Final Report

SportsPA

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Date: **18/04/2018**

Abstract

The purpose of this final report is to give an overall view of the project. It will outline the requirements and if those requirements were fulfilled. It will also detail any problems encountered and how they were overcome. The document will be a final synopsis of the overall project.

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1. Introduction

This final report describes the final product of my Software Development final year project at IT Carlow. It will outline how the overall project progressed. It will outline both where the original idea came from and also the requirements.

A description of how the application works will provide details of each page/screen of the final product. It will show how the user can select what files to be used in their analysis. The process of doing the actual analysis, i.e selecting events, and how the results are produced will be given.

An administrator has the ability to upload files which the user will use for analysis. In order to do this, the administrator needs to login. This process will also be explained.

A chapter on Conformance to Specification and Design will outline any variances, if any, to provided specifications. Any design changes introduced will also be explained.

There are 2 learning outcomes which I experienced throughout the lifecycle of this project. They are both personal and technical learning outcomes. I believe they are both of equal importance and I will outline how both have been achieved.

A review of the project will be given, whereby I will explain things that went both right and wrong with the project. Most things went right but, as in any project, there were things that went wrong. The problems I encountered were important for 2 reasons. One is that it made me realise, that regardless of how much planning you do, not everything turns out as might be expected. The second is that it gave the realisation, that by coming across these problems as early as possible, they had less effect on the outcome of the project.

All the requirements specified throughout the project were met. However, there were some things that, given more time, I would liked to have implemented. I believe these would have improved the product and will be outlined.

There are not many approaches I would have taken differently, but this document will include these and any advice I would give to those undertaking such a project.

Finally there are some people, who were an enormous help to me throughout the project. I believe it is very important to acknowledge the role they have played.

2. Project Description

SportsPA is an application which will be used to parse certain XML files into a more user friendly visualization for use in Sports Performance Analysis. The application is the outcome of a specific identified need for such an application at IT Carlow.

My original project idea involved designing and building a mobile application titled 'Sports Team Management Application'. The details of this original idea, and this project's path from the original idea to the end product, can be viewed in the Research Document. As part of my original research, I was in regular contact with Johnny Bradley, a lecturer in Sports Performance Analysis at IT Carlow.

It was at a meeting with Johnny that he identified a genuine need within his department for software which is the result of this project.

2.1 Application Requirements

The Sports Performance Analysis course at IT Carlow currently use third party software to record and analyse statistics. This software is provided by SportsCode, who provide products at different price ranges, with the dearest product priced at approximately €6,000 per annum The SportsCode software used in IT Carlow has a price of approximately €1,700. It allows the user to record coded events from a video of any type of sports. The user first of all codes an event. This is achieved by simply creating an event, such as 'IRL Poss'. This event is actually a button on the users device. This event could then be recorded, everytime team Ireland gain possession, by clicking the button attached to that code. When the user clicks the button it starts recording that event. When the event is finished the user clicks that same button again. This produces a start and end time for the coded event. The software allows for recording the match from video or live.. The final results of using this software is the recorded video and an XML file, as shown in Figure 2.1.1 and Figure 2.2.2. The XML code shown in these figures is from the sample file I used while completing this Project, however the application is designed to work with any XML file, using the same tags.

As can be seen in Figure 2.1.1 and Figure 2.1.2, the results provided by the SportsCode software used at IT Carlow is not very user friendly. To get more user friendly results would need a big investment in upgrading to the more expensive version of the SportsCode software. This investment of approx €6.000/per annum is very cost prohibitive.

Therefore there was a real need for an application to parse the resulting XML file into a more user friendly product. The requirements for this end product would be provided by Johnny Bradley, as the project progresses.

```
1      <file>
2          <ALL_INSTANCES>
3              <instance...>
9      <instance>
10         <ID>2</ID>
11         <start>538.3944231740</start>
12         <end>540.3944231740</end>
13         <code>Match Start/Stop</code>
14     </instance>
15     <instance>
16         <ID>3</ID>
17         <start>541.5550327760</start>
18         <end>560.9146562810</end>
19         <code>IRE Poss</code>
20     </instance>
21     <instance>
22         <ID>4</ID>
23         <start>552.5566347640</start>
24         <end>568.1148758920</end>
25         <code>NZL CP</code>
26     </instance>
27     <instance>
28         <ID>5</ID>
29         <start>552.9146562810</start>
30         <end>570.9146562810</end>
31         <code>IRE Turnover</code>
32     </instance>
```

Figure 2.1.1

```
3990   <row>
3991       <code>NZL Press</code>
3992       <R>0</R>
3993       <G>0</G>
3994       <B>0</B>
3995   </row>
3996   <row>
3997       <code>NZL PS</code>
3998       <R>0</R>
3999       <G>0</G>
4000       <B>0</B>
4001   </row>
4002   <row>
4003       <code>NZL Turnover</code>
4004       <R>0</R>
4005       <G>0</G>
4006       <B>0</B>
4007   </row>
4008   <row>
4009       <code>#ERROR</code>
4010       <R>26214</R>
4011       <G>5397</G>
4012       <B>0</B>
4013   </row>
4014   </ROWS>
4015   </file>
4016
```

Figure 2.1.2

2.2 Application Description

This section will describe the finished product. It will detail any changes and additions that were made throughout the project.

