Mobile IT Support for Multisport Competitions

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Abstract

This paper discusses designing technology for a *mobile race awareness application*, called MORA through which the multisport activities can be made safer and more fun to accomplish. Existing technology is problematic because it cannot withstand the adversity of conditions entailing extended and extreme outdoor activities, as well as being hazardous in traffic. The research presented here is based on several case studies of multisport competitions, involving the researcher and subjects in the pertaining preparations and teamwork throughout. We have studied extreme triathlon over ironman distances, i.e., 3.86 km (2.4 mi) swimming, 180 km (112 mi) cycling, and 42.2 km (26.2 mi) marathon running with a mountaintop finish. Hence, our findings are expected to apply equally for other types of multisport and even adventure, guiding and other backcountry activities.

1 Introduction

This paper looks into designing a robust system for multisport. Robust means that can be used in the extreme weather condition like rain and snow. In this research triathlon competition is taken as a case study and the design is discussed in that context. However this problem exists in many other team activities, such as skiing, hiking, surveying, guiding etc. Many non-participants may not be aware of the highly prevalent collaborative aspects of such sports.

For most people not themselves involved in multisports, it may come as a surprise how much live race coverage of *and by* the athletes themselves is appreciated in real-time by friends and family, as well as the athletes themselves, in real-time as well as in retrospect. Thus, the motivation to design, adapt and adopt new technology for training and races continues to be strong. Infotainment is starting to supplement traditional monitoring. The aim of the project described in this paper has been to implement mobile multisport support using robust and easily available components, whilst avoiding the hazards of cycling or running when using a mobile phone. Another novelty of our application is that it emphasizes and supports the social aspect, which makes the targeted activity more enjoyable as well as safer. A third aspect of our research has been to try to create a sufficiently user-friendly interface for the application, given that it is supposed to be used outdoors in all kinds of weather conditions.

This paper discusses broadcasting options regarding the location, health and experience reports ("micro blogging") of multisport participants, through the application

This paper was presented at the NIK-2012 conference; see http://www.nik.no/.

MORA (Mobile Race Awareness Application). MORA shows how location based services can influence the race experience. It points out some problems being faced in endurance sports, with regards to using technology during racing, and suggests improved design ideas for mobile devices in this context. Some of the core findings are that user interface components probably have to be designed using new materials as well as new methods, which take into consideration not only the extreme conditions under which they are to be used, but also "pre-packages" communication elements, i.e., snippets of text or mini-macros that fit into predefined contexts.

Our project also brings to the fore some significant unexpected race day experiences, which were counter-intuitive, for instance that a car cannot as easily as expected overtake a cyclist or even a runner. However, the main contribution of this paper, from a requirements analysis perspective, is to try to bring to the fore the social fabric of which these activities are a part, and show how much technology already is being used, some of it haberdashery as well as hazardous.

We do not aim to promote increasing technology support for sports per se. Many aspects of sport are sought exactly because problems are faced and solved "in the rough", without plans, structure and PCs. On the other hand, if technology is used in a domain already, and in multisport it is, there is a tremendous opportunity of user experience designers to learn from it, as well as improve and explore new IT where it represents added (rather than detracts) value.

Multisport Endurance Activities

Multisport is a common heading for many endurance athletic activities, in which athletes race in a continuous series of stages including different athletic discipline. One of the increasingly popular multisport sports is triathlon. Normally in triathlon, we have three disciplines, or legs: swimming, cycling and then running. Even though it varies a little between particular races (one comprises multiples of the "maximum" distances and a spread over several days), usually the whole triathlon course (swimming, cycling and running) is to be completed by each athlete individually without breaks. It may also be performed as a relay involving a team of athletes in order to complete the race course. Although not typically the case in triathlons, there are also a few like Norseman Xtreme Triathlon in which team support members, who do not take part in the race directly, help the athlete in all possible ways (except racing) to finish, by fulfilling their needs during the course of the race.

