

Insight Computer Vision

“Teaching Computer Vision to Kids”

Report Name	Outline Project Specification
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Project description

The project is titled “Teaching Computer Vision to Kids”, with the end product running under the title “Insight Computer Vision”. The intent of the project is to create a digital learning environment for students to be introduced to a number of the key topics in computer vision. Due to the difficult nature of the topic, this is best-approached using interactive technologies, as detailed during a 2003 review of Computer Vision Education[1].

The project has two main paths of approach: a computationally complex side focused on computer vision, and a more abstract side detailing how to educate it.

This will be handled by producing a competitive lesson scheme with small games. The style of learning draws from popular educational tools such as Duolingo[2] and BBC Bitesize[3]: a student is given information to study, has some of the content enforced and reiterated through gamification of theories or practices, then finally completes a standardized test of all the content to measure knowledge retention.

The primary learning content will be taking theories from some of the key areas of computer vision: edge detection, background subtraction and feature tracking[4], with the framework for creating these leaving plenty of room for expansion into further topics in the future. The user will be given the opportunity to experience the technology as part of the lesson plan, allowing for a larger coverage of the “Creative Dimension” [5] for software and learning tool interaction when taking in to account the games and standard written content they will also be experiencing.

Proposed tasks

1. Prepare Equipment

Knowing that this service will be web based, one of the earliest tasks will be preparing web equipment. This can be broken down into progressively higher-level sections:

- Hardware: Choosing a server to run the project from
- Software: Choosing an Operating System, Database etcetera that will be able to support the needs of the system.
- Languages: As a web based project, there are a variety of languages that could be chosen. Considerations regarding the language will include whether it is executed client side or server side.
- Frameworks and Libraries: With complicated technologies, frameworks and libraries can make creation of projects significantly more efficient.

The preparation of the equipment must be completed prior to any work beginning, as limiting factors presented by any of the above sections are likely to present significant issues if they are not laid out early on.

2. Feature List Creation

This project will be approached using the Feature Driven Development (FDD) methodology. FDD has 5 main activities – Domain Object Modelling, Building a Feature List, Development planning, then the feature specific design & build by feature[6] - that will be followed for the project. The features will largely be discussed in the project deliverables.

2.1. Client Research And Communication

Although the features are available in the deliverables, they must be discussed with the possible clients in the form of teaching staff who may be interested in implementing the tool at their institution. The opportunity to actively involve school children in the testing of the project will require ethical clearance that must be arranged. As a Welsh based educational project, translation is also likely to be necessary.

3. Design Website

The first feature that will need to be created is the website. This will be hosted using the hardware and software proposed previously. The intention is to run a LAMP server on a Linux operating system. The application will be developed using a combination of PHP, JavaScript, HTML5 and CSS. To handle some of the more complex aspects of the website, the PHP framework CakePHP will be used to allow for such complicated tasks as authentication.

4. Create Lessons

Each lesson will contain written 'revision' information, which will be interjected with demos and image/video content where relevant. The demos will be best done using a JavaScript vision library. The choice of using JSFeat[7] allows the user to experience various image processing techniques in browser, while leaving some freedoms to the developer that are hidden away in other methods. The lessons should be created in such a way that each is specialised, but the overall structure could potentially be expanded in the future.

Project deliverables

1. A working version of the Insight Computer Vision educational website.
 - 1.1. A basic framework for producing a full topic set (revision, game, test).
 - 1.2. Revision content in the form of written text, interactive demos and videos for each topic area.
 - 1.3. Learning Games focused on a key area of the topic in *Deliverable 1.2*.
 - 1.4. Test based on the topic area in *Deliverable 1.2*.
 - 1.5. Results and ways of comparing results with other account holders.
2. A complete set of tests for the above site and all of its containing code.
 - 2.1. Behavioural tests for each feature.
 - 2.2. Functional test for lower levels of coding.
3. Full documentation detailing the planning, design, implementation and testing of this project.
 - 3.1. An included comparison of learning methods (e.g. test score comparisons between those who did not complete the game, game scores versus final test scores) as evidence for possible further studies in the area of how computer vision can be taught.

Initial annotated bibliography

- [1] G. Bebis, D. Egbert, and M. Shah, 'Review of computer vision education', *IEEE Trans. Educ.*, vol. 46, no. 1, pp. 2–21, 2003.

The recommendations of developing effective software tools, creating online computer vision repositories, developing interactive materials and introducing teaching innovation are all in line with the direction of this project. Given the nature of the IEEE, it is likely that there have been documents that act as a follow up to this one. A more recent source would not only be useful, but also help show trends that continue in the field.

- [2] 'How effective is Duolingo?', 2014. [Online]. Available: <https://www.duolingo.com/effectiveness-study>. [Accessed: 04-Feb-2015].

Duolingo is widely regarded as one of the best examples of gamification to encourage learning, and their evidence shows its effectiveness. Their practices are particularly relevant to this project following their recent expansion in to a full educational programme for schools (<https://schools.duolingo.com/>), a similar environment to this product. They will be a useful resource to draw influence from.

- [3] BBC, 'BBC - Bitesize', *Bitesize*, 2015. [Online]. Available: <http://www.bbc.co.uk/education>. [Accessed: 04-Feb-2015].

BBC Bitesize has recently had a revamp, but it is still sticking to the same structure it has had for many years; a large database of information with the structure "revision, activity, test" to be used to teach children from KS1 through to GCSE. Although this is younger than my target audience, it is one of the most used learning tools available, so its general structure is recommendable. However, the site has received criticism in the past, so any influence will be made with full critical evaluation.

- [4] R. Szeliski, *Computer vision: algorithms and applications*. Springer Science & Business Media, 2010.

Szeliski explains many of the areas of computer vision as an engineered approach and the issues that are faced when the algorithms are applied. The book has a comprehensive cover of many topic areas, and has the added benefit of explaining how to apply them. As a book published in 2010, the work is slightly out of date, but as computer vision evolves at a rate relatively slower than other fields of computing, this shouldn't be a major concern at this point.

- [5] K. Kahn, 'Helping children learn hard things: computer programming with familiar objects and activities', in *the design of children's technology*, 1998, pp. 223–241.

Although the topic of this paper focus on educating younger children on computing theory, the practise is the same and the conclusions give a reasonable test bed for future research. Given the age of the paper, one would hope the anecdotal evidence collected on the effectiveness of the methods now has some scientific evidence to support it.

- [6] S. Ambler, 'Feature Driven Development (FDD) and Agile Modeling', 2005. [Online]. Available: <http://agilemodeling.com/essays/fdd.htm>. [Accessed: 04-Feb-2015].

Scott Ambler (and his associates) advises multiple organisations on how to apply agile methodologies and lean processes to their business, and are experts in the field. Therefore, their knowledge of the field should be considered one of the best available resources when searching for information in the field.

- [7] E. Zatepyakin, 'JSFeat - JavaScript Computer Vision Library.', 03-Sep-2014. [Online]. Available: <http://inspirit.github.io/jsfeat/>. [Accessed: 05-Feb-2015].

JSFeat has been designed to implement the basic techniques of image processing in to a browser using JavaScript and WebRTC, an open framework for audio-visual components in applications. JSFeat has been in use for a couple of years, so provides more documentation than comparable projects.