3DSSC (3D Smart Sense and Control)

Deliverable D1.1 Revised Experiment Specification and Planning

3D Smart Sensing and Flexible Task Programming for On-Line Trajectory Adaptation in Fast Surface Treatment

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1 Revised Experiment Specification

The preliminary specification of the project proposal defines the experimental setup consisting of a standard commercial robot, with real-time PC-interface, equipped with smart 3D sensing and force control, to perform a new task (coating removal on a cheese block using a plane shaving tool) in a known area. The envisaged prototype consisted of smart 3D sensing instead of accurate but expensive commercial 3D camera systems, simple force control and the integration of 3D sensing and coating removal in a single motion.

Interviews with potential customers in the food industry,revealed their strong preference for (I) a milling process that resembles the existing manual procedure using electrical planing hand tools and (ii) minimal contact between tool and product (cheese) surface for hygienic reasons.

These preferences where taken into account in the tool design and process development iterations. As a result, our primary experiment design and setup focuses on:

(i) a the peripheral plane milling approach which is the underlying technology of the electrical planing hand tools currently used in the food industry, and

(ii) a position controlled contact point, rather than the originally proposed simple force control solution, in order to minimize contact with the product (a planar product-tool contact is needed to impose the required cutting depth using force control).

The impact of this adaptation is a need for a higher accuracy from the smart 3D sensing and control solution, since there is no passive force control to eliminate any remaining positioning errors. However, this new approach will possibly allow us to increase the speed of the process because the bandwidth of the active or passive force control system might limit the process speed.

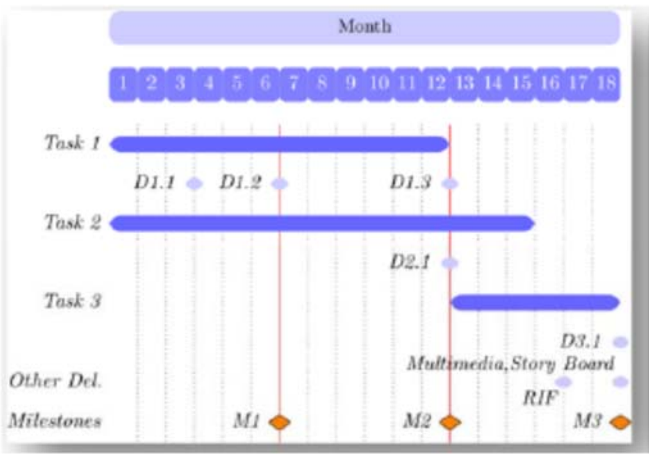
The following table retakes and revises the 'experiment-related Technical indicators' reported in the Impact Analysis.

Nr.	Indicator	Start	End	Means of verification/outcome
1)	cycle time	The human worker in the current process	Cycle time which is not more than 30% slower than the manual work.	Measurement at final demonstration (Milestone 3)
2)	Minimize the material losses (unnecessary removal of cheese)	The human worker in the current process.	material loss 0.5-1% of total weight smaller than with manual work	Measurement at final demonstration (Milestone 3)
3)	Development of a 3D sensor set-up with 1D laser distance sensors	Need for expensive 3D scanning systems producing point cloud and requiring data processing with high computational load	- Accuracy : < 1 mm - Width of the line covered by the laser sensors up to 300-400 mm (depending on the application)	Accuracy analysis e.g. comparison with high-precision measurement or data based on measurements of reference objects with

			- Distance of laser sensors to surface: ~ 100 mm (depending on the application) - Curvature, i.e. variation of depth over the scan line: +/- 20 mm	defined surface structure, Video / data set of the working algorithm Month 6, D1.2 (Milestone 1)
4)	Accurate surface modeling	Results of 3) 3d sensing	Accurate surface model from which constraints can be derived	Proof-of concept, Video, Skype demo + data sets, month 12, D1.3 (Milestone 2)
5)	Implementation of software architecture for constraint-based trajectory generation and motion control	-Results of 3) Development of a 3D sensor set-up with 1D laser distance sensors and 4) Accurate surface modeling - Existing methodology and tools at KU Leuven	- Real-time trajectory adaptation and motion control - Accuracy of generated motion: < 1mm; verified by measuring the excursions executed by a validation measurement system	Month 12 D2.1 integration into the results of 5 (Milestone 2)
6)	Experiment showcase	The human worker in the current process	Automated system with on-the-fly 3D surface measurement and trajectory adaptation	Month 18, D3.1 comparison with human work, video, skype / RIF demonstration (Milestone 3)

2 Planning

The aforementioned revision of the experiment specification do not require an adaptation of the planning. Following table shows the task planning. Following table shows the task planning, followed by the Gantt-chart of the project.



3 Conclusions

The main adaptation to the specification is the focus on a position controlled contact point, rather than the originally proposed simple force control solution, in order to minimize contact with the product (a planar product-tool contact is needed to impose the required cutting depth using force control). This has no further consequences on the proposed planning,are no deviations.