There are many basic needs that an athlete needs covered during such race, like food, clothes and emergency help. Since it is a long race, typically lasting 12-18 hours, they should carry as little weight as possible for comfort/ability purpose. Thus, some races have access for support team members who can provide necessary services to an athlete, in parts of or throughout the course.

The project described in this paper concerns developing a mobile application for a race such as Norseman, using as an extensive and representative test, the Trollveggen Triathlon, which is a shorter race with some of the same characteristics.

This research is based on experimentation and ethnography. The ethnographer himself was one of the athletes of Norseman Xtreme Triathlon, who have already completed four Norseman Races.

Support Crew Roles

The multisports with which we are concerned in this paper, is generally a team work in which there are a number of people who are directly and indirectly involved in the play to achieve the goal. For example in boxing, there is a direct involvement of boxer in the game but there are other people like coach, doctors, etc. who are also a part of the team which helps the boxer to win the match. In long-distance sports there are normally the involvement of a team involving athletes and support. In this situation computer supports them through telecommunication technology and enable participants to enjoy social sport experience together [3]. [6] has demonstrated the social experience using "jogging over distance" in which people located in different places interact with each other and share the experience of jogging together using mobile devices. The system would calculate the pace and heart rate of the partners and on the basis of that, they would hear their partner's voice with stereo effect giving them the feeling whether the partner is front, side, or behind. They can interact and communicate with each other through the medium of technology and help each other obtaining their goals. In our case the goal of the support is to fulfil the needs of athlete and the goal of the athlete is to finish the race with the help of their support team.

Though the athletes of these races are highly trained they may need help during the competition. So, some races like Ironman Triathlon deploy a large number of volunteers to provide the support service, such as food, drinks, clothes and emergency aid to the athletes. However, they do not allow the support to provide direct help to the athlete. On the other hand, some races like Norseman Xtreme Triathlon and Celtman Triathlon demand for the own support of the athletes. Though there are volunteers available, athletes are required to have at least one support, who provides them with the necessary support throughout the race.

Many competitions have cut-off time for the safety of athletes. Cut-off may be linked or related to quitting the race, both phenomena which may introduce confusion, annoyance and even dangerous situations unless the physical and emotional status is clearly and timely communicated to the support.

Currently, there are a lot of technologies involved in the races. They include GPS watches, heart rate monitors, bike computers, etc. They can be used by the athlete during the race and can be used as "personal trainers" as well. The use of RFIDs for calculating race times of the athletes is also quite commonly used in many races like Norseman and Ironman Triathlons. The use of both low frequency (LF) and ultra high frequency (UHF) timing RFID chips are common. The LF chips are one time, cheap, light and disposable whereas the UHF chips are multi-use, durable, and expensive, and the athlete must return them after the race.

Though many technological "building blocks" exist, there is still a lack of perfect technology to provide enough support for the entire crews of athletes and organizers, which is what we shall investigate further upon in the remainder of this paper.

2 Related Research

[7, 4] discuss about guiding the individual in a trip or hike providing them enough information about the route and and destination including the notifications about the weather reports etc., using a mobile device. In those studies. the collaboration with team or social aspect of using such applications are not considered.

[9] studied the norms of the use of mobile technology and aimed to support collaboration in co-located groups by enhancing the awareness of the presence or the

absence of other team members. [5] have studied collaboration in relation to context-aware mobile terminals and discuss the possibilities on enhancing the collaboration and improving the usability of mobile applications if these two technologies are combined. [6] has demonstrated the social experience using "jogging over distance" in which people located in different places interact with each other and share the experience of jogging together using mobile devices.

[16] have pointed out the missing link between sports medical basics and GIS. Our approach also share some common features like using sensors for collecting health and context information data and combine it with GIS information to get meaningful results. They are more focused on motivating and improving individual health with different levels of athletic expertise. We use health and GIS data to enhance the collaboration between the members of the team at the real time in outdoor sport activities.

[10] has influenced our multimodal eye-free interaction quite a lot. It uses a touch pad which sense the touch and provide the audio feedback about the location in the menu. We follow similar approach to browse and select the list of audio menu items.

