot was remotely controlled through a specific route while capturing stereo, laser and IMU data for UPO (for future localization and navigation analysis). Also for these scenarios, YD took some light measurements to evaluate the possibility of AR projection and the use of other pointing devices over different surfaces.

Figure 8: FROG Project teams working together.

At the end of the meeting all the partners had the data to continue with the implementation of their modules (see group photo at Figure 9).

Figure 9 : Family “FROG” group photo.

2.2. Integration/Data Collection Meeting Royal Alcázar 13th-17th May 2013

At this stage of the project, the Frog base platform was already completely developed with the following characteristics:

- Robot Kinematics: 4-wheeled differential drive (pneumatic tires for uneven terrain)
- Weight without batteries: 39 Kg
- Weight with batteries with 8 12V/17Ah lead acid batteries: 87 Kg
- Payload Capacity: 30 Kg
- Height: 0.3m
- Maximum Velocity: 1.6 m/s (low-level software limited to 1.0 m/s)
- Acceleration: 1 m/s2 (low-level programmed)
- Emergency Stop Acceleration: 3.3 m/s2 (low-level programmed)
- Batteries Autonomy: 4 to 6 hours
- Installed components sensors and actuators:
- Sensor&Management Boards
- Motor Control Board
- Power Switch Board
- Charger Board
- Two Hokuyo UTM-30LX lasers
- Ring of bumpers (with 12 switches)
- One inertial sensor XSens MTi-G

The upper structure was not developed at this point in the project. To be able to integrate and test the partners' components on the robot a preliminary Bosch profile structure was developed. The components that were introduced in the Frog upper Structure for this meeting were:

- One 17'' touchscreen Monitor
- One Kinetic Xbox camera
- One set of two stereo cameras
- One stand-alone camera
- One projector
- One power inverter
- One Ethernet Wireless router
- One Ethernet Switch
- Navigation computer(UPO)
- People tracking computer(UVA)
- Facial expression analysis computer (ICL)

2.2.1. Integration Meeting Activities

IDM

Supported the integration, in the Frog robot platform, of high-level devices (cameras, lasers and computers) from the different partners. Tested the robot in all areas of the Royal Alcázar over different types of floor. Supported the partners tests (see Figure 10).

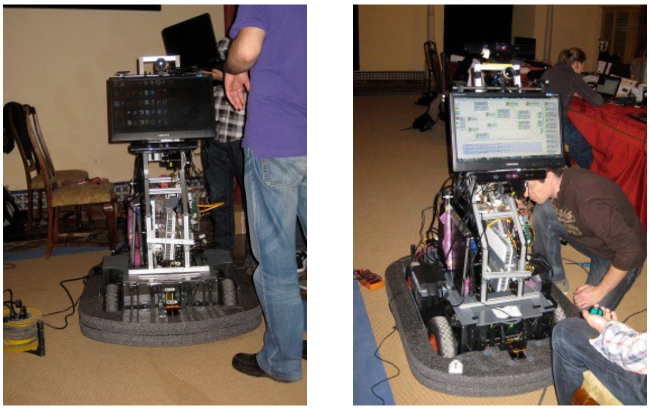

Figure 10: Integration of the partners equipment into the robot

UPO

Integration and testing of the navigation module in the final FROG robot. Performed initial experiments with Frog robot navigating autonomously in the Real Alcázar. Tested the navigation software in a very crowded scenario. Provided a simulator that executes the same navigation and localization software as the real Frog robot, to be used to test the communications with the rest of the system through the provided proxy.

Provided a robot for experiments of experiences of robot tour for visitors (see Figure 11).

Figure 11: UPO testing robot

UvA

Tested the final version of the people tracking algorithms in the Frog platform. Integrated tracking algorithms with the rest of the system. Tested the algorithms in real end-users site conditions. Taught the UPO team to use and calibrate the developed people tracking system.

ICL

Integrated and tested the developed algorithms in real end-users site conditions, with tourist, in changes of light and with robot moving (see Figure 12). Expression face images and audio acquisition. Tested the communication between the developed software module with the rest of the system.

