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Human Resources

SRL

The project is coordinated by Professor Carsten Griwodz. Konstantin Pogorelov, Jonas Markussen all contribute to the innovation and scientific work. Elisabeth Andersen and Katarina Subakova contribute to the administrative work.

MIK

The project is led at MIK by Benoit Maujean, R&D Manager. Fabien Castan, as lead developer is the technical manager of LADIO project, to coordinate the partnership in all development-related project work. Yann Lanthony and Grégoire De Lillo (software engineers) as well as Jean Melou (PhD student) contribute to the development of LADIO softwares. Thomas Eskénazi, as software architect, contributes to the data model and API definition.

INP

The project at INP is led by Pierre Gurdjos. The innovation and scientific work is supervised by Sylvie Chambon, Vincent Charvillat, Simone Gasparini and Géraldine Morin, all senior researchers. Clément Debize is the research engineer on the project.

CTU

The project at CTU is led by Dr. Tomas Pajdla. Main innovative and scientific work is carried out by Ph.D. students Cenek Albl and Michal Polic. Additional contributions come from MSc. students Pavel Trutman, Jan Krcek, and Oleh Rybkin.

Project Progress

WP1 - Onset Data Acquisition

In the 4th quarter, SRL has no longer hired former employees of ex-partner LABO Mixed Realities. Instead, they have focussed fully on their new business Quine.

During the 4th quarter, LADIO partners have repeatedly met Quine both in person and in telcos, and negotiated the conditions for Quine to join LADIO as a new SME as a replacement for LABO. At the end of this reporting period, the Second Amendment was nearly ready for submission, except for assignment of Quine's LEAR. This has since been done and the request for an Amendment has been submitted.

The discussions with Quine have a strong influence work package 1. Quine has integrated the open source software developments of LADIO into their products, but they have replaced the LADIO hardware design from WP1 with a new hardware generation, and changed the operating system from Linux to Windows. There were several reasons for this. The choice of new hardware was due to the cost of hardware in the LADIO design: while LADIO was aiming at market-readiness after summer 2018, Quine is delivering hardware to film sets now. While hardware availability for the LADIO design was supposed to improve and costs to go down, Quine negotiated with manufacturers for simpler customer hardware components and went for a full re-design based on the LADIO CamBox design assuming the currently achievable market prices. Beyond the re-design that gained from Quine's founders' experience in the LADIO project, they bring to the project:

- A tracking bar with witness cameras and IMU's
- A metadata reader and transmitter
- A robust point-to point WiFi solution

The reselection of the operating system was a major discussion point in LADIO's discussions with Quine, but LADIO had to concede that we cannot influence Quine's decisions made outside of the project, and the choice is well-founded, with arguments in favour of the change ranging from the skillset of the Quine founders to their ability to negotiate very good prices for custom-developed hardware (witness cameras and IMUs) only with manufacturers who provide exclusively Windows drivers.

The new hardware fulfills the same purpose as the LADIO design, but it is available now, several units have been used in productions, and there are several dozen pre-orders. Quine has agreed to sell 3 units to LADIO partners at a considerably reduced price (SRL has bought them on behalf of the project), to enable LADIO to develop for a platform that will remain available and professionally supported for several years. Quine has also agreed to a long-term deal that allows partners to buy 10 new units per year at strongly discounted price after the end of the LADIO project.

LADIO has therefore invited Quine to join the consortium and base LADIO's further development on their current hardware.

Task 1.3 "LADIO SetBox" of LADIO had at its core a development goal that was considered essential by former partner LABO : the development of frequency selector and frequency switcher for WiFi communication between CamBox/MiniBox units with the SetBox. The experience to implement this solution was very limited among the other consortium partners, although the basic knowledge to implement such a solution without LABO does exist within SRL. However, the reason for developing this frequency switching technology was LABO's ambition to maximize the resources of the WiFi network on set for the purpose of data transfer and consistent replication among several nodes on set. Quine does not share LABO's opinion that this technology is required right now to enter the market, and actual customers prove them right. Quine does instead work on the development of point-to-point WiFi connections in combination with reliable transport protocols and the use of standard, automatic frequency selectors. This path will be pursued during the lifetime of the LADIO project.

WP2 - Data Model and API

T2.1 - Data Model and API
(planned duration months 1-6)

The EBU released a new version of the EBU Core Metadata Set (EBU Tech 3293) and the EBU EBU Class Conceptual Data Model (CCDM, EBU Tech 3351) in October 2017. We have not updated the LADIO data model accordingly yet, but changes should be minimal since our work was based on unreleased draft of the 2.0 release. We must complete these updates in January 2018 before integration of the LADIO application.