3 MORA for Smart Phone

The prototype was built for Android phones. First we identified the problems and the needs based on the previous work reviewed earlier in this document [op. cit]. We then applied the PACT analysis, which helped us identify the requirements more clearly. The following are the list of major functionalities which was decided to accomplish from the prototype:

- **Tracking**
  Through the application, the athletes support crew should be able to see athlete's location information and vice versa.

- **Communication**
  Support and athlete should be able to communicate with each other. We decided to make the message as text. For this purpose, we need to have a chat like application from which the user would be able to send the predefined text message to the selected user.

- **Hotspots**
  Athlete and support should be able make a prior agreement to stop at certain places and meet so that support could provide necessary help like drink, food and clothes to the athlete. We named such place as hotspots and the application needs interface to select the hotspots.

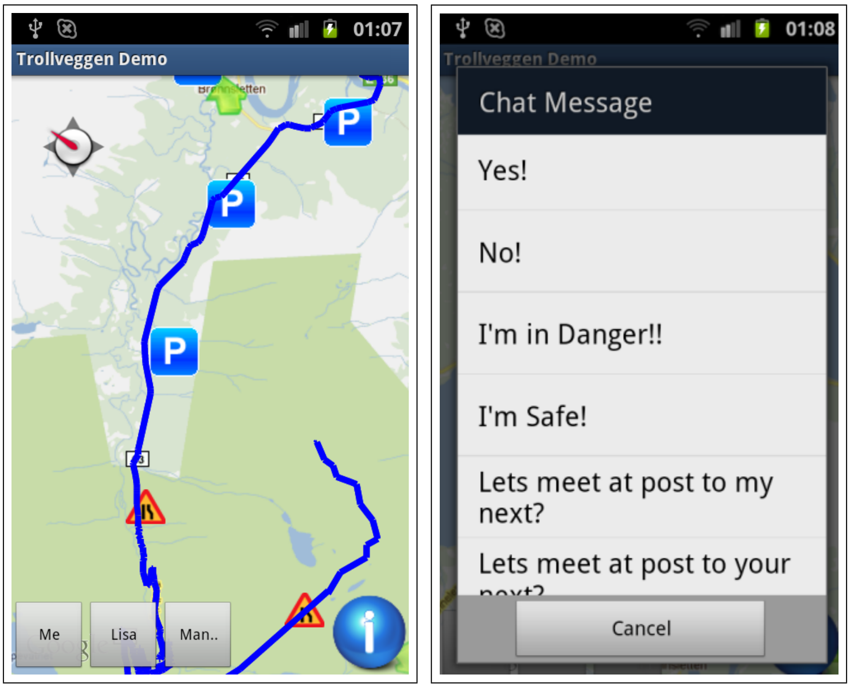
- **Coldspots**
  Coldspots are the points in the map where the narrow road starts within which the support could not overtake the athlete. If this condition meets then the support cannot provide help to their athletes in an efficient way. So a user interface is needed to mark coldspots and the device could automatically alert and suggest the support whenever he was behind the athlete and had the slow speed so that he could not catch up the athlete before coldspot with the current speed.

- **Documentation**
  The user could document the race by taking the picture and videos with the help of the application.

4 Implementing the first Prototype

We implemented the first version of the prototype following simple client server architecture. We have a central server, which may handle the requests sent by the mobile client. The server helps sharing the location between the team members, send message to each other. On the client side, every support and athlete needs to carry the android phone. The phone could communicate to the server through mobile network. Http requests were sent in order to query and send data to the server.

The map-view is the default view of the application. The map includes the route of the race, which we construct in advance from a kml file, drawing the routes in the Google Places and exporting to the kml format. To visualize ongoing tracking, we have constructed the map views using google map API level 8, which will show the location of user as well as the location of the support. The GPS device in the phone collects the user location and shows them in the map. The received location of teammates by phone, polling the server, was plotted on the map. It also has a compass showing the direction of the user as in figure 1.