Figure 12: Integration of the face tracking algorithms into the robot platform

UT

Exploratory study to find out how people/tourists react to a (tour guide) robot that is approaching them and giving a short tour (see Figure 13). Tested small changes in the robot behaviour and spoken contents to make the robot tour more appealing. Videotaped all the experiments for future analysis of human behaviour to help in forming guidelines about robot behaviour.

Figure 13: Exploratory study to find out how tourist react to guide robot.

YD

Creation of an integration platform for the project. Integration of the different partners' software modules with the proposed solution. Tested and validated the proposed solution.

Validation of the applicability of the content and content presentation strategies that had been designed. Referencing real world POI's using the navigation world mapping developed. Tested the Arm laser pointer inverse kinematics.

2.2.2. Data Collection Results

On the first day IDM finished the hardware integration and started supporting all the other partners. UvA and UPO partners already had a computer installed on the Frog robot but Imperial was using a laptop. On the second and third days, all partners tried their developed algorithms in the real robot. The robot was able to navigate autonomously in the crowded Real Alcázar, without any collision problems.

The last days were dedicated to software integration. Lots of work was done in the last 2 days and many problems solved. UvA module was able to receive messages but could not send. Most of UPO's problems were solved but transmission of images (to UPO) was still a problem. ICL's communication problems still needed to be solved. Due to overheating problems with the ICL computer it was impossible to finish programming. Send and receive communications have been tested but ICL still needed to do stress tests.

During the week the UT team was able to perform the exploratory study to learn how people react to the robot tours. This was performed using a teleoperated UPO robot.

New guidelines and deadlines were defined in this meeting for the next steps to be taken for the integration meetings in Lisbon Zoo (see Figure 14).

Figure 14: Project meeting next steps discussions

2.3. Integration/Data Collection Meeting Lisbon Zoo 8th-12th July 2013

The robot platform base used in this integration was the same as the one that was used in the previous integration meeting held in Seville, but the upper structure was already the final one. The components that were introduced in the FROG upper Structure for this meeting were:

- One 17" touchscreen Monitor
- One Kinetic Xbox camera
- One set of two stereo cameras
- One stand-alone camera for people recognition
- One projector
- One power inverter
- One Ethernet Wireless router
- One Ethernet Switch
- Sound System
- One 3DOF motorized arm with a laser pointer
- Navigation computer (UPO)
- People tracking computer (UVA)
- Interaction computer (YD)
- Facial expression analysis computer (ICL)

As this was the first time that robot and the partners were at the zoo, and taking into account that the review demo was going to be performed at the Zoo, the highest priority for the week was to gather data and to build the map for localization and navigation in the Zoo.

2.3.1. Integration Meeting Activities

IDM

Supported the integration, in the FROG robot, of high-level devices (cameras, lasers and computers) from the different partners (see Figure 15). Tested the robot in all areas of the Real Alcázar over different types of terrain. Supported the partners' tests. Zoo tour visit to identify and the select the POI's and robotic tour to be implemented.

Figure 15 : On-site changes

UPO

Built a complete localization map of the Zoo tour. Tested the navigation algorithms in the zoo. Calibrated, tested and collected data with UVA's people tracking software (see Figure 16).

Figure 16: Camera calibration and outdoor data collection.

ICL

Tested the face tracking algorithm with different lenses and configurations. Data expressions acquisition using the FROG robot in real Zoo environment with visitors (see Figure 17).

Figure 17: Face tracking algorithm and data collection.

UT

Zoo tour visit to identify and the select the POI's and robotic tour to be implemented. Continued with the exploratory study to find out how people/tourists react to a (tour guide) robot that is approaching them and giving a short tour.

YD

Zoo tour visit to identify and the select the POI's and robotic tour to be implemented. AR definition, implementation and test on site. Arm laser antenna movements definition. Test of AR content on site (see Figure 18).

