Embedding formative assessment features into LabView interfaces

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***Abstract*— Virtual instruments (VI), namely those designed using LabView, are increasingly used to enable access to remote instruments over the web. In an academic context, such VIs may be used to build a remote workbench that enables the students to carry out a laboratory task from their homes. Remote workbenches, or simulation environments, are not meant to replace real labs, but rather to complement them. They enable the students to continue their work in the lab, even after leaving the university campus. In most cases, a remote workbench constitutes a replica of what the student sees in a real workbench. However, VI interfaces may be designed to provide a much richer educational experience, namely by embedding formative assessment features, as described in this work-in-progress paper.**

***Index Terms*— e-learning, formative assessment, online labs, LabView.**

I. INTRODUCTION

The objective of this work is to design embedded assessment features into common VIs, used to build remote workbenches in academic contexts. An embedded assessment feature may be seen as a VI extension that captures and stores formative assessment information, describing how a student handles an instrument. This information will be made available to the student and to its teacher, and may be used to identify areas where the student skills / knowledge need to be improved.

The picture below illustrates a remote workbench that was developed to support laboratory assignments in digital / analogue electronics. This remote workbench comprises an oscilloscope, a waveform generator, and a multimeter, besides live images from the lab.

Figure 1. A remote workbench supporting basic electronics experiments

The students running an experiment will have to adjust the waveform generator and the oscilloscope. If this was done in a real lab, with a tutor nearby, he/she would be able to assess if the student knew how to handle these instruments, just by watching how the student carried out this first step. The objective of this work is to study how far the same conclusion can be derived by automatically monitoring how the student handles the VIs.

II. REFERENCE MODEL

The PTSE lab at FEUP already uses various VIs that are used to design remote experiments in electronics. All such VIs were developed using LabView. The proposed approach consists of analysing the LabView scripts for such VIs and devising ways to identify and capture the relevant embedded assessment information. In the initial phase of this work, a simple VI representing a basic instrument (e.g. a voltmeter) was used to look for an appropriate development model and its implementation strategy.

Only a few student actions are relevant from the assessment point of view. One of the first questions to be considered was therefore how to identify what actions should be logged into the assessment report. On the other hand, a given action may or may not be relevant, depending on the operating conditions at that moment, and on what the student may be trying to achieve. The rules that identify when a given action is relevant for assessment purposes are therefore dynamic and must be continuously updated as the experiment progresses.

Let's consider the example of an oscilloscope VI where one channel is being used to observe a given input signal. The V/div and time base buttons define the display conditions, and need to be adjusted by the student in accordance with the amplitude and frequency of the input signal. A 5 V / 1 KHz sine wave may be visualised by adjusting the display channel to 2 V/div and the time base to 100 μs/div, although there are other settings that might as well be selected in this case (e.g. the same V/div scale and a 50 μs/div time base, or any other neighbouring amplitude and time base scales).

The acceptable ranges for V/div and time base settings are therefore dependent on the input signal, and may be represented as shown in figure 2, where each range is defined by a lower and a higher limit, defining a dotted area that represents the success space. Notice that the success space may be n-dimensional in more complex examples, or uni-dimensional in very simple cases (such as the voltmeter VI referred above).

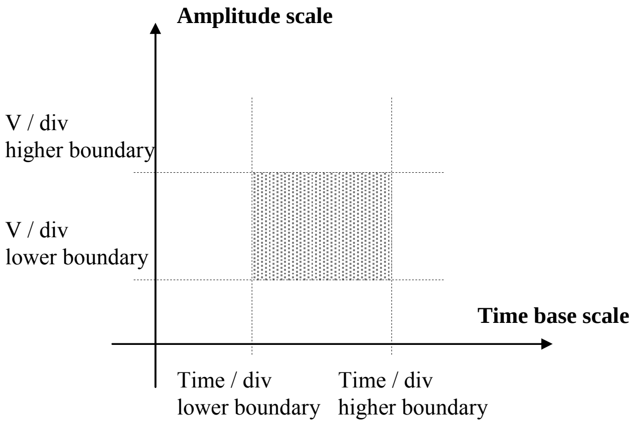

Figure 2. Generic representation of a possible success space

An assessment event is triggered when the students are asked to calibrate the oscilloscope channel. Reaching the success space (and staying there) in less than 20% of the time available or taking more than 100% of that time to get there, will generate formative assessment information, which will be added to the assessment report. Any event that adds information to the assessment report is a valid assessment event. When the student reaches the goal of the assessment event within 20%-100% of the time available, no assessment information is produced. If the student is asked to calibrate the display channel but is not able to select V/div and time base scales within a given time period, this may mean that his/her skills need to be improved. On the other hand, if they reach their goal very quickly (e.g. in less than 20% of the time available), then this may be indicative of a very good student. In both cases, the assessment event should produce assessment information. The actions performed by the students (i.e. any intermediate settings selected while trying to calibrate the oscilloscope) during a valid assessment event shall also be recorded in the assessment report.

