CO-010

MAP ANIMATIONS FOR VISUALIZING ORIENTEERING COMPETITIONS

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ABSTRACT

This paper gives an overview over methods for visualizing the tracks Orienteering runners in the last World Orienteering Championships. The visualizations are based on GPS-positions received by equipment carried by the participants. Further, the paper discusses how the existing methods can be extended with a view to making the presentations easier to understand by the general public. On television the different animations need to be pre-maid, while Web users can handle interactive animations. It also points out that the visualizations need to have a distinctive appearance depending on the media they are prepared for.

INTRODUCTION

Orienteering is maybe the sport that has closest connections to cartography. This is however a sport that traditionally has been very little visible in media. It has been difficult to attract the attention from a broad public for a sport where the athletes are hidden in the woods most of the time. Some years ago the sport Biathlon was in a similar situation. Delayed result lists, because of the interpretation of the shooting results, made the sport less interesting to the public. New technology has however made Biathlon to a very attractive sport. In the same way there are great potentials in making Orienteering a more public-friendly sport by the use of new technology.

GNSS technology (today usually GPS) makes it possible to "follow" the athletes during the competition. Together with well made cartographic applications this makes the sport more interesting for media as TV and the Internet as well as the spectators at the sport arena. In the latest World Orienteering Championships new and exciting ways of presenting the competition to the public have been employed. GPS tracks - synchronized and visualized as map animations for the public give the sport a new dimension. Examples from the World Orienteering Championships 2010 (WOC 2010) showed that it was even possible to study some mistakes done by the athletes before the same athletes knew about it themselves.

Over the last years there have been developed a few visualization tools suitable for Orienteering events. However, there are still great potentials for improving the methods and for making new and innovative visualizations of the athletes' movement in the terrain. So far Orienteering has been a "poor" sport when it comes to economy. An important factor here is the lack of interest from a broad TV audience, and since there in general are limited economical resources involved the development of visualization methods moves slowly forward. On the other hand, more audience friendly presentation of Orienteering events might make the competitions more attractive for TV.

FUNCTIONALITY IN EXISTING APPLICATIONS

To follow each athlete closely it is necessary to track their routes by the use of GPS and to transfer the measured positions by the use of a transmitter. Usually a mobile phone technology as GSM is used to convey the position. The participants need to carry this equipment to make live information about the competition possible. This paper will look at the hardware as prerequisites and focus on the visualization of the collected data.

There are several commercial providers of software packages for tracking sport events. Some of them are made with orienteering in mind, while others have a wider perspective and are sometimes focused on other sports like sailing, cycling, cross-country skiing etc. In the following this paper will have a look on some of them, and in particular the systems used by the latest World Orienteering Championships:

- WOC 2010, Norway : GPS-seuranta (WOC 2010)
- WOC 2009, Hungary: SmartWay by Micro-Team Co. Ltd (SmartWay)
- WOC 2008, Czech Republic: TracTrac (TracTrac)
- WOC 2008, Czech Republic: OAnimator by OrienteringOrganiser (Orienteeringorganiser)

All the systems are studied as Web-applications on the events Web-pages after the competitions. Two systems seem to be connected to WOC 2008. TracTrac refers to this event on their own Web-pages where replays of the competitions are available. At the same time the official WOC 2008 Web-pages are linked up to the OAnimator system for replay. At the first glance a development towards better visualizations and more interactivity in the animations can be detected over these three years. All the systems are based on

showing the athletes track as a moving icon on the orienteering map. In addition the track of each runner can be shown. This is a quite basic functionality that is simple to implement in an application. The differences between the applications are evident when it comes to interactive options, how user friendly these interactions are and how intuitive and easy understandable the animations are. Below is a short description of existing applications while Table 1 shows an overview over the various functions in the software.

OAnimator

This is by far the most primitive application in this study. Like the three other applications the tracks of the athletes can be animated in the Orienteering map. However, the animation runs to fast, the map jumps around on the screen in a stepwise manner and it is no obvious control to adjust this. In general it is very difficult to understand how the control panel works. This application, as it is presented at the Web-pages of WOC 2008, should be avoided.