2.2.1 Home page

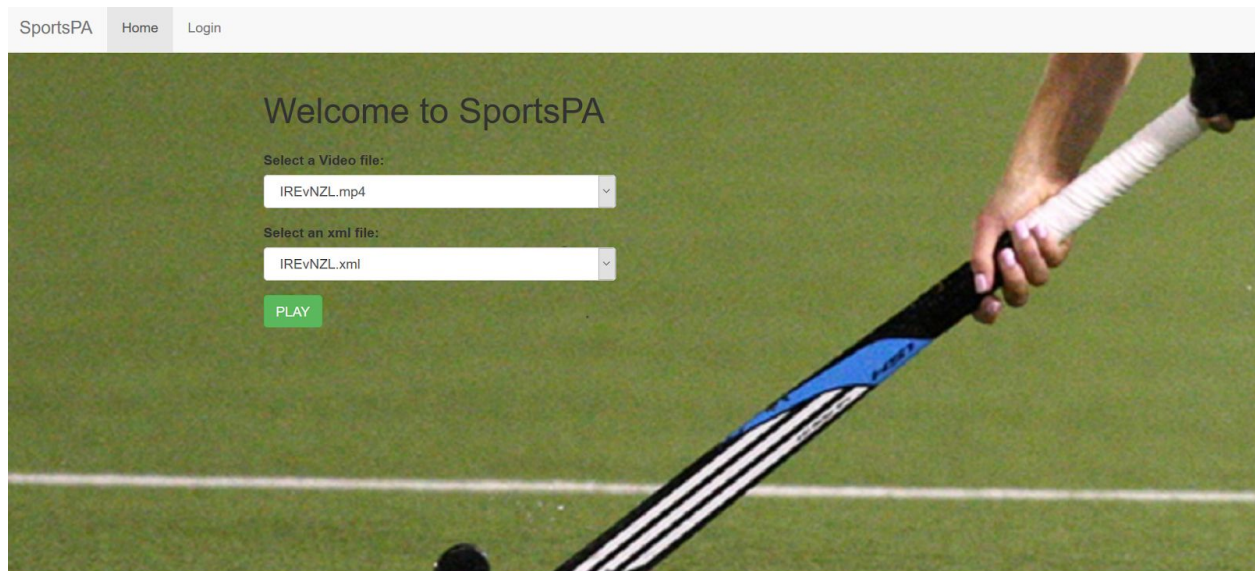When the user opens up the application the Home page, as seen in Figure 2.2.1, will be displayed.

Figure 2.2.1.

The ordinary user, the Student, does not need to login in order to do analysis. They will be given 2 dropdown boxes. The first dropdown box will allow the user to select the video, from a list of previously uploaded videos, to be analysed. The second dropdown displays a list of the uploaded xml files, from which the user can select one. After selecting the video and xml file combination, the user then hits play and will be forwarded to the Play page.

Another option on the Home page is a tab which brings you to the Login page. This login is for the administrator only, and on successful login will be able to upload mp4 and video files.

2.2.2 Analysis page

After a user selects a video and xml file, SportsPA will then read the xml file, parse the data and produce a plot of all the recorded events relating to that file. The associated video will also be displayed, as can be seen in Figure 2.2.2.1
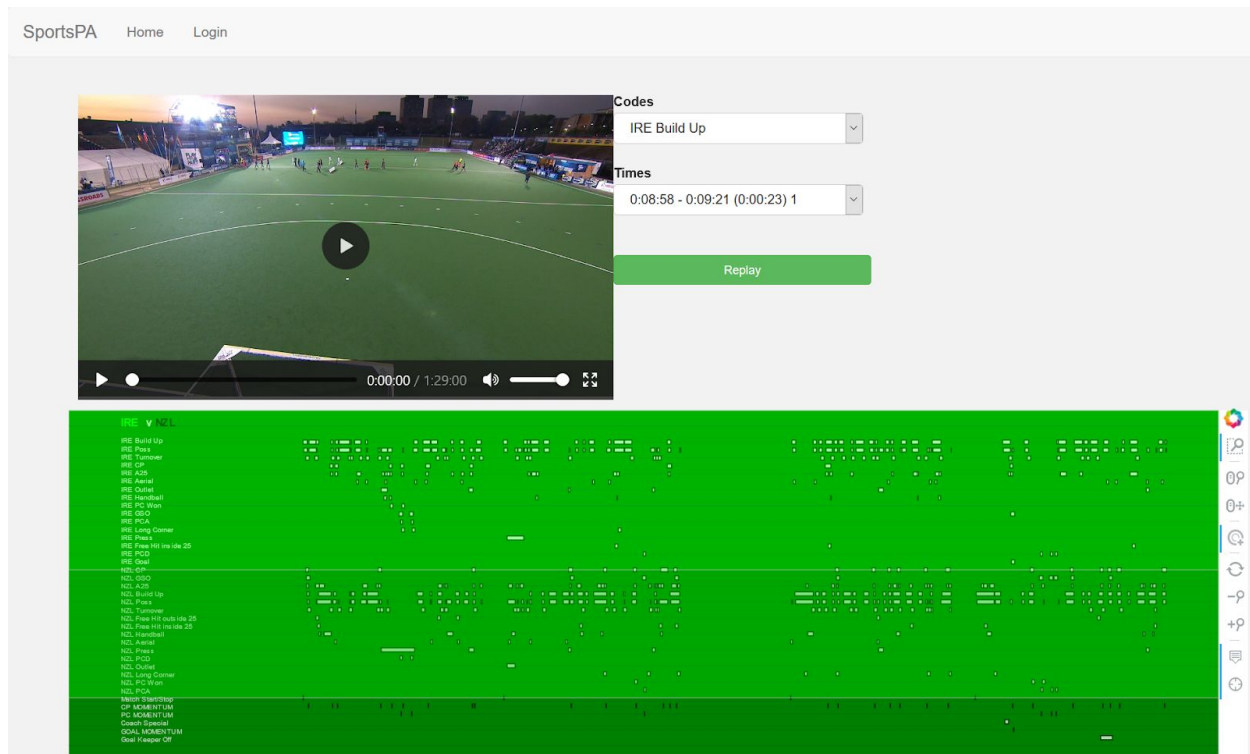