Figure 18: Test of AR content on site

2.3.2. Data Collection Results

Until the beginning of the integration meeting the robot stayed in Seville so UPO's team would be able to perform more tests with the platform. The actual platform was taken back to Lisbon for the data collection. Some problems with the robot had to be solved before going to the Zoo. After correcting the platform problems it was taken from IDM to the Zoo and the partners' equipment was installed. While the problems were being corrected, the UPO team went to the zoo to place localization marks, to be used to localize the robot on the Zoo (see Figure 19).
In the morning of the first day Paulo, Fernando, Betsy, Vanessa and Filipe walked a new route through the zoo. And did define the POI's and contents to be showed in each one.
The Stereo cameras were calibrated by the UPO teams and used to collect data for UVA and also for the UPO navigations algorithms.

Figure 19: UPO Localization marks

ICL was able to use the robot several times for data acquisition and tried the new updates on site. The integration communication issues were solved and the software was able to send face tracking information to the other modules.

UPO used their own robot with lasers to create a map and to navigate in the Zoo. After that, the same algorithms were tried in the FROG robot, but this overheated the drivers and motors. The way the robot was moving was taking too much current from the batteries and the motors were getting too hot. It was possible to test short paths but then the robot had to stop to cool down.

The integration software was validated and used to check the position accuracy offered by the system to the AR contents.

At the end of the week everybody had the opportunity to make their tests and experiences and each individual module was able to communicate thought the FROG Proxy software to the other modules (see Figure 20).

Figure 20: Data acquisition under shifting weather conditions

2.4. Integration Meeting Lisbon Zoo 21st-25th October 2013

In this integration the robot platform was the same one that was used in the previous integration meeting. To reduce the weight of the robot and overheating of the motors, six of the lead acid batteries that were powering the electronics were changed to LiFePO4 batteries. With this change the platform weight was reduced from 87 Kg to 56 Kg. The PCB lines for the motors were enlarged, to increase the current that they were able to conduct and finally heat sinkers with fans were installed in each motor. With those changes the drivers and motors were able to perform all the tour without overheating at any point.

Some components were added to the upper structure. The components that were introduced in the FROF upper Structure for this meeting were:

- One 17" touchscreen Monitor
- One Kinetic Xbox camera
- One set of two stereo cameras
- One stand-alone camera for people recognition
- One stand-alone camera for interaction
- One projector
- One power inverter
- One Ethernet Wireless router
- One Ethernet Switch
- Sound System
- One 3DOF motorized arm with a laser pointer
- Interaction board and Frog eyes
- Vertical Hokuyo laser To detect ramps and stairs
- Navigation computer (UPO)
- People tracking computer (UVA)
- Interaction computer (YD)

Only IDM, UPO and YD were present. This meeting was going to be focused on the Navigation and behaviour tree implementation.

2.4.1. Preparation of October's Meeting

Before October's meeting there was a previous navigation integration effort made by the UPO team. They came to Lisbon in September (16th-20th September, 2013) to finish developing the robot navigation algorithms and the Lisbon Zoo Map. During the September tests, some specific locations were identified as being problematic. The Tiger's Cave exit ramp and the Monkey's house entrance ramp, had to be studied due to their high inclination. Those ramps were being detected as obstacles by the robot lasers.

Tests were performed to test the algorithms in real conditions. The way the robot navigates to a POI, the people aware navigation and the final approach to the waypoints and POI's were intensively tested. Different strategies had to be adopted in some of the POI's and waypoints, due to steering problems on different kinds of terrain and path inclinations.

The UPO team also developed a basic Arduino based temperature measuring system to register the temperature of the motors and drivers of the robot in real time. This system was used to test the effectiveness of the adopted solutions to reduce the overheating of the motors and drivers.

2.4.2. Integration Meeting Activities

IDM

Introduced some changes on the robot to reduce the motor and drivers heating. Integrated all the needed equipment on the robot (see Figure 21). Helped the other partners during the integration week.