WP3 - Advanced 3D reconstruction

T3.1 - SfM : LIDAR integration
(planned duration months 7-15)

One approach to the 3D registration of a reconstructed 3D scene (sparse or dense point cloud) with LIDAR data makes direct use of the point clouds, relying on the structure of spatial features, point densities, or general shapes. In a series of tests, we have explored several state-of-the-art approaches to this kind of 3D registration. In the absence of controlled LiDAR data, we used a CAD model to emulate the accurate point cloud that we expect as LiDAR output.

Figure 1 below shows a 3D printed box, the original CAD model, and the reconstructed point clouds from the SfM (OpenMVG) and MVS (CMPMVS) steps, respectively. The model was well-textured and the reconstruction was made from 1878 frames.

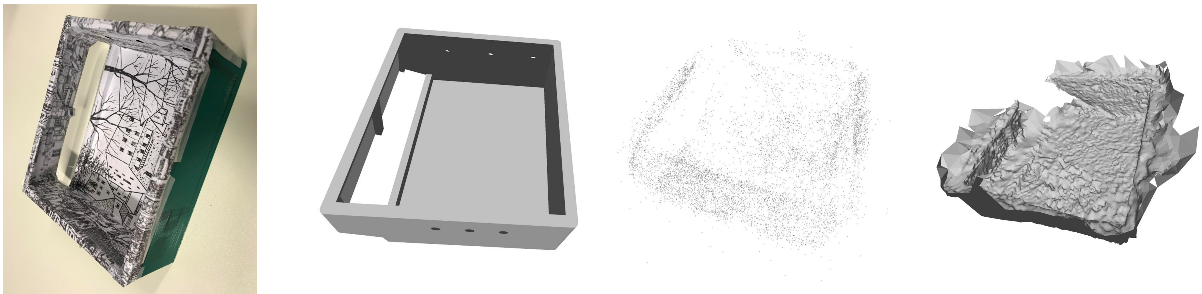

Figure 1: Box example. From the left to right is: (a) the 3D printed cabinet which we record a sequence at, (b) the original designed CAD model, (c) the sparse point cloud from SfM, and (d) the reconstructed mesh from MVS.

We tested several state-of-the-art 3D registration algorithms to align the different point clouds describing the same scene, and to match the imperfect reconstructed result from images with the designed CAD model. To extract a point cloud from the CAD model, we used recursive refinement to identify a chosen density of points within the model.

We used the global algorithm *4PCS* [Aigar:2008] and local algorithm *Iterative Closest Point* (ICP) [Besl:1992] to align the point clouds. It is obvious that the global algorithm is expensive and the iterative algorithm suffers from local optima. Figure 2 below shows the registration results from a speed-up 4PCS implementation [Mellado:2014] and ICP (implemented in Point Cloud Library [Rusu:2011]). We performed pre-processing including downsampling and scaling on sparse and dense point clouds.

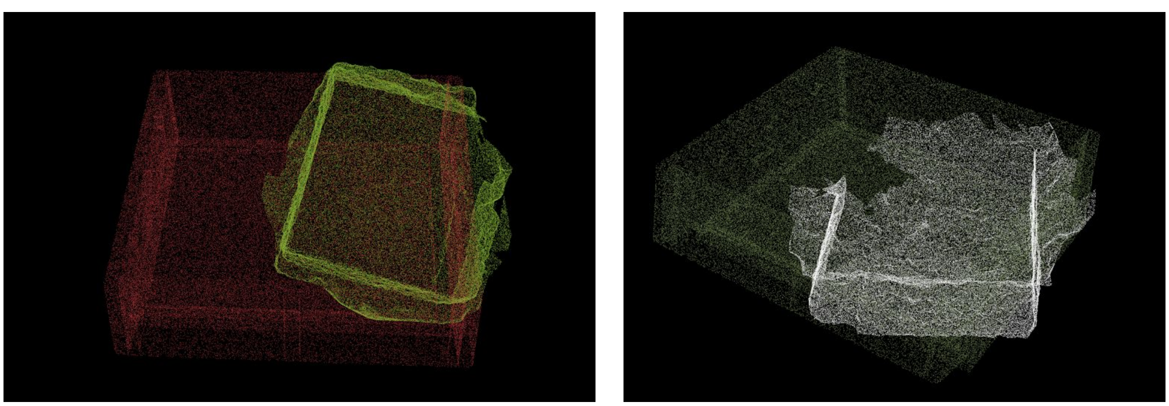

Figure 2: Matching results after using ICP to match point clouds from different source. From right to left: (a) the visualized result using ICP, (b) visualized result with 4PCS.