TracTrac

Even if there are no references to this system on the WOC 2008 Web site TracTrac refers to WOC 2008 on their own "event list". And various maps and routes from WOC 2008 can be animated by this application (TracTrac). The animations in TracTrac are Java-based and the application is prepared for several sports. However, the main focus seems to be on sailing. The user interface for WOC 2008 is still quite simple but more user friendly than OAnimator. More recent events like the European Youth Orienteering Championships 2010 make use of a more advanced user interface for the TracTrac system. Hence this will be used in the further comparison.

SmartWay

This is a Flash-based application developed in Hungary. From the Web site it seems like the company behind the application hopes to use the application in different sports. So far it is applied for orienteering and MTB cycling. Since the WOC 2009 is the first listed event it is reasonable to believe that this application was made with this championship in the mind. The functionality in the control panel is slightly less than in the TracTrac application. However, the host important functions are available and the application includes a smooth zoom controlled by the mouse wheel. In addition there is a small vignette map where it is possible to pan the main map. A peculiar detail in the zoom slide bar: The scale is decreasing when moving the handle towards "+". This is contrary to most other map applications on the WEB.

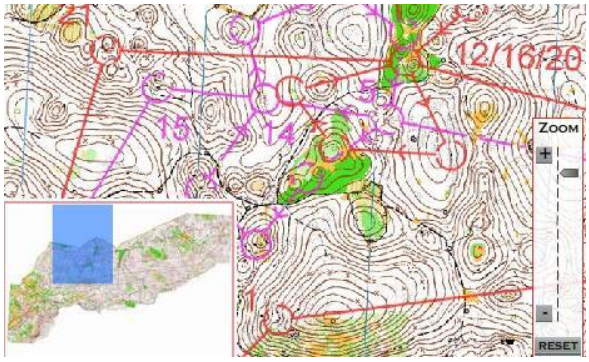

Figure 1: A cut from the SmartWay application

GPS-seuranta **(Figure 2)**

This appears to be a Java-based application and the functionality is close up to TracTrac. Also when it comes to the animation of the tracks this application is quite similar to TracTrac. Like in SmartWay it is possible to zoom in and out by using the mouse wheel. The vignette map includes a zoom control and a scale bar. However, the pan functionality in the small map is less intuitive than in the SmartWay version. GPS-seuranta also has the most advanced tools when it comes to the comparison of selected competitors in different part of the track. The menu for these options is however hidden by default and most Web users will probably not find it.

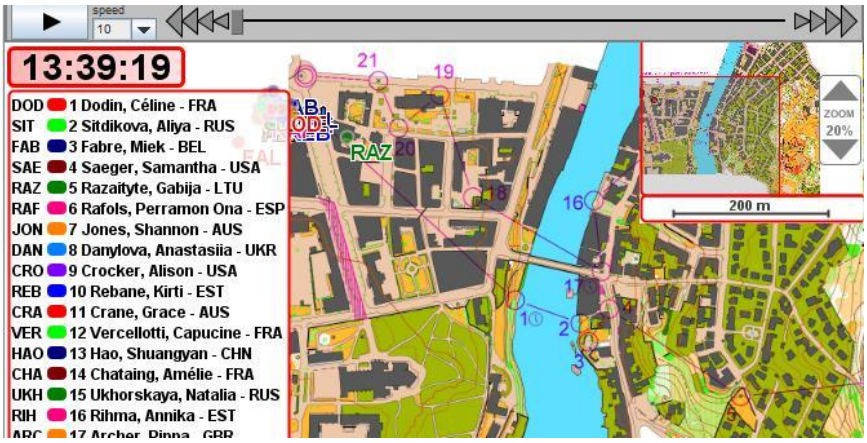

Figure 2: A cut from the GPS-seuranta application

In addition to the visualization of routes on Orienteering maps there have been some initiatives on presenting orienteering by using 3D animations and by looking at the terrain in a perspective view. First of all this method requires a terrain model. One approach is to put the Orienteering map on top of the terrain model and make a non-orthographic display of the map (3Drerun) (Figure 3).