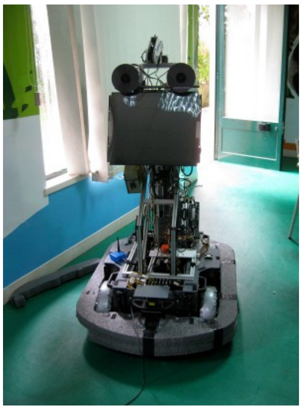

Figure 21: The FROG Robot without shell

UPO

Tested the new navigation algorithms for the FROG robot. Localized the FROG robot on the Zoo using the map created in September (see Figure 22). Navigated in the Zoo from point to point using the behaviour tree to set the next POI.

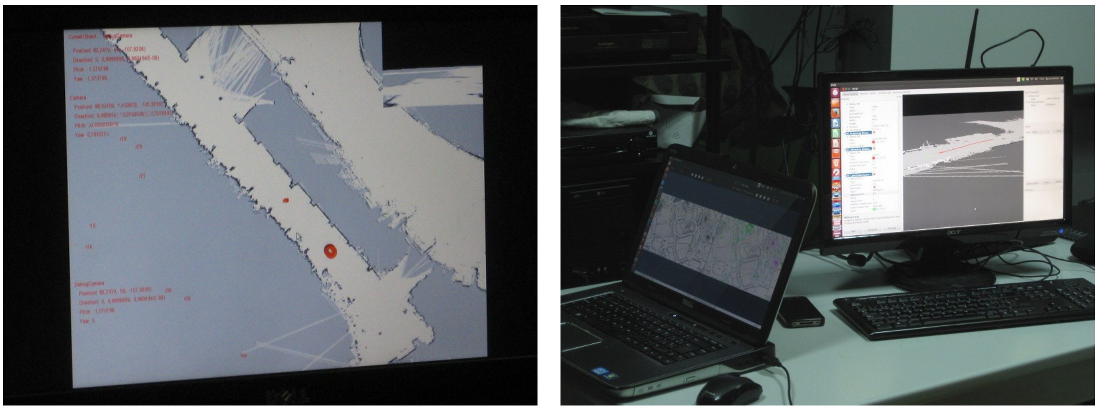

Figure 22: Zoo Mapping

YD

Developed and tested a simple behaviour tree to be able to send and receive commands and data from and to the navigation module (see Figure 23). Integration of the FROG eyes and arm on the interaction content.

Figure 23: Behaviour tree integration and testing

2.4.3. Integration Meeting Results

The second Zoo integration meeting was an opportunity to navigate in the Zoo using the map created in the previous meeting and detect the possible obstacles/problems that the robot could encounter in the Zoo. In this meeting the robot was able to navigate from point to point using the behaviour tree to set the next POI.

The robot was able to perform several complete tours without the motor or drivers overheating. Some navigation problems were identified and solutions proposed. Due to weather conditions the navigation conditions were limited to small periods of time without rain (see Figure 24).

Figure 24: Adapting FROG for the weather conditions

2.5. Integration/Review Meeting Lisbon Zoo 11st-22nd November 2013

For these two integration weeks the robot platform and upper structure were already completed and using the same elements as in the previous meeting. The two integration weeks ended with the Second Year review meeting demonstration.

2.5.1. Integration meeting activities

IDM

Supported the integration, in the FROG robot, of high-level devices (cameras, lasers and computers) from the different partners. Helped the partners with the tests and experiments. Software development to control the eyes, arm with laser pointer, sound and video contents. Preparation of the review demo.

UPO

Navigation and map tuning. Tested the new solutions to deal with some parts of the Zoo terrain. Point to point navigation. Preparation of the review demo (see Figure 25).