Figure 2.2.2.1.

This page contains the selected video on the top left hand corner. Below the video the plot contains all the recorded events that happened in that match. The events are stored on the y-axis and have been ordered per team. The plot background is also colour coded per team. The third colour coded background represents any event that is neutral to either team. The x-axis represents the match timeline. Each bar on the graph represents one recorded event. The left side of the bar is the start time, with the end of the bar being the end time. When the user clicks on a bar on the plot, the associated video segment will be played from the start time of that recorded event until the end time.

2.2.2.1 Tools

The plot also contains some tools along the right hand side which can be turned off or on. One of these tools is a tooltip, as can be seen in Figure 2.2.2.1.1, which will display details of that particular event, including name, number of that event, start time, end time and duration.
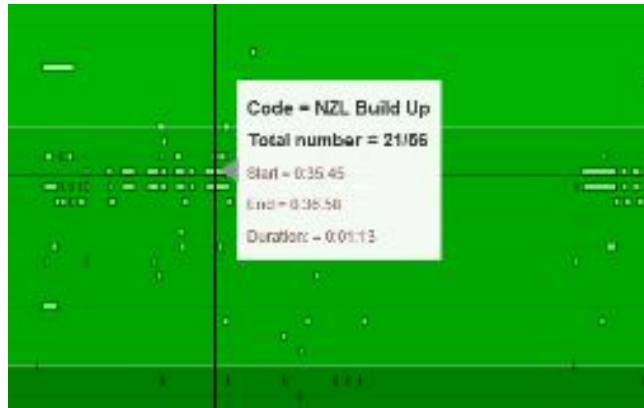
Figure 2.2.2.1.1.

The next tool available is a crosshair. This can make it a lot easier to locate some of the smaller plot bars. The crosshair can also be seen in Figure 2.2.2.1.1.

Zoom in and Zoom out buttons are shown in Figure 2.2.2.1.2, which works by repeatedly clicking on the tool. A wheel zoom exists whereby the user can point the mouse over a section and then use the wheel to zoom into that area. The box select tool allows the user to select an area of the plot which will automatically be selected when selected.
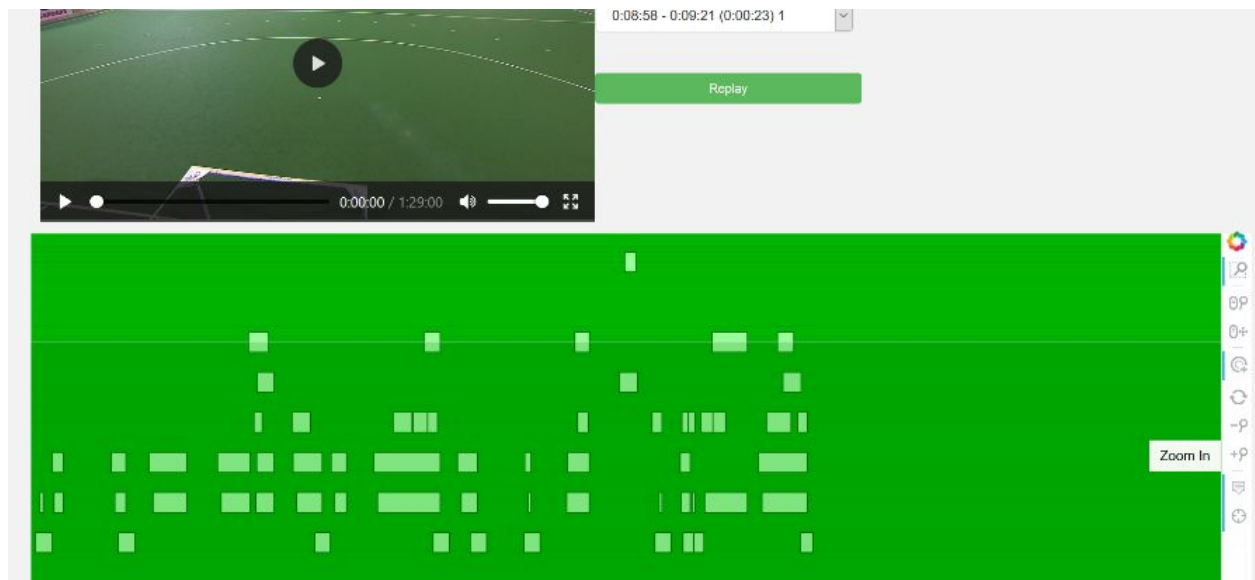

Figure 2.2.2.1.2

A reset tool, when clicked, will return the plot to its original state. The most important tool is the tap tool. When activated, this tool allows the user click on a bar to play a section of the video. The video will start playing from the start time associated with that bar and end at the associated time. This is where the user will do their analysis.

