DexBuddy review, Karlsruhe, 2016-07-29

The project partners (ArtiMind and KIT present; Shadow and AEA partly present via teleconference) spent a day with the reviewers explaining and demonstrating the work done in the Echord++ DexBuddy project. This project ran from 2015/01 to 2016/06.

Contractual status

DexBuddy was an integrative project aiming at vision-based robotic cable clipping. The project involved 4 partners: Shadow Robotics, for dexterous manipulation support; KIT, for vision and teach-in; AEA, for use case support; and ArtiMinds for task programming and integration.

The project proposal promises the following outcomes, in five correspondingly numbered tasks:

1. integration of the available robot, new hand, and camera systems (completed)
2. integration of the ArtiMinds intuitive programming software suite (completed)
3. application specification (partly completed)
4. evaluation and benchmarking (partly completed)
5. dissemination (not completed) and exploitation (promising: a less technically ambitious application is developed in an innovation project with Siemens AG)

and the following deliverables and milestones:

1. Del. SB: Story Board: not completed
2. Del. MMR: Multi-Media Report: not completed
3. Del. RIF: Report on RIF visit outcome: not completed
4. Del. 1.1: Multi-Media Report on hardware integration: was delivered approx. 5 months late. The deliverable is acceptable.
5. Del. 2.1: Report on software integration: was delivered approx. 12 months late. The contents not complete (last sentence: “This is the last functionality lacking in the overall DexBuddy software system and will be implemented by ArtiMinds at the beginning of 2016, to be usable for the main experiments.” but there is no report that this has been done), but otherwise acceptable.
6. Del. 3.1: Multi-Media Report on applications: was delivered approx. 6 months late. Report is acceptable.
7. Del. 4.1: Intermediate Report on Evaluation: delivered in time & contents OK.
8. Del. 5.1: Report on further dissemination strategy: not completed.

Milestones 1, 2, and 3 have been completed; milestone 4 (successful evaluation) and 5 (plan for further dissemination) has not been yet met.

The exploitation of the project seems promising, despite the objective difficulty to achieve the project goals. On the one hand, the promised TRL level of 5 has been met only within the quite restrictive limitations of the demonstration setting, as explained below. The research impact has been so far very limited or absent, there has not been any visible public dissemination in the form of articles or newspaper reports, and the promised YouTube channel cq. video, or website exploitation has not been realised. The planned exploitation at the Bristol RIF has not been realised or attempted. On the other hand the spin-off project with Siemens seems realistic and achievable.

Technical status

The DexBuddy proposal is ambitious within the framework that the consortium set itself. Though solving this problem in such a use case is certainly not impossible, it is also not easy to solve in a robust way and with limited resources. The work has a good industrial relevance, and the selected use case is realistic.

The choice of hardware in the proposal is not clear. The planned use of two RGB and two RGBd cameras for scene analysis is not explained in the proposal), and indeed the demonstrator only uses the depth information from a single RBGd camera (thus, task 1 is only partly completed). The resulting vision component is a hand-crafted, engineered solution which works but lacks robustness and generality. The result is not publishable nor usable in a real scenario in its current form.

The calibrated vision component renders Cartesian set points for the UR3 with C6M hand to grasp it. This part works stably, but the OptoForce sensors which are integrated in the finger tips suffer from limited sensitivity and are, in the end, so far only used to detect contact. The cable insertion task—arm movement, grip, insertion, release, etc.—is engineered to match the specific use case.

The use of a multifingered hand is, in one video, demonstrated by using the fourth finger to blindly push down the cable. But that (not really necessary) nicety goes at the cost of limited hardware robustness, and at a less dependable cable grip; both issues are key in industrial exploitation.

All in all, the result looks like a carefully crafted demo to obtain a video of what could be possible. In the life demo, it works depending on the initial position of the cable.

Exploitation and dissemination status

The dissemination of the results has been limited so far, only involving showing the video at the 2016 Automatica. This is not only not in line with the project proposal, but also a missed opportunity. Even when the system is engineered to get it working, the resulting video is nice and should be demonstrated. Also, a high-level article in, e.g., a regional or national manufacturing publication would have been nice to inform the general public about the theoretical possibilities of the project.

There have not been any scientific publications related to DexBuddy, nor are any planned. The latter is seen favourably, as the work done has so far limited scientific interest.

ArtiMinds continues their work in this direction with multiple direct use cases with Siemens, one of which they say is not confidential. That use case involves ``blind'' cable insertion in Siemens' mobility facility in Allach, and is somewhat related to—and likely inspired by—the DexBuddy project.

Use of resources

The reviewers have obtained no insight into the use of resources; the following is therefore based on the planned use of resources.

As many travels (e.g., RIF or conference trips) have not been taken place, we are confident that these will not be charged on the project budget. Also some of the hardware has not been bought (viz. 3 cameras).

The personnel planning at AEA and Shadow may have been somewhat optimistic. AEA's focus was on defining the use case, but the selected use case is one of the three suggested in the proposal. Furthermore, some aluminium fixtures were designed and milled. The budget of 6PM may be considered generous for that. The planned analyses (Task 4 and 5) have fallen short.

Apart from repairing the hand, Shadow's contribution was significantly redirected towards the unforeseen integration of the OptoForce sensors in the finger grips. For technical reasons not caused by the consortium, these do not work well enough but are still useful in the demo. The other planned tasks, focussing around exploitation and dissemination, have fallen short under the dissemination respect.

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