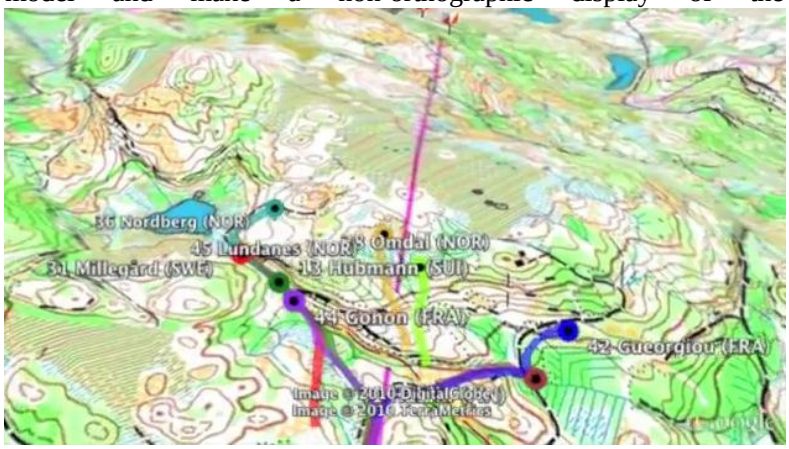

Figure 3: 3Drerun, orienteering map in a perspective angle.

Since the map loses some of its qualities in this kind of visualization the information value is debatable. A 3D view of the map can act as a good transition from a TV camera into an orthographic map projection. On the other hand it might be difficult to for example assess distances in perspective visualization (Petrovic and Masera 2006).

Another approach is to make the terrain surface as realistic as possible (WoO-TV). This method may be of great value in a TV-production to present the competition area. However, to make the visualization true to the nature it is necessary to include detailed models of objects on the surface. This is still a major obstacle.

The example in (3Drerun) shows the sprint competition in the Norwegian Championship 2010 where a 3D model based on a combination of an Orienteering map and Google Earth is used. Since the terrain model in Google Earth is rather coarse and inaccurate the 3D visualization could be considerably improved by using a better terrain model and higher resolution pictures. In many areas there are intensive uses of airborne laser scanning for making better terrain models. This may pave the way for better 3D visualization in connection with orienteering events.

	OAnimator	TracTrac	SmartWay	GPS-seuranta
Colour code for athletes	Yes	Yes	Yes	Yes
Easy to select athletes	No	Yes	Yes	Yes
Selectable colour	No	Yes	No	Yes
Smooth zoom	No	No	Yes	Yes
Scale bar	No	No	No	Yes
Interactive vignette map	No	No	Yes	Yes
Adjust size of athlete symbol	No symbol	Yes	No	Yes
Adjust thickness of line (track)	No	Yes	Yes	Yes
Select athlete symbol	No	Possible?	No	No
Select label to follow symbol	No	Yes	No	No
Real time animation	Yes	Yes	Yes	Yes
Mass start mode from start	Yes?	Yes	Yes	Yes
Mass start from post-control	No	No	No	Yes
Show route	Yes	Yes	Yes	No
Show tail	No	Yes	Yes	Yes
Adjust length of tail (seconds)	No	Yes	Yes	Yes
Adjust thickness of tail	No	Yes	Yes	Yes
Hide map	No	Yes	Yes	Yes
Opacity of map	No	Yes	No	Yes
Time offset for individuals	No	Yes	No	Yes
Adjust speed	No	Yes	Yes	Yes
Start, pause, stop buttons	Yes	Yes	Yes	Yes
Slide bar (time)	No	Yes	Yes	Yes
Slide bar (zoom)	No	No	Yes	No
Calculate speed and distance	No	No	No	Yes
Athlete legend in map	Poor	No	No	Yes
Whole route/present route	Poor	No	Yes	No
Zoom by mouse wheel	No	No	Yes	Yes
Pan by using mouse	No	No	Yes	Yes
Initials when "mouse-over"	No	No	Yes	No
Follow selected athlete	No	Yes	Yes	Yes
Info about the athlete	No	No	Yes	No

Table 1: An overview over functionality in existing applications

Experiences from WOC 2010 show that it is a great demand for visualization of the runners' tracks both from broadcasting and spectators (GPS-Exp-WOC2010). It also shows that live tracking is quite slow and boring. Hence, the tracking applications need to provide fast replays and comparison of the athletes in selected part of the route.