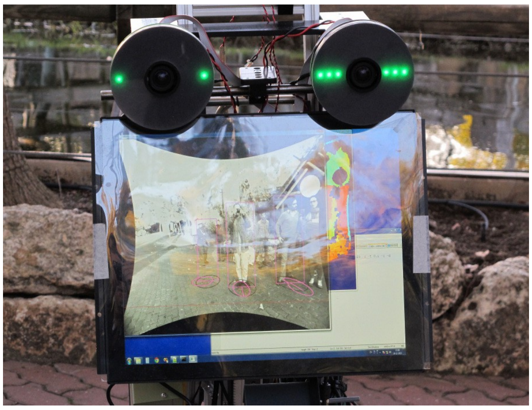


Figure 25: Preparation of the review demo

ICL

Integration of the equipment on the robot. Test of the new updated algorithms. Preparation of the review demo (see Figure 26).

Figure 26: ICL face tracking tech-demo

UT

Preparation of the contents to be used in the review meeting. Preparation of the review demo (see Figure 27).

Figure 27: Full demo for the review

YD

Integration and test of all the modules into the behaviour tree. Integration of the interaction contents into the behaviour tree. Preparation and test of the AR projection contents (see Figure 28). Preparation of the review demo.

Figure 28: AR contents projection tests

2.5.2. The Review

For the review the partners wanted to show a first version of the complete system in operation while providing a real Zoo tour for the reviewers. This included navigation in all the tour path, play videos and sounds and use the interaction elements already available in the robot.

In this second review meeting FROG (see Figure 29) was already able to show the following features:

1. Detect and approach people, present himself and start the tour. For this it was using the stereo cameras to detect groups of people, approaching them by locating himself on the map and navigating to their location. Then it was able to display a welcome message on the monitor and speakers while showing different patterns on the LED eyes. The behaviour tree was managing all these events.

2. After starting the tour the robot navigated to the first POI. There, it was able to reach the exact position, start a video and give information about the POI. The projector was tested to show how it will be used in the future. After ending the content presentation about the POI, the robot entered a wait state inviting the users to touch the screen when they were ready to proceed to the next POI. Once they touched the screen, the robot invited them to follow him and moved to the next POI.

3. After visiting all the POIs the robot reached the end of the tour. Here it says goodbye to the visitors and returns to the starting point. During the navigation the robot was subject to some disturbances. The robot had to avoid collisions with people, detect bumper collisions and had to recalculate the trajectory to a POI due to impossibility to follow its normal path. The zoo tour was about 1.8Km and it lasted for about 45 minutes.

Figure 29: Demo during the 2nd Review Meeting

2.6. Integration Meeting Alcázar Seville 24th-28th February 2014

For this integration meeting, the robot platform and upper structure were already completed and used the same elements of previous meeting. The FROG robot was dressed with an unpainted shell. Problems with a damaged motor did not allow to test navigation algorithms to be tested with the robot, but it was possible to integrate the different algorithms implemented by each partner.

A small robot from IDM, with the same interaction elements of the FROG Robot, was used to test the interaction contents.

2.6.1. Integration Meeting Activities

IDM

Supported integration activities of the partners, validated the integration of the shell and its intersection with onboard equipment (see Figure 30). Verified and discussed with partners the requirements for the operational autonomy, namely, powering up the computers and starting up applications. Defined with UPO the details of the deployment of the docking station. Used a small robot with the interaction elements of the FROG robot to test interaction contents.

Figure 30: The FROG robot with an unpainted shell

UPO

Worked with YD in all position-related AR component functionalities. First tests of the full route of the scenario (see Figure 31). Tested the enhanced navigation stack integrating UvA component. Defined with IDM a place to deploy the docking station.

Figure 31: Royal Alcázar full route navigation

ICL

Tested the face recognition algorithms with the YD behaviour tree. Tested the algorithms on the robot to see what kind of data can be obtained in real situations and what kind of output can be used by the other modules.

UT

Session experiments to investigate people's understanding of behaviour cues. Evaluation of AR application performance and effectiveness of the interaction strategies using IDM's small robot platform (see Figure 32).

Figure 32: Evaluation of AR application performance and interaction strategies

YD

Tested the integration with all the modules. Tested the contents in real scenarios by preparing a programming interface to test the FROG eyes and arm (see Figure 33). Tested a real tour.