2.2.2.2 Widgets

There exists, beside the video 2 dropdown boxes and a replay button. These were not contained in the requirements and are additions that we added. The premise for adding these additions was to increase usability and improve user experience. Sometimes it can be hard to locate some of the bars in the graph, particularly for a short event, and the dropdowns are another alternative. This addition was very much welcomed by Johnny when presented.

The first dropdown box contains a list of all the recorded events taken from the xml file, as seen in Figure 2.2.2.2.1.
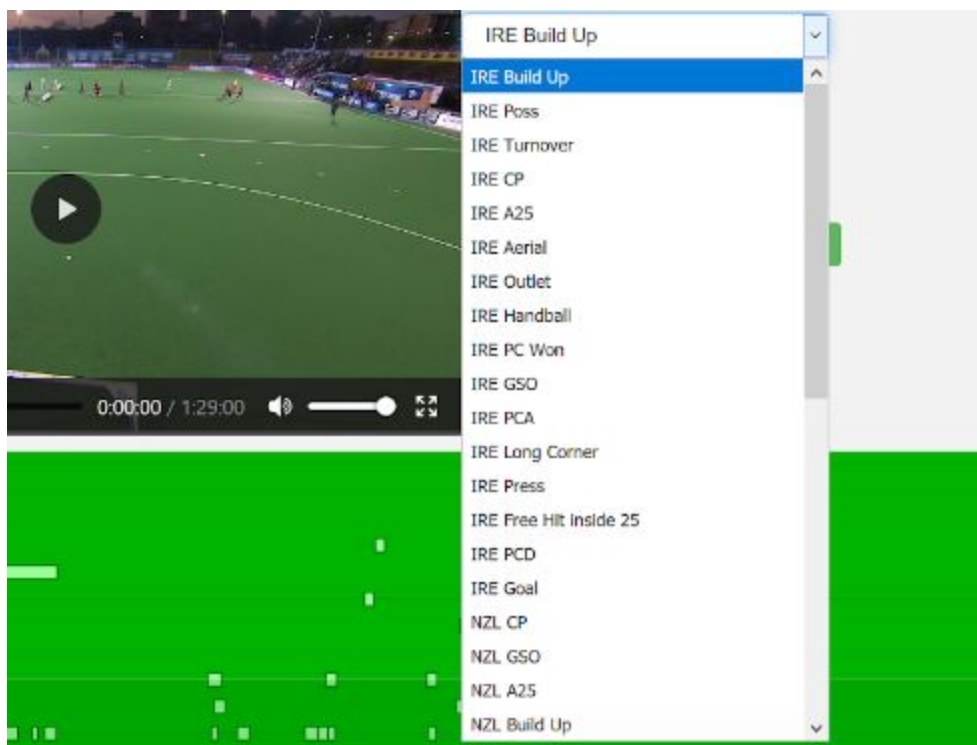

Figure 2.2.2.2.1.

The second dropdown contains the times of the events. It will originally contain only the times, in chronological, of the first event in the 'Codes' dropdown. The user will be first able to select a code, from the 'Codes' dropdown, that he/she wishes to analyse. On selection of the code the 'Times' dropdown will be automatically updated to the times associated with that coded event.

Figure 2.2.2.2.2 shows the 'Times' dropdown updated when 'IRE Long Corner', was selected from the 'Codes' dropdown.

Figure 2.2.2.2.2

The 'Times' dropdown displays the Start Time, the End Time, the Duration and the number of that code in relation to the total amount of that code in the overall file. As can be seen, there were only 3 of these 'IRE Long Corner' events recorded.

A user can now select a time and the associated video section for that event will be played.

A replay button has also been included as an addition. This makes it easier for the user to replay an event just played, instead of having to locate the same event again. During analysis something might be missed by the observer, or something important might need to be viewed again. Again, when presented to Johnny he was very happy with the addition.

2.2.2.3 Information Displayed

The xml file produced for analysis by SportsPA will sometimes contain extra information in a tag called labels. This information will be seen, on selection of an event either from the plot or dropdown, in the top right of the screen. As well as the information from the associated label, other information described, as detailed earlier, will also be displayed here. An example is shown in Figure 2.2.2.3.1.

Figure 2.2.2.3.1.

2.2.3 Upload page

When an administrator, such as Johnny Bradley, logins in he/she will be taken to the upload page. This will give them the opportunity to upload xml and video files. This page can be seen in Figure 2.3.1.

Figure 2.3.1

The admin will be able to browse through their PC to locate mp4 and xml files to upload. These file types will be the only types shown when browsing, to ensure no other file types can be uploaded. The admin can upload multiple files at the same time on clicking upload.

These uploaded and stored files will then be available to the student in the dropdowns on the home page for analysis.