(a) Race Route in prototype (b) Chat window for athlete

Figure 1: Prototype for Android Smartphones

On the map there are buttons representing each member of the team as in figure 1. These buttons are placed on the map view in order to provide easy access of team members and own information with a single tap. The map is centered to the particular member when the button is pressed and popup a window appears which shows the information about that particular member. The information comprise of latitude, longitude, speed and height of the member. Pop up window also had a button to send the text message to the member.

The athlete and support can define hotspots, which is displayed as an overlay on the map. The prototype has an interface to select the hotspots by marking the hotspots on the map. Support can define and mark the coldspots on the map. The user simply have to go to menu and select the hotspot or coldspot and then tap on the map to add hotspot or coldspot. They are able to be dragged to other points to change their locations. This helps to change the hotspot and coldspot locations in one hand and on the other hand, when the user taps to create hotspot or coldspot in wrong point on the map, it helps them to place on the map more precisely. Each record of hotspot and coldspot information are saved in local sqlite database available in android phones.

As hotspots are the place for athlete and support to meet, there should be some space for parking. So, the icon for parking was put for hotspots. Similarly, coldspots were the place where the road is narrow, so we put the icon for narrow roads for coldspots (fig. 1a).

The application can automatically alert the support whenever he/she is behind the athlete and have the slow speed so that support could not catch up the athlete before coldspot with the current speed. Moreover, it can also suggest the support with approximate speed with which the support should drive in order to make pace with the athlete. Arrow based off-screen visualization technique [2] is is used to visualize the members out of the screen. The main objective about the first prototype was to know more about the need and the requirements of the participants after its evaluation. The application has a provision for sending text messages to the teammates so that they could exchange the needs and send important messages. As affording to type text message is almost impossible in the context of both athlete and support during the race, we have created separate list of possible messages that athlete and support could send. Participants can send the message to the teammates by selecting message from the predefined list of messages. The prototype has been programmed to take the picture from the application in both athlete and support side. The ability to take the pictures and videos from a single application may help them to make their personal documentary and preserve the beautiful scenes that they encountered on the way in an easy way. User has to go to the menu and select camera or video in order to start media.

5 Case Study: Trollveggen Triathlon

For this project, we were able to undertake a field study of a real triathlon race known as "Trollveggen Triathlon", which is organized every year in a place called Åndalsnes in Norway. This year it was scheduled on 28th August 2011.

The plan was to evaluate our design and test whether the application would be usable in a real environment with the given technology during the course of the race. The athlete was familiar with about the features of the application and so was the support crew, of course. Thus, it was not planned not expected for user interface design as such to be assessed, but rather the extent to which the conceptual realization of this technology held up against real life-usage, with real mobility taking place in real weather.

The starting field consists of no more than 140 athletes. The swimming starts from beautiful Åndalsnes port. The length of the swim is about 1200 meters (600 meters back and forth). The water is expected to be at about 18 degree Celsius. The cycling, described above, will at the end only cover a distance of about 22 km, which is unusually short for a triathlon of this kind. As we shall see, this poses additional, rather than easier, requirements of the support crew, since the stretch of road during which aid may be offered is shorter. The route for cycling consists of a flat road for about 12 km from Åndalsnes port to Trollstigen and then the steep narrow and winding road in mountainsides for about 10 km at about 750 meters more above the sea level. Even at the flat bits to begin with, the road is narrow and overtaking is difficult. Thus, the correct position of the vehicles following the athletes needs to be found from the beginning, and maintained throughout. The running distance is be around 5.7 km. The run leg represents a unique nature and sports experience, but it also is technically difficult and it is not given that even a fit person will be able to catch up with other.

The fieldwork consisted of conducting and supporting the race for one athlete and two crew members (one driver and one main support). The following sections describes the race from an ethnographers point of view, and should be taken partly as a rich description made in order to sensitize designers to the web of requirements encompassing this type of application development, as well as a slightly more systematic evaluation of our prototype.

There was a race meeting at 10 o'clock on the race day. This meeting was called in order to give basic information and direction about the race and answer the queries of the participants. The meeting was hosted entirely in Norwegian. However, there were people from different countries. The meeting ended with playing "Black in Black" by AC/DC. The atmosphere may still have been a little tense.