From the registration result in Figure 2, we observe that 3D registration with existing methods based on point cloud densities is not trivially applicable, at least in indoor scenarios. To summarize the challenges:

- Varying densities and scale: Our point clouds originate from different source, namely a LiDAR scanner and our visual reconstruction software (sparse and dense). Therefore, the scale factor and densities vary between source to target. Also, LiDARs provide a regular sampling of points in a spherical pattern, while image-based reconstruction leads to higher point densities in well-textured regions. For existing implementations, point clouds must be re-sampled for similar densities before attempting registration.
- Missing data: both dense and sparse point cloud are missing data since our reconstruction comes from image sets. Figure 1 demonstrates a possible effect, where the left corner in Figures 1(c) and 1(d) is not reconstructed due to a rejection of frames looking at this portion.
- Noise: Point clouds are computed based on the corresponding features from different frames, but a number of points are reconstructed at the wrong depth. Literature does generally work on convex objects that are reconstructed from all sides, which eliminates the worst outliers. For indoor reconstructions and other concave scenarios, the outer hull is unknown and mistakenly reconstructed points create outside volume that does not really exist. This conflicts with the resampling mentioned in the first bullet.

T3.3 - Improve SfM accuracy and precision
(planned duration months 1-9)

- **Local Bundle Adjustment (LBA) improvement**

Previously, as reported in QMR3, we developed a strategy to reduce the number of refined parameters in the Bundle Adjustment (BA) part of each step of the incremental SfM pipeline by using the so-called Local Bundle Adjustment (LBA) [Mouragnon:2006][Mei:2011]. As a result, we were able to decrease the total computation time in SfM.

There are two majors constants to be fixed when using LBA so we ran multiple tests to evaluate the best value for each of these.

➔ **Threshold on distances to newly added cameras within the camera graph**. As it is explained in QMR3, all the reconstructed cameras are stored in a “camera graph” where vertices are cameras and edges link camera pairs only if the two cameras have a sufficient number of matched measurements of 3D landmarks. We define LBA as the problem of refining all parameters of *active* cameras while parameters of *passive* cameras are set to constant (the parameters of skipped cameras are not considered). The distance between two cameras refers to the number of edges in a shortest path from one camera to the other one. An *active* camera is a camera at graph-distance less than a threshold D on newly added cameras. The *passive region* of a camera is the subgraph of vertices not in the active region but which have edges connected to cameras of the active region.
We have tested several values for D (e.g.,1,2,3 up to 30) on different datasets. We found out that choosing a value > 1 increases the reconstruction computation time with no

significant effect on the reconstruction accuracy (basically the same number of cameras and points).

➔ **Minimal number of matches**. We also investigated what is a “good” number of matched measurements of 3D landmark to connect two cameras in the graph. This minimal value allows to reduce the graph density due to bad matching. We found out that M=50 seems to be a good compromise on real reconstruction with high quality images (previously M=100).

➔ **Calibrating cameras during BA**. In the previous BA and LBA implementations, the intrinsic parameters of a camera were set to constant as soon as 10 views of this camera were added. The new strategy is to quantify the variations of a camera intrinsics over time and set the intrinsics as constant when the variation drops below a threshold.
Usually intrinsic parameters are updated every time a camera is added to the reconstruction. During the reconstruction process these initial values vary from the EXIF values to asymptotic ones. The aim is to find a criterion to decide when we can consider the intrinsics reaching their asymptotic values in LBA so they can be considered as constant, not being refined any longer. To do this, every set of camera intrinsics is saved with the number of processed poses/views. We compute the ratio between the standard deviation of the focal length corresponding to the last N poses (we choose $N = 25$) and the range of all the values of the focal length. If this ratio drops below 1%, we consider the camera intrinsic (associated to the studied focal length) as constant.