Figure 33: Programming the interface to test eyes and arm

2.6.2. Meeting results

The partners' equipment was re-integrated on the FROG and the shell was successfully mounted. A location for the robot docking station was defined to be in the shop at Royal Alcázar main entrance.

The Robot was able to navigate in the Alcázar for the first two days (see Figure 34). On the end of the second day a problem with the tuning of the motor gains, of the FROG robot, burned one of the motors. The robot was not able to perform any navigation experiments. For that reason, the week meeting time left was used to test the communication between modules, the behaviour tree and, although it was impossible to navigate with the robot, it was possible to push the robot to the different POIs and use the odometry and localization of the robot to test interaction contents and perform camera data acquisition.

The face tracker software was tested with the behaviour tree. All the modules ran well and the subsystem was able to send data to the server without problems.

Another goal was to test the obtained data of the face tracker module in real conditions. The result showed that the face tracker had a higher failure rate when the camera was pointing towards an area with bright background and the algorithm generated more false positives in this case. The data provided by the module consistes of the face ID, face pose, location of 66 facial landmarks, validity flags, valence, arousal, level of engagement, and time-stamp. A confidence level was included so that the behaviour tree does not trigger a demonstration or behaviour “into thin air” when there is no-one present.

To test the interaction components YD prepared an interface to allow to program sequences for the FROG eyes and arm. A small robot (Baby-FROG) was customized using the FROG eyes and arm to play the sequences for deployment in user experiments.

Several tours with different user experiments were executed and the data collected.

Figure 34: Test of the Navigation with behaviour tree

2.7. Integration Meeting Alcázar Seville 28th April 2nd May 2014

For this integration meeting the robot platform and upper structure were already completed and using the same elements of previous meeting. The FROG robot was dressed with the painted shell and the pointing arm on the head.

2.7.1. Integration Meeting Activities

IDM

Supported the proper integration of the partners equipment on the FROG robot. Installed and tested the new painted shell on the robot (see Figures 35). Installed the top arm on the robot. Developed a windows based program to help test interaction contents with the real FROG robot and tourists.

Figure 35: FROG robot with the painted shell

UPO

Gave support for integration of the rest of the modules and adjusting the whole behaviour. Tested a virtual machine that can be used as a simulator to test the new state machine and a new software for tracking people and predicting their path. Tested localization and navigation in autonomous mode by monitoring the operation of the robot (see Figure 36).

Figure 36: FROG navigating in the Real Alcázar and displaying contents

ICL

Tested the interest-level prediction algorithm in real-time with the FROG robot using the newly installed computer and graphical card (see Figure 37).

Figure 37: Face recognition tests

UT

Did user experience experiments with a setup of a tour that IDM had prepared (see Figure 38). First AR contents tests running on the robot. Projection tests outside and on the yellow tiles indoors.

Figure 38: Guide tours experiences (not autonomous)

2.7.2. Meeting Results

The robot worked without problems during the whole week. The robot was able to localize and all of the path and it was possible to perform several completed tours.

It was possible to make different user experience experiments with the real robot and retrieve information with the tourists about the tours performed by the robot.

In conclusion it was a very successful integration meeting allowing to decide what it will or not be possible to show in a 24/7 operation.

2.8. Integration Meeting Alcázar Seville 16th-27th June 2014

For this integration meeting the robot platform and upper structure were already completed and using the same elements of the previous meeting. These two weeks meeting in Seville were intended to prepare the 24/7 tests in September.

In the first week all the developed software was going to be installed and integrated so that on the second week the robot could provide two to three tours a day to the tourists.

2.8.1. Integration Meeting Activities

IDM

Supported the proper integration during the first week. Deployed the charging docking station (see Figure 39). Discussed with the partners the different details regarding the preparation of the robot for the 24/7 operation.

Figure 39: FROG robot at the charging docking station

UPO

Supported the integration of the rest of the modules and adjusted the whole behaviour.