2.2.4 Delete page

Having successfully logged in, an administrator will be forwarded to the upload page. Here he/she will have to option to go to the delete page via a 'delete' tab. On clicking the tab the administrator will be presented with the page displayed in Figure 2.2.4.1.
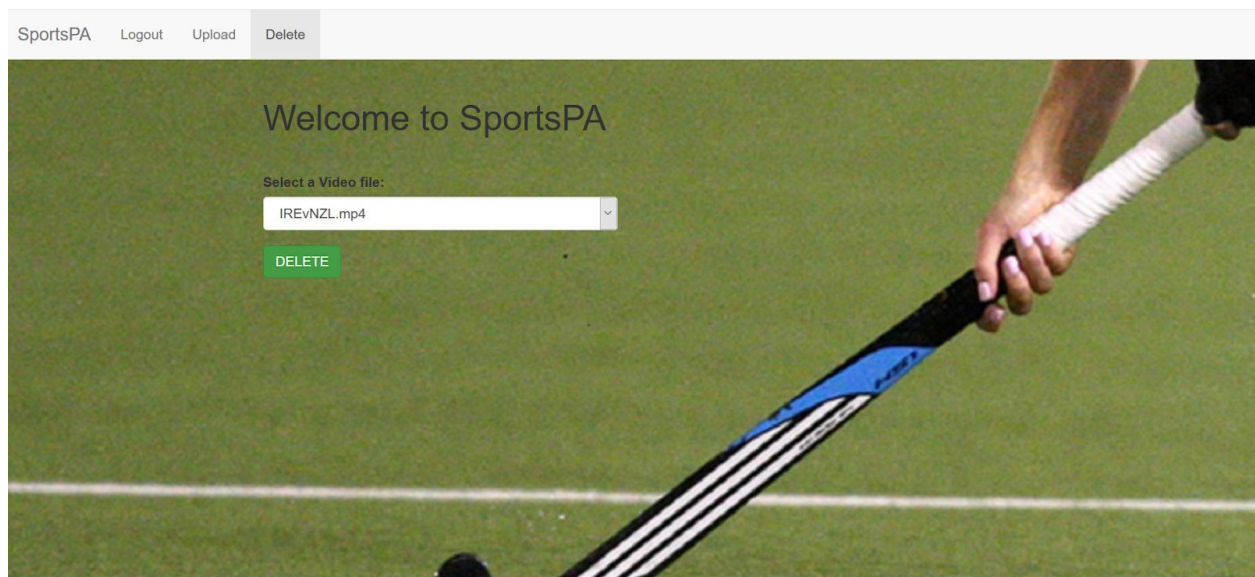
Figure 2.2.4.1

As can be seen in Figure 2.2.4.1, a dropdown box will display all the .mp4 and .xml files available for deletion. The administrator then selects a file for deletion and clicks the 'DELETE' button. If the deletion was successful the administrator will be informed as can be seen in Figure 2.2.4.2.

Figure 2.2.4.2

If the deletion was unsuccessful, the user will also be informed of this , as can be seen in Figure 2.2.4.3.

Figure 2.2.4.3

The administrator can then select another file for deletion, go to the upload page or logout of the system, which will bring him/her back to the home page.