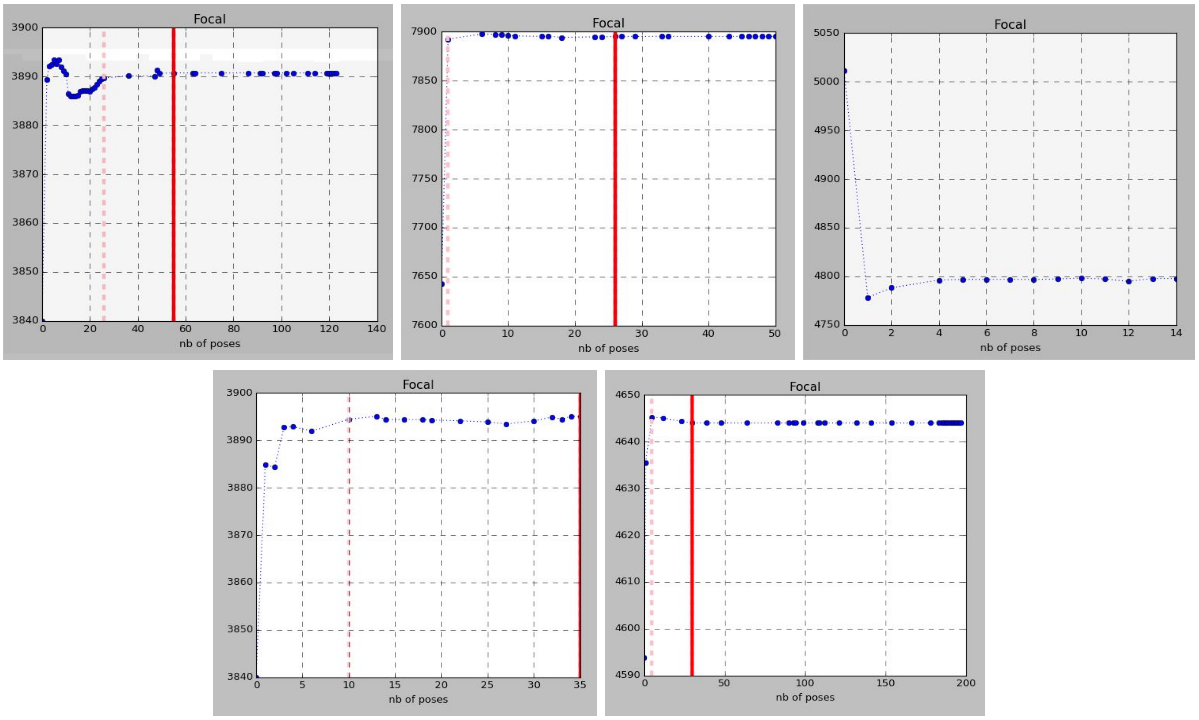

Figure 3. Evolution of the focal length in K_2, K_3, K_6, K_{13} and K_{19} during the reconstruction of the dataset Cirque (544 images, 26 intrinsics). Red lines: indicate the moment when the criterion is reached. Pink lines: indicate the beginning of the computation window $(N = 25)$.

- **New Local BA tests**

To complete the evaluation of the Local BA, we made some tests with new datasets coming from a database specializes in reconstruction benchmarking (www.tanksandtemples.org).

Dataset name	Courthouse	Meetingroom	Palace
#images	1106	371	506
BA	5 h13	29 min	14 min
LBA	28 min	2 min	1 min 45
Gain	**x 11.13**	**x 15.9**	**x 7.9**

Table 1. Gain speed evaluation of the Local BA approach against the classic BA method.

Dataset name	Courthouse	Meetingroom	Palace
#poses BA	1103	370	375

#posesLBA	1096	364	402
Ratio	**99.4%**	**98.4%**	**107.2%**
#points sans LBA	88570	23327	44051
#points avec LBA	88441	22132	45970
Ratio	**99,9%**	**95%**	**104.4%**

Table 2. Comparison of the reconstruction quality between the Local BA approach and the classic BA method.

- **Limit the number of loaded matches**

We had a way to run the reconstruction reducing the number of loaded matches. This option reduce the needed time to the reconstruction, but decrease the number of final 3D points: it can be useful to get a fast rendering or during demos.

- **NViews triangulation with LO-RANSAC**

Previously, we determined the 3D point location using only two of these observations (2-views triangulations); other views were used later during the BA part only. This way induces two majors issues :

- The algorithm to select the two views must be very robust → to avoid degenerated 3D points
- The distribution of the *reprojection errors* of this point in all views where it is seen is not homogeneous (~0 pixels on the 2 views used for triangulation, $\gg 0$ pixels on others).

We replace this 2-views triangulation algorithm (based on a *direct linear transformation (DLT)*) by a N-view robust triangulation based on the LO-Ransac algorithm [Lebeda 2012]. Thanks to this change, it is also possible to triangulate a point only if its number of observations $\geq N$ (by default, $N = 2$).
It can be interesting to use $N = 3$, it reduces drastically the noise in the point cloud (#points: -40%) without removing too much cameras (#cameras: ~-5%). This parameter is now available for the launch of SfM.

- **Parallelization of the resectioning**

Triangulation (compute 3D points position) and resectioning (compute cameras position) being splitted, we parallelize the code to reduce the time spent on these parts.

- **Change of libraries**

We replaced all the libraries used to load images and metadata by OpenImageIO (http://openimageio.org). It allows us to support more image file formats as inputs and provides a better metadata support. This enables to load images in floating point buffer which can be used by the feature extraction. This allows also to keep the full quality when the images contain this level of precision (for instance for RAW or EXR file formats).

T3.4 - SfM : Multi-body

(planned duration months 9-14)

CTU made extensive tests of different approaches during 2 thesis: Jan Krcek and Filip Srajer thesis. A workshop has been organized in Paris with CTU, IRT and MIK to refine the task based on the CTU expertise.