After the meeting, one of the organizers was explaining about the map and the route. But they did not have the proper map except those hand-sketched ones. It was only then we understood that there had been a change of the course. However, they explained that it would not be a problem for the athletes as throughout the course is was marked with arrows and there would be volunteers at different points. It had been raining for long time and there was risk of bigger rockslides on the mountains. So, for the safety of the athletes, the race route was changed and the new route was a bit shorter than the regular one. The starting point of the race was being set up at the port of Åndalsnes with a little space reserved for each of the athletes, which had tagged by the athletes bib number. It comprised a rack for mounting their bikes and a box to pack the clothes for riding, to change into from the wetsuit after swimming.

The bikes and the boxes were in position with the number to each set of bike and box. There, both of the members (athlete and crew, participating in the evaluation) met. As it was raining we had to install the application into the other two mobile phones in the car. Besides, the mobile network was giving the problem as sometimes it was working and sometimes it was not. As we shall see, this was only the first of a host of practical problems related to connectivity.

Next, we wanted to set up the points (hotspots) in the map of our application where the support could meet the athlete and provide some aid, at least in the form of food and water. One of the volunteers helped to determine the starting and the end point of the race and the starting and ending point for the cycling. After that, we marked-up some hotspots in both of the mobile device (athlete and support) so that support and athlete could meet and help the athlete. We decided to make it simple and just rendezvous at the bottom of the hill and again at the top.

By this time all the athletes were ready and already into the water. It was quite cold because of the rain, still everybody including athletes seemed to be enjoying it as lots of people were there hooting for the athletes and the music was quite loud which may have made them charged and energized. It was very difficult to find or recognize the teams particular athlete among a number of people getting ready to swim in the water. Only heads were visible and we could not even see the athletes tag. Bearing in mind that this was a small race with only about 140 participants, one cannot say that the area was particularly congested. We know that in bigger races there are going to be at least two thousand people at the starting line, which makes the swim so busy that the athletes bump into each other a lot during the swim. In realistic conditions therefore, we may safely say that athlete identification is going to be a major issues.

The race started at 12:30 and all the athletes begin to swim. The length of the race was about 1200 meters in the green fjord of Romsdalsfjorden. Only heads with swimming hats were visible in the lined up athletes in the water. Though it was totally difficult to identify own athletes in the water, people were continuously cheering all over for their athletes.

There were a number of volunteers out at the course to guide along at different points. They were showing the directions for the race and controlling traffic when necessary so that there would be no obstacles and interference to the athletes and the race would go smoothly. In fact, it was very difficult even to drive on the road, as there were a lot of athletes cycling and we had to be careful so that none of them were hindered or hit by the support teams. Consequently, it was quite impossible to really overtake athletes on their bicycles, as other, stronger athletes kept passing us on both sides. Another risk found was that the route generally was open to traffic. Other vehicles would interfere with the line of cyclists and support cars which would also be quite risky because the other vehicles may not even know about the race going on, which means they may not be very careful at all when passing. This could lead to accidents.

Here is a small conversation between the two supports:
Support1: I think we lost him. Can we go a bit faster?
Support2: It is crazy to drive here, too many bikers. It is totally difficult to overtake. Bikers are in front of us blocking our way and it is raining. We cannot drive faster.
Support1: Yeah!, and bikers from behind are trying to overtake from all sides.
Support2: Yes, and cars are coming from the other side. Must be careful so that we would not hit any athletes.

We managed to capture some pictures and video footage of the athletes using the application from the car, but not really to provide any efficient aid.

The signal on the mobile was very poor near the mountains so, the connection to the server was lost time to time. As a result, the athlete was lost during the cycling leg. The location of the athlete in the supports device was not changing. We were nearly hopeless about the application thinking that it will not work. We had set up a meeting point before the race but as we lost the athlete, we could not meet him at that point. Because of rain, the athlete could not take out the mobile phone and check the meeting point on the map and perhaps did not stop anywhere.