DEVELOPMENT OF NEW VISUALIZATION METHODS

The existing methods for visualization of Orienteering competitions are based on the most "obvious" way of animating the track. The Orienteering map is shown with a north up orientation and the GPS-position and the track of the runner is indicated on the map. The most "advanced" visualization is when the GPS-

position is given a tail that indicates the speed of the runner (this is in fact a very nice detail). In this section we will have a closer look on how the methods for visualization may be improved and suggest some new methods that can be included in a visualization system. Some of them can be implemented by using existing maps and data, while others require inclusion of additional data about the terrain and landscape.

First of all it can be useful to do something with the orientation of the map. All the existing application shows the routes with north on top of the map. This is appropriate when the purpose is to show an overview over the course. However, when the idea is to focus on the leg between two control points an orientation based on the track direction should be considered. There have been examples on TV-productions of Orienteering competitions where the camera angles have shown the athletes running one way, while they on the parallel map seem to be moving in a quite opposite direction (Figure 4).

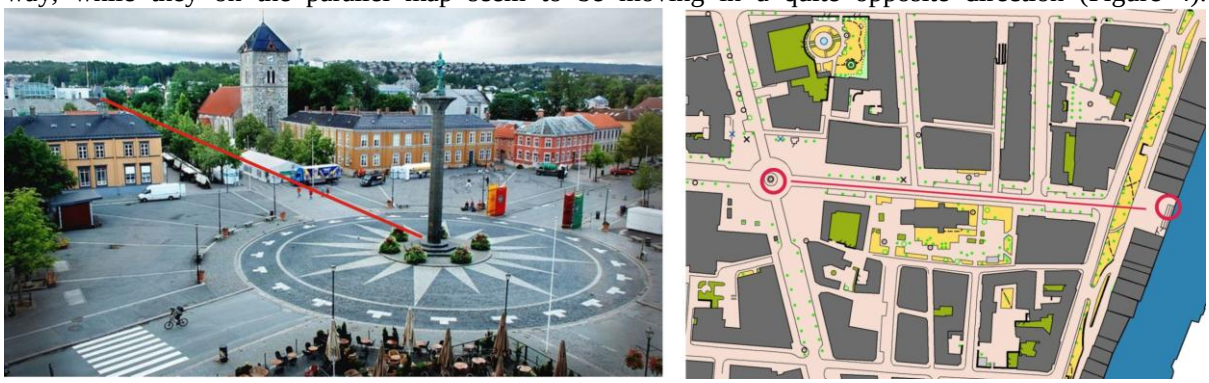

Figure 4: Camera and map points in different directions

This generates confusion for the TV-spectators since they need to do a mental rotation to understand the situation. When using a map for navigation it has been shown that an egocentric view is most efficient (Porathe 2007). This gives that the direction on the map is the same as the direction in the terrain. This is also the way an orienteering competitor will keep the map during his/her run. For an Internet user with some experience in Orienteering it will probably be advantageous to orient the map from the "start" control towards the "end" control when focusing on single legs. For TV-spectators it will be most important to align the map in accordance with the camera angle to avoid the mental rotation. A 3D map seen in perspective from the camera position can help in an animated transition from the TV picture into the map (Figure 5).