WP4 - Detailed 3D representation

T4.2 MVS GPU Optimization

(planned duration months 10-18)

To prepare the merge of the MVS code into the AliceVision, we refactored the image Input/Output code by using the OpenImageIO library. Based on this library, we replaced all proprietary file formats used to store image buffers with standard image file formats:

- depth maps are stored in 32 bits floating point EXR
- similarity maps are stored in 16 bits half-float EXR
- depth index maps are stored in 16 bits integer PNG
- visibility maps are stored in 8 bits integer PNG
-

These new file formats optimize the storage needs, improves the interoperability and enables to visualize the intermediate files.

Instead of one global command line for the whole MVS pipeline, we now have one piece of software per step, that can be combined in one global pipeline in *Meshroom* (see T 5.2) Each step is now able to import/export files into custom folders, so *Meshroom* can generate intermediate folders and now properly deals with files invalidation when the user changes one parameter at a specific step.

We implemented the support of custom UVs for texture mapping when loading the user mesh (OBJ file format). It is important for retexturing, as the graphic artist can create his own model (by retopology for instance) and manually create proper UVs to limit seams artefacts. We created a new software for mesh simplification called “meshResampling” based on the *Geogram* library. This enables to generate lower resolution meshes.

We have performed math and code optimization in a GPU implementation of a normalized cross-correlation computation function *compNCCby3DptsYK* widely used in many plane-sweeping-related GPU-kernels to compute a similarity value for texture patches. The main performance improvements were achieved by reimplementing point-to-plane projection math computations: instead of iterative recomputation of a projection of a point shifting within 3D-trapezoid to a target texture plane, we have implemented incremental point shift directly within the target texture plane. To eliminate a negative effect of the incremental computations, we have used double-precision arithmetics for the intermediate computations. The precision loss caused by using of the incremental arithmetics instead of the repeated point projections was measured at a level less than an initial precision loss caused by the previously used single-precision projection arithmetics. Additional performance increase was achieved by inlining and optimization of a computation performed in a *CostYKfromLab* function. Final performance testing was performed on a full CMPMVS pipeline and is depicted in Table 3.

The full pipeline run time for different CMPMVS versions		*Performance gain*
Original	*Optimized*	
16:44:04 (60,244 seconds)	13:10:43 (47,443 seconds)	21.2%

Table 3: Run time of the CMPMVS original and optimized full pipelines executed on an Intel Core i7-6700K CPU@4.00GHz×8, 16 GB DDR4 RAM, nVidia GeForce GTX 1080/PCIe/SSE2, Samsung SSD 256 Gb, Ubuntu 16.04. The dataset used contained 67 frames of Buddha.

The natural feature extractor PopSift was improved in various ways. Loading of float images in addition to byte-based greyscale images is possible. A new descriptor extraction method that minimizes memory access was tested. The interface makes use of the C++ concept of promises and futures to simplify the integration of PopSift into code that is classically making blocking calls to a SIFT library without sacrificing the speed of asynchronous operation.

Speed has further been improved to yield running times as illustrated in Table 4. This is an important performance improvement because SIFT feature extraction and SIFT feature matching are two of the most time-consuming steps in the creation of the sparse point cloud. We have invested effort in maintaining the accuracy at the level of the best known CPU and GPU SIFT feature extractors, and succeeded, as Figure 4 shows.

	VLFeat		PopSift	
	runtime	descriptors extracted	runtime	descriptors extracted
main	7.195 sec	44666	0.043 sec	44930
cap	7.232 sec	44966	0.043 sec	45179
boston	6.060 sec	30262	0.037 sec	30473

Table 4: VLFeat on an i5-4590 at 3.3Ghz vs PopSift on a GTX 1080. The time spans keypoint detection and descriptor extraction (and CPU-GPU transfers for PopSift) but no image decoding or disk operations. Frames had resolution 1920x1080, upscaled to 3840x2160, using the default parameters of VLFeat.