2.2.5 Hosting

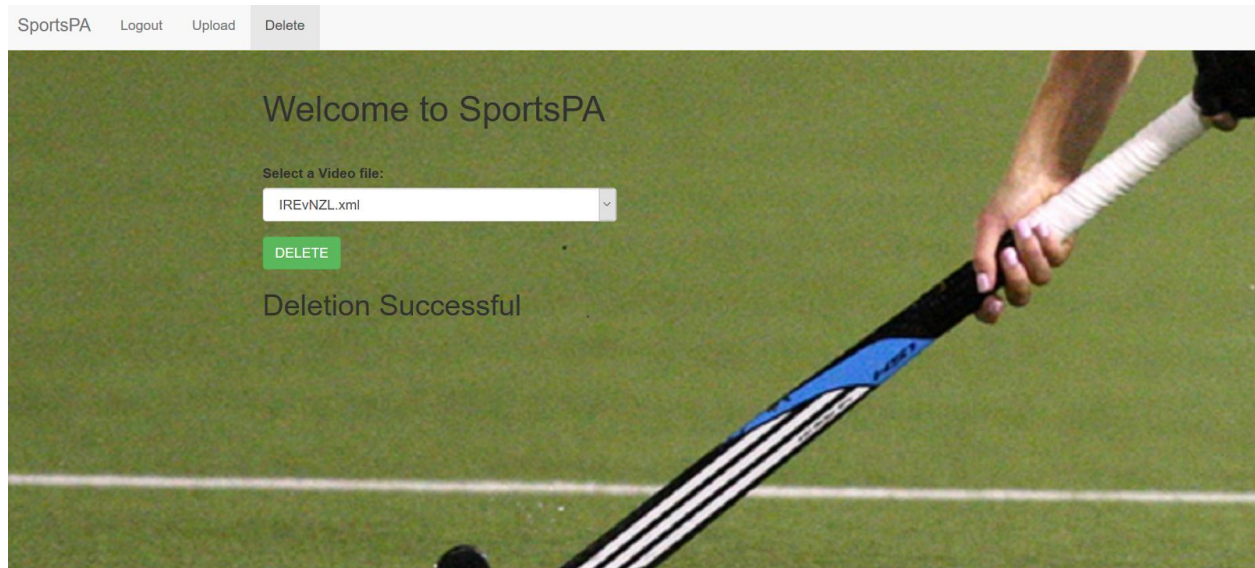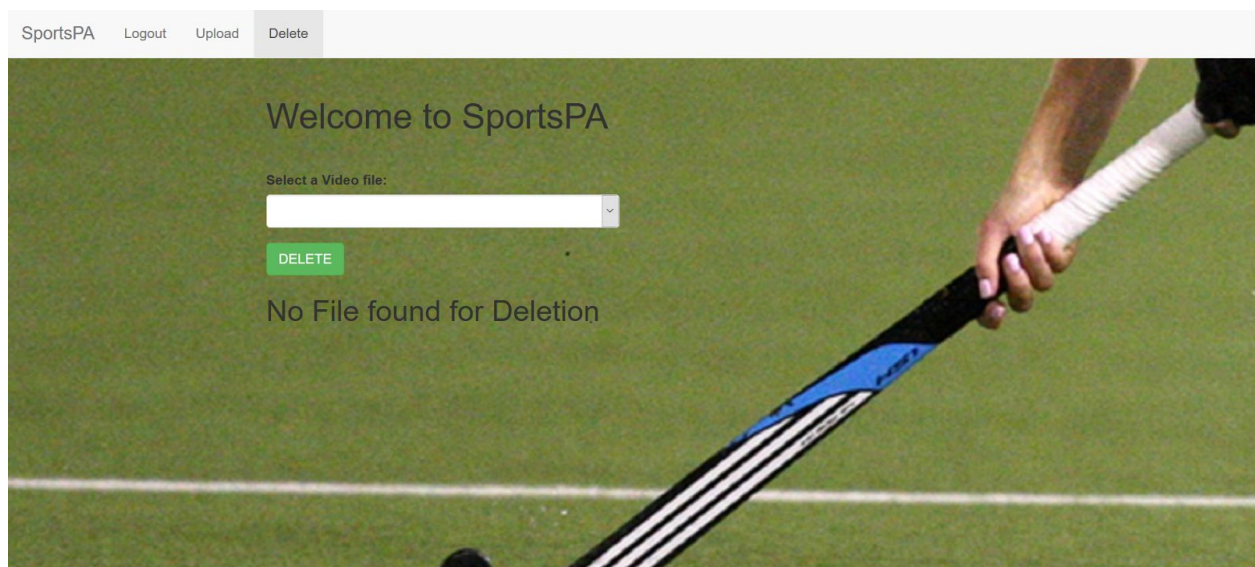SportsPA has been deployed to Glasnost at http://sportsvideo.itcarlow.ie . Having worked as expected on localhost it was anticipated that there would be no issues when deploying to Glasnost. However this did not prove to be the case.

There was only one issue, though a major one which could not be solved due to how late it occurred in the project. This is outlined in chapter 5.5.2 Deployment.

As stated, deployment to Glasnost was not a requirement of this project. It was another extra benefit we had hoped to implement. Therefore, we do not see it as a failure on our behalf to deploy it. The original requirement was, given a video and xml file, to provide a tool for students to analyse videos. This was achieved.

3. Conformance to Specification and Design

The project has conformed to all of the specifications that were stated in both the functional specifications and the design documents. Specifications were added and altered throughout the lifecycle of the project and conformance was met on all of these.

As well as specifications being added, I proposed and delivered other specifications and functionality which I believed would benefit the final product. One of these was not successful, and was unable to be resolved due to time constraints. This is outlined in detail in chapter 5.5.2 Deployment.

4. Learning Outcomes

This chapter will outline the learning outcomes I have achieved while undertaking this project. They have been divided into 2 sections, namely Personal and Technical.

4.1 Personal

This has been the largest project I have undertaken to date, either inside college or outside. Having thought long and hard during the summer prior to 4th year on what I would like to do regarding the project, I decided it had to be something I would enjoy doing. I have always, and still do, have a love of sport. During the summer break before entering 3rd year, I undertook to build my first mobile app. This was related to sport and I got enjoyment and great sense of achievement from successfully completing it. Therefore it made sense to me to do something similar but on a much larger scale. As part of my research for my initial idea, I came into contact with Johnny Bradley, a lecturer in Sports Performance analysis at IT Carlow. Johnny identified a requirement in the college which gave birth to SportsPA.

Having done a lot of Research on my initial idea, I had to put it all to one side and start again with the new requirement about 4 weeks into the project. This threw me a little but I knew it was still very early in the project and it was my first experience, but not the last, of how such things can occur.

I came across numerous issues during the lifetime of this project. Most of them involved Bokeh, whose support is outdated. Bokeh is a new technology which is evolving at a fast pace but unfortunately the documentation is not keeping up. Anything I wished to achieve using bokeh I looked up online, where i found support. However a lot of the time when I implemented the suggested solutions they did not work. This was very frustrating at times but I persevered in finding the solution myself. This gave me a greater sense of satisfaction. I discovered I had a greater resolve than I initially thought when it seemed at first there was no way out.