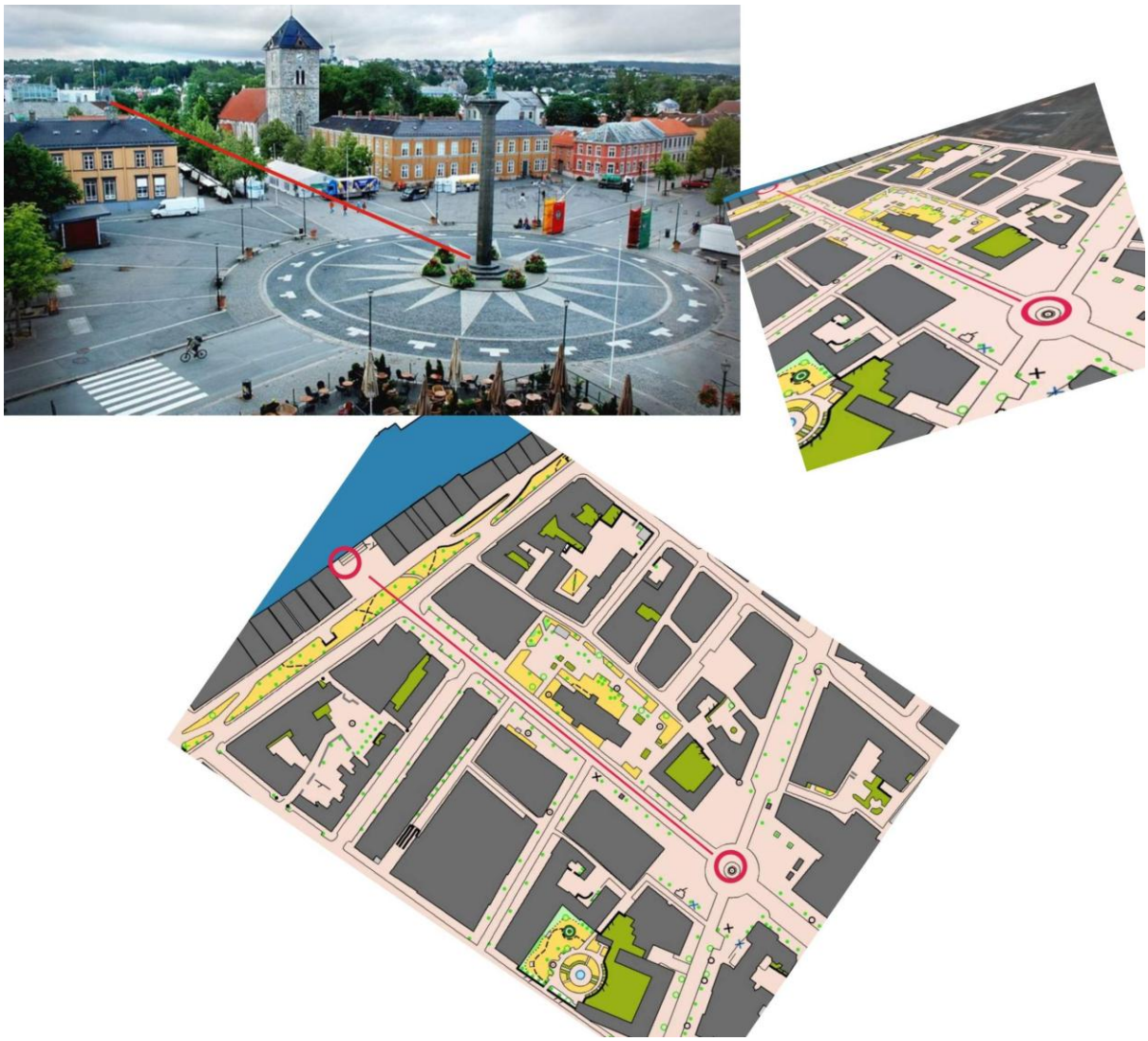

Figure 5: Keeping the orientation with an animated transition from camera to map

Different kinds of spectators have different requirements for a visualization system. People who are active within Orienteering often prefer the Orienteering map as it is, while, as Zentai and Guszlev (2007) suggest, it may be vise to simplify the information for the broader TV audience. A TV production will normally focus on some selected parts of the track. Then it is possible to prepare these parts for some more visualization effects. When introducing selected part of the route to the audience most of the map can be less visible (faded down in an animation). In this way details that are important for the route selection can be emphasized and easier distinguished from less important information. This may help the TV commentator to explain the different options and different route selections. Some of the map can even be faded during the animation of the athletes tracks, and some important details can "fade in" during the production to help the explanation of certain situations.