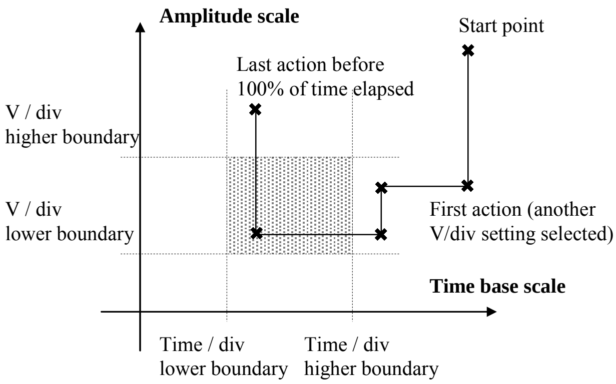

Figure 3. Failing to reach a successful outcome

The example on figure 3 illustrates a case where the student fails to achieve the goal of calibrating the oscilloscope channel, within the time available to do so. Notice that this conclusion is questionable, since he/she reached the success space in time, and might just have modified the V/div scale to show something to a colleague. However, and since many assessment events will be triggered as the experiment progresses, improbable situations as the one just described are not expected to be statistically meaningful.

III. Technical Implementation

The cases considered in the previous paragraphs indicate the need to develop embedded assessment reference models, able to provide an abstract representation of the required assessment features. Such reference models will be specific of each VI, describing their own n-dimensional success spaces, indicating what (dynamic) information determines the success space boundaries, the time period associated with each assessment event, the information to be added to the assessment report in case of a valid instance, etc.

Once a reference model that describes the embedded assessment features of a given VI is ready, it is possible to start its technical implementation. Since the VIs that are available at the PTSE lab were built using LabView, the requested embedded assessment features is best done in the form of a LabView VI assessment extension. Assessment extensions should be developed in modular form, meaning that each VI may exist with or without them. Embedded assessment extensions are not necessarily visible at the VI interface level, but the student should always be aware of their presence.

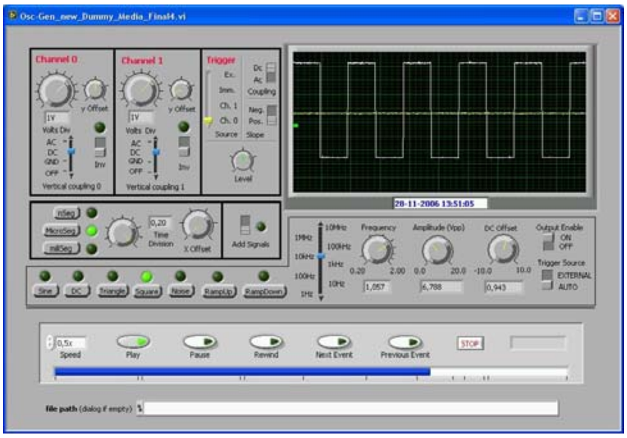

Figure 4. A VI and its assessment extension

Our first implementation goal consisted of recording all student actions and marking all student-driven events, as shown in figure 4. The assessment extension adds a control panel at the original VI button, enabling the tutor to identify those moments in time where meaningful events may be located. The tutor is able to replay at normal speed the whole experiment, or to fast forward at various speeds. He/she may also jump directly to the moment where a given event is marked.

IV. Conclusion

The current implementation is able to record all student actions and to identify the possible meaningful moments for assessment purposes, but is still missing the automatic assessment features. The final prototype will be able to help tutors and students to obtain formative assessment information, which can be used to identify any areas where further training is required. Notice that recording student actions may raise ethical issues which have to be discussed beforehand and the students must be aware of its presence. In particular, it is important to ensure that all students are aware of the embedded assessment features and in agreement with their use.

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