I also found it improved my ability to manage time. I had weekly meetings with my supervisor, Paul Barry and this was a great help in this regard. As the nature of this project was very fluid, in that requirements were being added or changed regularly, different options were tried and presented to Johnny for approval. Therefore I had regular meetings with Johnny also. This meant I had to manage my time well to ensure I had something to present to Johnny at these meetings.

4.1 Technical

The main language used in this project was Python. I was familiar with Python from year 3 and that experience proved very beneficial. However I did have to become very familiar with some of its libraries not experienced before.

ElementTree was used to parse the xml file into a suitable format of python lists, dictionaries and sets. The learning curve for this was not that big and did not prove an issue.

The Python Bokeh visualization library was used to implement the plot for the recorded events. This took a lot more time and proved very difficult at times. Bokeh is a fairly new, but very interesting tool which is being updated regularly. As stated previously, the supporting documentation and online support is not keeping pace with the library itself. However, despite this major drawback I encountered, I believe it was well worth learning and is something that will be used a lot more in the future due to its real-time interactive nature.

Javascript was also used as callback functions in Bokeh. Although having some experience in JavaScript, I had never used it to code CustomJS callbacks within Python Code.

During the project I learned the importance of well commented code. The requirements in the project changed quite often, meaning code also had to change. This would have been made far more difficult had I not commented my code.

Having completed the project as per the requirements, we decided to deploy it to Glasnost. This was the last thing that was planned in Iteration 3. Withe the project working as required on localhost I presumed deploying it to Glasnost should not cause any major issues. This presumption was wrong on my behalf. The very large size of the mp4 files would not allow them to load from the server. This showed me both that major issues can arise at any stage and that though an application may run locally, deployment to a server can cause issues.

5. Review of Project

Having completed all the requirements on time, I was very happy with the outcome of my SportsPA project. It had its ups and downs but overall it was a very enjoyable experience. The fact that there was a real client, who had a genuine need for the project, made it all the more interesting for me. I met the client Johnny Bradley very regularly and his feedback each time was very helpful. I made suggestions on occasion on how things could be improved and Johnny was always open to suggestion and found most of them to be very beneficial.

5.1 Things that went right

There were many things that went right about the project. A lot of the code in the project involved parsing the data into different lists, dictionaries and sets. These would then be used in generating the plot. The most of this was done at the start of the first iteration. However, as requirements were changed or added, further lists had to be created. There was a lot of logic involved in arranging these different lists in the correct order to achieve what was required. I found this enjoyable and rewarding as logic is something I would consider as one of my strong points.

Learning Bokeh in order to provide the plot was interesting but challenging at times. The challenges came from the lack of updated supporting documentation. However I stuck with it and that proved very worthwhile. When I first produced a plot of the events I was very thrilled with the outcome. The requirement provided by Johnny stated that he wanted a plot just like the one provided by the sportsCode software. I got a great sense of achievement in being able to do this.

The next thing that I was apprehensive about was the ability to be able to play a segment of the associated video by clicking on a bar of the plot. I remember discussing this with my supervisor Paul Barry and wondering how was this going to be achieved. After some hard work and a lot of experimentation it was achieved and proved to be the second big milestone in the project.

5.2 Problems Encountered.

This will describe the issues and problems I encountered during the lifecycle of the SportsPA project. They are broken down into two sections. The first describes issues with the dropdown boxes. Although this was solved, it did take up quite a bit of time. The second includes problems encountered when deploying to Glasnost. However, this was not a specification that was provided but something I had hoped to achieve.

5.2.1 Dropdown Boxes

One of the major issues I had was when creating the dropdowns for the coded events and the times. This may seem a very trivial issue but it is one that caused a lot of time to be spent on it. It was an extra functionality that was proposed to Johnny in order to improve the user experience. The idea was to have one dropdown which would allow the user to select an event. On selecting an event, the second dropdown would update with the times associated with that event.

I created the dropdowns using widgets in Bokeh. I coded it in a separate file so that I could experiment with it without the chance of it affecting the rest of the code. In order to update the

second dropdown, the use of Bokeh Server was needed. I successfully got this working in my separate file and plugged it into my code. However, when I tried to play the video using Bokeh Server it was not compatible and would not play. I sought a solution but ended up having abandon using python to update the dropdown.

My second approach was to update the dropdown using JavaScript on the client side bu using the Document Object Model (DOM). I achieved this but when finished noticed that after the second dropdown was updated, selecting a time would cause the times to refresh to the initial default values. It was as if the browser was refreshing each time. Again I spent some time finding a solution.

After much research, I discovered I could still update the dropdown using JavaScript but without manipulating the DOM. This was done using some python code to pass into a CustomJS callback.

This solution worked perfectly, but not after spent a lot of time arriving at it.

5.2.2 Deployment

Before deployment SportsPA was tested on localhost and any issues were fixed. When deploying to Glasnost a few issues arose. The first issue was the use of Python Literal String Interpolation, or f-strings as they're better known, in my code. F-strings were introduced in Python 3.6 and therefore the server had to be updated to support. This was not a major issue.

The next issue was the size of the mp4 files being produced by the Sports Analysis Department. Theses files are, on average, about 4 GB in size and have caused major issues, in so far as it can't handle them. This problem arose very late in the project, giving very little time to come up with a solution.
One solution that could have been pursued would be to split the video into segments. The segment sizes would match the size of each corresponding event that was recorded. So if there were 650 recorded events, then the file would be broken into 628 smaller files. Then, when the user selects a segment to analyse, either through the plot or the dropdowns, the relevant file would be loaded.