A map is a horizontal projection of the terrain where the indication of vertical variation is given by the use of contour lines. Many people find it difficult to interpret vertical variation in the terrain by using contour lines only. To produce more "vertical information" we need a digital elevation model for the actual area. This can for example be generated by converting contour lines. However, today there are extended uses of airborne laser scanning for making digital elevation models, and many Orienteering maps are constructed by the use of these data. Consequently, it can be practical to use the original elevation model (which is more accurate) when it comes to visualization of height differences. To visualize some of the height

variation the elevation model may be used to introduce a 3D appearance by generating shadows (Figure 6).

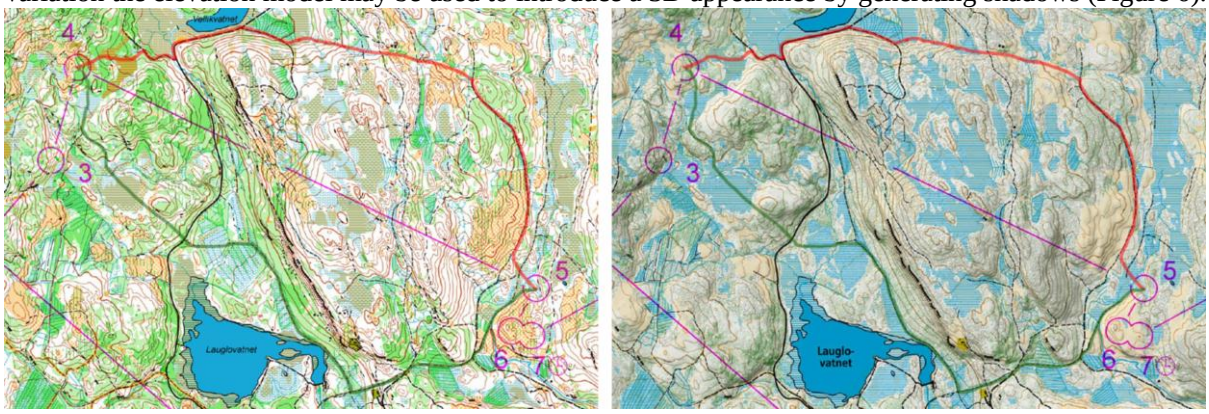

*Figure 6: Orienteering map with and without analytical hillshade. From WOC 2010 made by Ema*p

However, this may invoke some problems if the map is going to be rotated. It is also possible to get an impression of vertical differences by putting the map on top of a terrain model and view it from a perspective angle. However, as stated earlier, the map will lose some of its general properties this way. Another interesting way of using the terrain model in a more accurate way may be to focus on the vertical track profiles between two controls. In a TV production this can for example be done when presenting the track choices before start. Vertical profile of the most plausible routes between two controls can be compared and discussed. During the race vertical profile of tracks of selected competitors may be studied. This profile will also give information about total height difference, actual length in the terrain etc.

It is possible to do even more extensive analysis of predicted and accomplished routes. Suleng (2009) suggests a method where various types of terrain are classified according to how fast it is possible to run. To do this it is necessary to make a kind of "land use map" based on the orienteering map. Together with the terrain model this data set can be used to predict how fast it is possible to move along selected tracks.

In existing applications one of the most interesting animations is when several competitors are compared between two controls and the time is synchronized in way that it looks like a mass start. This concept may be developed to make more analysis of the tracks. One possibility is to make a fast animation of a few selected participants. When the first one reaches the control the animation stops and show differences between the competitors on this particular part of the route. More detailed information may for example be showed by using "mouseover" etc.

Another, more advanced function, is automatic detection of fails. In particular when the runners are closing up to the control and have unexpected stops, turns in the wrong direction or are passing by the control it is an indication of fails. These situations can be flagged in the live animation from their track. A reliable GPS position is critical for this kind of functions.

The existing application described earlier in this paper animates each participant with a kind of icon (normally a small circle) and a line showing the track they have passed. The participants are separated by using different colours and by using an abbreviation of their name in connection with the runners' icon. When there are many participants it is easy to mix colour codes together, and the name abbreviation can be improved to make it more visual. One idea is to use the national flags to separate participants Suleng (2009). This might be applicable in World Championships where there are few participants from each nation and it can in particular be a good solution for relays where there is only one team from each nation. One could even consider using national colours when animating the track lines.