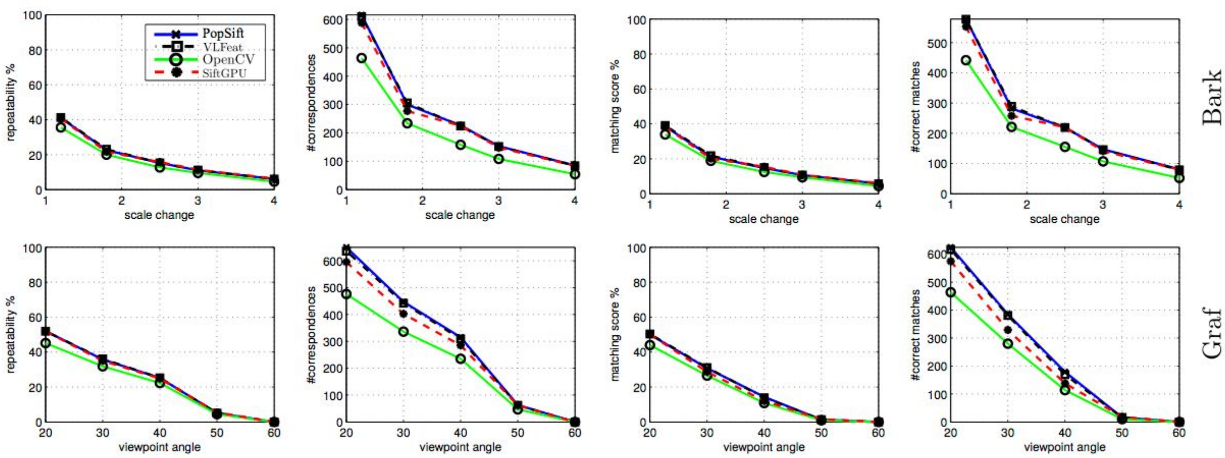

Figure 4: PopSift compared to other SIFT implementations in terms of quality (following [Mikolajczyk:2005]).

WP5 - LADIO Application

T5.1 - LADIO Application Timeline
(planned duration months 3-12)

The development in this work package has been seriously delayed while we are conducting our discussions with the SME partner who we expect to join through a second Amendment (Quine). We have asked for extensions on both deliverables of this task.

The two deliverables that were due at the end of this reporting period were not delivered as planned. LADIO requests for the inclusion of Quine as a new partner for the project. This task and its deliverables are at the core of LADIO's integration with Quine's product, and therefore the final outcome of the project. The measures that were implemented with the first Amendment, re-assigning these tasks from exiting company LABO to research lab SRL (without changing the project schedule) could not have resulted in a long-term feasible product. The allocated person months are moving from SRL to Quine along with the responsibility for these tasks. LADIO has requested permission from the Project Officer to shift these deliverables to January 31, 2018, and March 31, 2018, respectively, in a second Amendment.

Still, several video conferences to understand and align Quine's and MIK's requirements have been held, and meetings between SRL and Quine have been held to design the LADIO backend in more detail. Development has taken place in the period on several issues.

The communication between CamBox/MiniBox and SetBox should support 3 modes, as decided in previous discussions: streaming, bulk upload, and physical transfer of SD cards or other storage media. The following have been implemented.

- **Streaming of video content based on the HAL (the previous recording box) software**. This works for streams from 360 cameras like the Ricoh Theta as well. Extensions for other audio formats and metadata formats are pending. (https://github.com/alicevision/hal)
- **Download of files on demand using the "metadata acquisition daemon".** This refers to a bulk upload method that has fallen out of favour after experiments. A C++ library that is implemented both on client and server side. It complies with HTTP and uses a REST API for controls. The client (SetBox) can check availability and age of file on the server side (CamBox), and download updated files. This works with arbitrary files, but requires the CamBox to act as a server.
- **Upload of files using the FTP protocol**. This is now the preferred approach for bulk upload because it deals both with intermittent connection loss, data transfer and import of metadata into the SetBox database (DB). When the SetBox instructs the CamBox to upload its content, it includes an FTP server, root directory and login information. The directory structure on the CamBox has been fixed, with a UUID assigned to all versions of recordings made by a single rig handled by a CamBox. Metadata and Hashes are stored along with the files, while alternative representations (for example for Dailies) are stored in subdirectories. This structure is replicated to the SetBox using FTP. On the CamBox side, libcurl (https://curl.haxx.se/libcurl/) is used due to its several language bindings and its ability to reconnect after interrupted file transfer operations. On the SetBox side, Pure-FTPd (https://www.pureftpd.org/project/pure-ftpd) is used due to its ability to execute arbitrary functions on upload completion. This allows us to act automatically on the arrival of metadata files (just based on their name) and import the metadata into the DB running on the SetBox.
- **The choice of database** (DB) for the SetBox has tipped in favour of a NoSQL DB operating on JSON files. The current implementation does not use MongoDB (https://www.mongodb.com/), in spite of the large user base and existing experience at MIK, but ArangoDB (https://www.arangodb.com/). These two DBs have a lot of similarities, but ArangoDB understands a concept of triple store, which is a way of implementing a graph database. This allows us to implement the graph database option for metadata storage, which we planned to explore as one of three options in Deliverable D2.1's section on SetBox Storage. We have written both input and export code in Python that demonstrates the superiority of the NoSQL / JSON approach for documents that are

growing incrementally (such as the a Scene data structure to which we add additional Takes) over relational and XML-based DBs.

ArangoDB has a few small advantages over MongoDB. While the implementational advantage of the ArangoDB triple store concept over the MongoDB flat file concept isn't large, it provides an easier conceptual overview and faster search by offering Collections for the different classes of the LADIO data model, as well as separate "Edge" Collections for the relations between classes of the model. Two additional advantages of ArangoDB are (a) its Apache License allowing modifications if that should be necessary in the future, and (b) its built-in support for versioned documents (including Edges), which requires manual work in MongoDB. Both DBs implement replication and sharding, and commercial support is available.