Ensured localization and navigation in autonomous mode by monitoring the operation of the robot during the second week (see Figure 40). Localization of the docking station and deployment of the behaviour of approaching and leaving it. Tested the social navigation module and negative-obstacles recognition (like steps) by the use of the tilted laser. Recorded navigation data (sensor measurements).

Figure 40: Navigation tests at the Royal Alcázar

ICL

Connected the decision-making module to the rest of the robot software and adjusted it to optimize the end result. Tested the newly updated software that will increase the recognition accuracy, on site.

UT

Uploaded and tested the new software on the robot and tested it on site (see Figure 41). Deployed and tested the new State Machine and interaction contents on the robot.

Figure 41: Deployment of the new interaction contents

2.8.2. Meeting Results

During the first week all the software from the different partners was integrated and tested.

The interaction contents were deployed on the robot and several small tours were performed to check the contents in each POI and the navigation between each POI.

From Friday, of the first week, to Friday of the second week, the robot performed two or three complete tours per day, a total of 16 tours and more than 8,4 Km (see Figures 42 and 43).

The robot worked pretty well. However it was not perfect and the partners will improve their contribution for the 24/7 operation (the team will begin gathering some statistics to create a seed for the final report). In any case this week already proved many of the promised issues for the 24/7.

Figure 42: FROG performing tours

Figure 43: FROG performing Tours

2.9. Heading for 24/7 Operation in September

After the last integration meeting held in June 2014, a list of small improvements/tasks has been defined. They are now presented.

Electronics

- Development of electronics to unpower the docking charging station when the robot is not charging. This will be based on a relay associated with reed sensors that will detect if the robot is entering or leaving the docking station.
- Development of electronics to be able to turn the power of the cameras on and off.
- Development of electronics to disconnect all the devices (cameras, lasers and sound) while the robot is in charging mode.

Mechanics

- Make an adaptation for the web camera, on the arm pointer, to substitute the laser with a web camera.
- Find a solution to reduce the overheating produced by the charger electronics while the robot is charging.
- Change the angle of the tilted laser to be able to detect obstacles at a greater distance.

Navigation

- Handling of some particular places (slopes and other small obstacles);
- Improve the social component to make it more readable by people.

Engagement

- Use the level of engagement in more POI's
- Give visitors feedback on how they can be seen by the robot, draw the face tracking screen output on the UI.
- Present engagement in a “meter” instead of as a number.
- Integrate the text “Please come closer and look to the screen” at moments where the Face tracking is being used.
- Switch from the mini map , while navigating, to the face tracking camera view when arriving at a POI.

Contents and Robot Behaviour

- Indicate “near location” and stop saying “navigating to the next location” when the robot is already at the POI and is only rotating to the final orientation.
- Control the sound volume of the voice, clips and effects, based on the location.
- When the robot loses its participants of the tour (when there is nobody around the robot while it is giving a tour) the robot should stop the tour (after asking if there is anybody still interested) and return to the entrance of the Alcázar and look for new participants.
- Add eyes animations during the quiz and during the introduction of the robot.

- Use the projector as a separate screen. The screen of the robot will be black when the projector is about to be used. The robot will make clear to their users that the projector will be used, saying “Start projection”.
- Look for other augmented reality commercial software.
- Consider location-based AR. Use a more accurate model of the robot and arm pointer.
- Schedule the tour times.

Tour

- Polish up the videos.
- Make a language selection screen in the beginning of the tour. Allow the tourist to chose between English, Spanish and Dutch.
- Add more interactivity at the POI's.
- New “end tour” content.
- Additional POI contents.
- Refresh existing interaction (quiz) and add new interaction to the POI's.
- Move the POI-3 to entrance of the Crossing Courtyard to make better use of the projector.
- Change the location of the end of the tour (POI_end) to the Mounting block.
- Change the way the state machine handles negative user input after the robot introduction.
- Add a “progress-bar” of the tour to the UI. Where the length of the the line is the time left until the end of the tour.