Another solution would be do break down the file into two halves ie 1 before half-time and 1 after half-time. This would seem to be a simpler solution. However as the files would still be about 2GB in size, it is not known if the file size would still cause an issue. Investigations into this could have been carried out had it not occurred so late in the project.

5.3 Things that are left to do

All the requirements as specified by Johnny have been fulfilled. However there are a few additional things that I had hoped to achieve.

The first entails how the details, including the labels are displayed. I would have liked to put the details into a table. This was not of major importance and so was left to the end. However time became an issue at that stage.

The major thing that I wish I had time to achieve was to sort out the video size issue when deploying to Glasnost. The application has been deployed but the video will not load. Smaller videos will load no problem but videos with a size of 4GB will not load. This was discovered at the end of the last iteration and left no time to find a solution. I had several ideas in mind to solve this, such as splitting the video. However time did not allow it. As stated previously, this was an extra functionality that I would have liked to produce but did not form a part of the requirements supplied by Johnny.

5.4 Different approaches I would have taken.

The only approach I would have taken differently is my approach when initially parsing the xml file. As the project was very fluid in its nature, in that requirements were being supplied while the project was growing, I was unsure what format I would need the data in. I knew from the start that the plot of the events was a major requirement but again did not know what the data format should be. Therefore when parsing the data in my first iteration, I created different lists, sets and dictionaries, in the hope that they would cover all my future needs. However, as the project progressed, and I gained further knowledge on what data was needed, I was constantly having to put the data into different lists.

If I was to do the project again I would just do what was required at each iteration, rather than trying to predict what might be needed at a later stage.

That is the only approach I would have taken differently. Although I had some issues throughout the project, such as with the dropdowns I wouldn't have taken a different approach, having the same knowledge I had then.

5.5 Technology choices.

The major technology choice I had to make was what visualization library to use to produce the plot representing the recorded events. My initial project involved recording match statistics live as they happen on one device. This would then update, in real time, statistics on another device

whereby a coach could quickly make decisions. Having researched different libraries, it seemed Python Bokeh was definitely the right library to use in order to achieve this requirement. Bokeh is a relatively new library particularly suited to real time visualizations.

My project idea then changed into SportsPA. I spent some time discussing the requirements with Johnny Bradley. Mostly they were very general, with an agreement that more would be provided as the project progressed. Since visualization was still a major part of the project I decided to stick with Bokeh. One reason for this were that I was unsure if real time visualizations would become a part of the project. Another, and probably the main reason, was because its a fairly new technology and it would give me the opportunity to upskill in something that was only starting to grow in popularity.

Using Bokeh throughout the project caused me issues at various times. This was purely due to the supporting documentation not keeping pace with the changes being made. It would not be uncommon for such updates but I feel the documentation could be better. A lot of the issues I came across were solved by just trial and error.

Having described the issues I had, I would still use Bokeh if I were to start the project again. It is a very powerful library and can achieve very interesting results. I gained a good knowledge in its use and would feel comfortable in using it again. It is also something I can put on my CV, which at this stage will not be on many.

5.6 Advice I would give

Having successfully completed this final year project, there are just a few words of advice I would like to share with anyone undertaking a similar project.

The first is to select an area or topic you are interested in. There will be a lot of time spent on the project throughout the year, so it is vital it is something you will enjoy doing. Anytime I started on an iteration of the project I found it hard to leave it down to do something else, as it was something I was very interested in and enjoyed the challenges it provided.

The second is not to be afraid to go outside your comfort zone and learn and try new things. Some might seem daunting at first but will be well worth it in the end. This will be made all the more easier if you have chosen a project you are interested in.

The final words of advice is to stick to the iteration plan. I started to panic at times thinking I would not have enough time to do everything. If the plan has been worked out properly then it will all fall into place at the right times. Problems will inadvertently occur, but with some hard work and good support they will be resolved.

6 Acknowledgements

It would be remiss of me not to acknowledge the enormous support I got while undertaking this project.

The first person I would like to acknowledge and thank is my supervisor Paul Barry. From the very outset Paul shared my enthusiasm for SportsPA. We were both excited by the prospect of producing a project which had a real client in the college and would satisfy a genuine identified need. Paul and I had weekly meetings and this was a great help in keeping the project moving in the right direction and at the right pace. The fact that Paul was available almost 24/7 was also very supportive. I had some technical and personal issues during the project and Paul always showed understanding. Thank you Paul.

The other person I would like to acknowledge is Johnny Bradley. Johnny is a lecturer in Sports Performance Analysis at IT Carlow. I first met Johnny while conducting my initial research for my original idea. From that first meeting Johnny was very willing to help in any way possible. At a later meeting he suggested a slightly different project which he thought would be useful for managers and coaches. This showed Johnny's desire to help in anyway he could. It was then at a later meeting he identified a real need in his own department, and SportsPA was developed to meet this. Johnny's enthusiasm throughout the project matched that of Paul's and mine. Despite being very busy he was always willing to meet and was approachable and helpful at all times. Thank you Johnny.