We have not seriously explored the scaling performance of ArangoDB yet, relying on word of mouth (experiences at NRK). The main argument for this omission is the assumption that a film production would use the preparation phase to equip a SetBox with a pre-filled DB only for those aspects of the production that are relevant to the specific filmset. The alternative of replicating a large share of the central DB of a production house onto a machine that is taken out of the house is unrealistic due to the risk of theft and infiltration. Consequently, we expect that the SetBox operates on DBs of rather small size, and interacts with the central DB through an export-import step. Note that this does not preclude the automatic replication of the LADIO DB to the production house for resilience and ease-of-use, it only protects the established infrastructure of potential customers from several new angles of performing theft or attacks.

T5.2 - LADIO Application Media Presentation (planned duration months 10-15)

Considering the standby position of T5.1, MIK has focused on *Meshroom,* the 3D reconstruction part of the software with well defined specifications. *Meshroom* now provides a local computation mode to use it on-set.

The need for production pipeline integration led us to refactor some components of *Meshroom* core engine into Python language. This new version provides a revamped nodal workflow with a caching mechanism. It allows to compute 3D reconstruction both on local workstation or on renderfarm. The software is able to display progression information even when the computation is done externally on renderfarm. This mix and match approach enables to stop the local computation and resume it on a different workstation.

With the new engine, the project is relocatable without creating file invalidation. This allows to first compute on-set and then launch the end of the process later on farm when data have been transferred on the network storage.

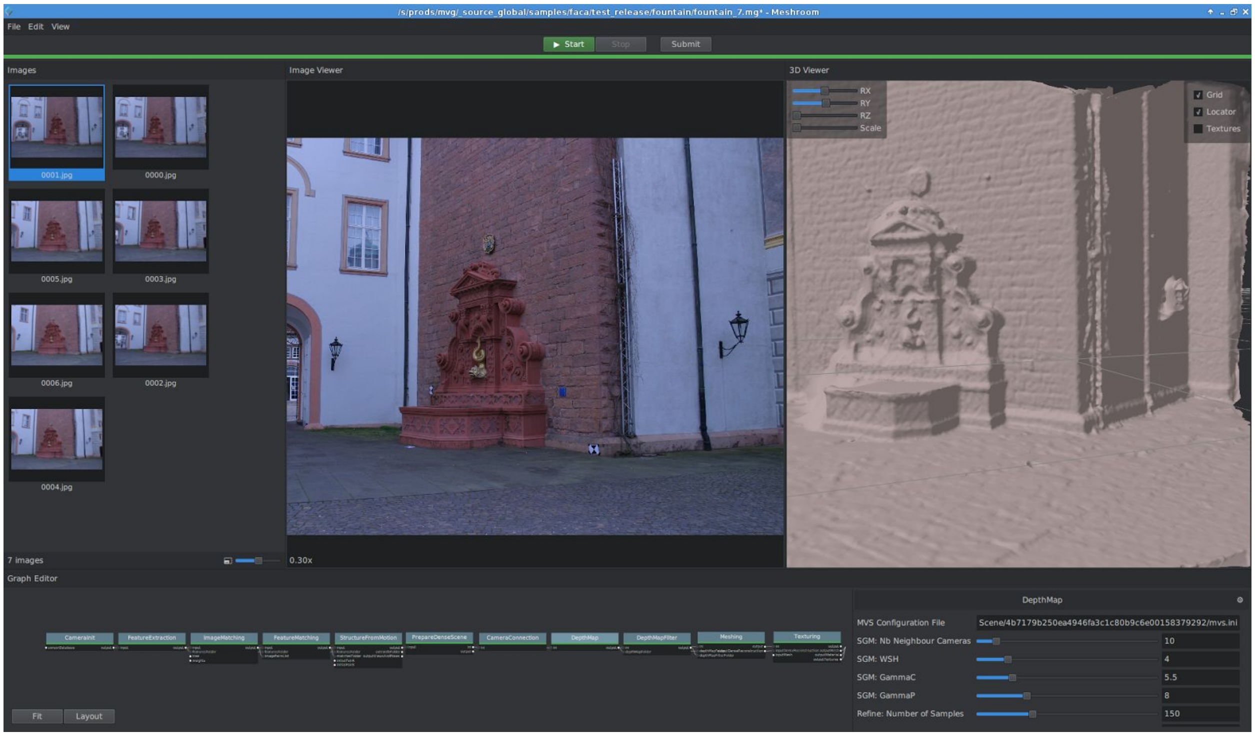

Figure 5: New version of Meshroom with invalidation graph and mesh viewer (with or without textures)

WP6 - Management

T6.1 - Platform for internal communication

Throughout the autumn, SRL has tested Mattermost as a free replacement for Slack, using Amazon installations. We used Mattermost for internal communication and as part of a university course. Although promising, we found that importing Slack repositories was extremely slow as well as unreliable, and user management including email handling was not quite reliable and required considerable attention from the local computer administration. It is probably feasible for use in a newly started project, although Slack continues to integrate new and desirable features, but it is not feasible to move to Mattermost during the runtime of a project that is already using Slack.