Finally, further developments of 3D visualization methods are of interest. To make it more interesting for television in the "HD era" it is necessary to use models of higher resolution than what Google Earth is providing today. To make the visualization more realistic it is also necessary to find efficient methods on how to generate 3D objects on the surface. 3D methods will be a good supplement to the map animations, and new 3D television techniques could easily be utilized to make the visualizations even more realistic.

DIFFERENT MEDIA AND AUDIENCES - DIFFERENT REQUIREMENTS

Presentations of Orienteering competitions are applicable for different media. WOC 2010 used GPS-tracking and visualization of routes both for TV, Web and for large screens on the stadium. Some of the visualizations could be used for all these media. However, the different media have different target groups and consequently different requirements for what the "ideal visualization" should contain. Since this paper is focused on map animations the following media is considered to be the most important. This gives an overview over media, target groups, interaction etc.

- Television. This is the media that reaches the general public - a public who probably have limited knowledge about Orienteering. There is of course no interaction and the producer needs to combine the different visualizations in an engaging way. It is important that it is easy and fast to make different presentations that can be included in the broadcasted program. And it must be possible to make simple and informative visualizations that are attractive to a wide public. An excellent TV production may increase the interest between the viewers and in the next turn result in more resources for development of the sport.

- Screen on the stadium. Like on television there is no interaction between the spectators and the screen. However, when it comes to target groups there is probably a big difference. Knowledge about the sport is probably quite high between most of the people at the arena, and they will be interested in detailed Orienteering maps rather than simplified visualizations. Experiences from WOC 2010 also show that the visualizations have to be larger on the stadium screen than on television. A modern TV picture is produced in high definition (HD) and can handle finer details, while the stadium screens have to be prepared for sunlight conditions and for "long distance" spectators (Figure 7).

Figure 7: Stadium screen on WOC 2010

- Web (computers). The target group on the Web does probably have more knowledge about Orienteering or are interested in sport in general. The Web does open for interactivity where the users can study their "self-controlled" animations. It is however very important to prepare the application in a way that it is easy to do the actual interactions (and easy to understand how to do it).

- Tablets. In the future one can expect that many spectators, both on the arena and elsewhere, are following the competitions on small handheld displays. While mobile phones are a little bit small to give a good user experience for this purpose, reading tablets seem to have an ideal size. Easy to bring and big enough for good visualizations. These platforms can be used for animation of orienteering tracks as well as replays, results and TV-broadcasting of sports in general. Today the tablets can use a standard Web interface for orienteering animations. In the future one can expect that designated applets are developed for this purpose. These will have interfaces and methods of interactions adapted to tablets with touch screens.

Both computers and tablets are well suited for a high level of interaction. The interaction methods in the existing Web-based applications are however a little primitive compared to what you expect to find on a tablet application. Instead of reading trough a list of athletes and mark the ones to study in the animation in a check box, this should be able to do by dragging the name/picture of the competitor into the map and place him/her on the part of the route that you want to study.

One key element in Orienteering is to keep the control points and their sequence secret until the participant receives the map at start. This will be in conflict with presenting the routes on different medias. One solution is to keep the competitors in a restricted area before start. It is necessary for the orienteering sport to adapt to the reality and find solutions that make the sport interesting both for the participants and the spectators.

CONCLUSIONS

GPS methods for positioning and GSM systems for communication have paved the way for the development of detailed animated visualizations of Orienteering competitions. However, there are still a great potential for the development of these methods. To increase the interest from TV it is necessary to make the visualizations even more public-friendly. When this reaches a certain level the broadcasting companies will push on for a faster development out of self-interest. Today the same applications are used for making presentations on different media. To make better visualizations on different media it is necessary to develop applications which are adapted to the media. Hence, you need other tools for TV-production than for making animations on the Web. This paper gives some examples on new steps in the direction of better visualizations of Orienteering competitions. Another exiting media has emerged the last year: the tablet. The use of tablets and touch screens for interactive animations of Orienteering tracks is highly interesting. The new touch-screen-methods for interacting with the screen can make the applications more user-friendly. The possibilities are many. However, the sport of orienteering has to adapt to the reality of new visualization methods when it comes to keeping the routes secret for the competitors before start.

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