T6.2 - Reporting requirements

T6.3 - Platform for dissemination of public project information

Agreement has been reached about the terms of Quine entrance into LADIO. An updated Annex B has been prepared and is about to be submitted to the Project Officer for feedback.

The official project website (http://ladioproject.eu) has now been moved under the AliceVision project umbrella and its name resolution problems have been resolved.

T6.4 - Data management planning

Datastes

Datasets have been updated by completing the LiDAR scans from Velodyne scanners, studio recordings with the iPhone 6s and the Red Dragon 4kHD: http://ladioproject.eu/#datasets

Workshops

- 3-4th October in Paris (MIK): workshop with CTU (Tomas Pajdla) and MIK (Fabien Castan, Yann Lanthony) to work on T4.2
- 16th November in Paris (MIK): workshop with CTU (Tomas Pajdla), IRT (Pierre Gurdjos) and MIK (Fabien Castan) to work on T3.4.

Plenary meetings

No plenary meetings took place in this period.

Plenary audio / video conferences

In addition to these face to face meetings, the LADIO consortium holds a video conference every 4th week to keep track of the project progress:

- October 11th 2017 - Video conference
- November 8th 2017 - Video conference

The meeting on September 13th 2017 - Video conference was cancelled because a large number of key personnel were on vacation after the rush of deliverables on August 31. Instead, a string of video conferences involving MIK, SRL and Quine and occasionally other partners were held to come up with a workplan and the terms for Quine joining the project (18.9, 22.9, 27.9, 29.9, 4.10, 6.10, 25.10).

Status of deliverables

Two deliverables were due in this quarter according to the 2nd revision of Annex B, which was in force at this time, but they were not delivered according to this plan. LADIO has requested permission from the Project Officer to shift these deliverables to January 31, 2018, and March 31, 2018, respectively, in a second Amendment. These tasks and deliverables are at the core of LADIO's integration with Quine's product, and therefore the final outcome of the project. The emergency measures that were implemented with the first Amendment, re-assigning these tasks from company LABO to research lab SRL (without changing the project schedule) could not have resulted in a long-term feasible product. The allocated person months are moving from SRL to Quine along with the responsibility for these tasks.

- D5.1 - Implement Backend Timeline Module. Would have been due on November 30, 2017. To be shifted to January 31, 2018 with the 2nd Amendment.
- D5.6 - Implement Frontend Timeline interface. Deliverable submitted on November 30, 2017. To be shifted to March 31, 2018 with the 2nd Amendment.

Person Months Contributed to the Project

Participant	Names of staff	WP1		WP2		WP3		WP4		WP5		WP6		Total	
		Planned	Actual	*Planned*	Actual	*Planned*	Actual	*Planned*	Actual	*Planned*	Actual	*Planned*	Actual	*Planned*	Actual
SRL	Carsten Griwodz Konstantin Pogorelov Jonas Markussen Elisabeth Andersen Katarina Subakova	10,5	12,48	9,00	8,78	4,67	3,27	2,33	0,61	6,5	3,15	3,33	2,24	**36,33**	**30,53**
MIK	Benoit Maujean Fabien Castan Grégoire De Lillo Yann Lanthony Jean Mélou Thomas Eskénazi	1,00	1,27	7,00	3,42	8,0	1,28	5,00	11,84	6,0	6,81	2,0	2,11	**29,0**	**26,73**
INP	Vincent Charvillat Sylvie Chambon Simone Gasparini Pierre Gurdjos Geraldine Morin Clément Debize	0,00	0,00	0,00	0,00	14,33	13,1	0,00	0,00	0,00	4,00	0,67	1,3	**15,0**	**18,4**
CTU	Tomas Pajdla, Cenek Albl, Michal Polic Oleh Rybkin Pavle Trutman	0,00	0,00	0,00	0,00	7,67	14,46	4,67	10,3	0,00	0,00	0,67	0,00	**13,0**	**24,76**
Total		**11,5**	**13,75**	**16,00**	**12,2**	**34,67**	**32,11**	**12,0**	**22,75**	**12,5**	**13,94**	**6,67**	**5,65**	**93,33**	**100,42**

Figure 6: The cumulative budgeted and contributed person-months since project start for each partner sorted by Work Package.

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