"This is the place for hotspot", one of the support said looking at the map. "Ya, but there but where is the athlete? He was ahead and we lost him".
"Probably he did not see us and he continued."
"Yes, let us go to the end point of bike and we will see him there."

So we went to the point where the cycling ends and running starts. We waited for him there, but it turned out that he had already crossed that point. However, at that place, athletes were arriving and the supports waiting for their athletes were cheering and helping them to start running. Moreover, there were labelled boxes of the athletes, which contained the necessary items like clothes shoes, jackets, drinks etc. Furthermore, the athletes were supposed to hand the bicycles to the volunteers who put them into the big trucks. The supports were to collect the bicycle of the athlete. Then they changed clothes wear running shoes, and start running. Some of them grabbed chocolates, drink or food before running from their T2-Box. The athletes were also served by drink and banana by the organizers. As we did not see the athlete but his bicycle, we collected the bicycle and the T2-Box for our athlete from them, by showing the organizer volunteers the receipt provided by them to us and waited for him there. Because after finishing the running the athletes were supposed to come back to that place. We were so restless and were checking the location of our athlete time to time and suddenly the display started to show his updates location, which showed signs of hope that it will work after all. After four hours at around 4:30 p.m we met our athlete.

Results and findings from Trollveggen Triathlon 2011

It was raining during the race. So, the mobile phone was put into a plastic bag and given to athlete, which he put into the pocket. We got the following issues and findings after we tested the application in the Trollveggen Triathlon:

Robustness

Due to the rain, athlete could not use the mobile device and check the hotspot or send any message to the support. As a result athlete and support could not communicate and meet at the hotspot.

Direct Manipulation Problems

As it was quite difficult for the athlete to allow himself to pay attention on the small mobile screen and tap on it during the run. Wearing gloves in cold weather also prevent the athlete from using the mobile phone. Furthermore, taking the mobile phone out of the pocket for each and every task is way out of interest for the tired and exhausted athletes. This implies the need of new interaction style that needs less visual attention.

Network Signals

Because of poor signals in the mountains, the application was not able to communicate with the server and the athlete was lost several times. So, availability of network should also be considered while designing such applications. There could be some mechanism for saving the important data in local mobile device until it is able to connect the server.

Overtaking of the athletes by support

It was difficult to overtake the athletes by the support crew car because there were many athletes and the athlete and support teams shared the roads, which were not very wide, with other non-competitor traffic. So, the support must make sure that they are not themselves an obstacle for the athlete, which makes the support slower. When the support is slow, the athlete behind the support tries to overtake the support from all sides, which makes support cars more difficult to drive.

6 Discussion and Design implications

Athletes do not have the possibility of maintaining visual attention over time, compared to their support crew because of their outdoor context of running and cycling which keeps them engaging and physically tired. For instance, athletes would not like to take the mobile device out of their pocket and tap the on the phone looking at it. Moreover, if it is raining they cannot take the phone out and of course it is almost impossible for them to use the phone with the gloves on while they are on the run. Furthermore, the system would be totally difficult to use outdoors on a bright sunny day because of the reflection of the light from the mobile screen. This problem demands the addition of new modal to the interaction, which demands less or no visual attention and the use should be able to perform all the necessary tasks at the same time. So we purpose different systems for athlete and the support side.

Unlike visual, sound feedback can be perceived from all angles without the need of concentration on the source. Moreover, sound can reduce the visual load on the system and is usable in the place where vision cannot be used or difficult to use. Hence, we have added the audio modality into our system. Trend of speech output has developed over the past few years into a robust technology and is increasingly common in navigation systems in cars and other areas such as announcements at railway stations, airports, etc.

In the project, TTS [1] service was implemented using android speech synthesis API that enables android device to speak the text of different languages. The basic tasks that the athlete would like to do while on the bicycle might be: calling support members, getting the next place to meet, distance and estimated time remaining to finish the current course, distance and estimated time remaining to finish the whole course, information about the location of the support etc.

Besides these tasks, athletes should be continuously motivated. It would be better if they get the automatic timely updates or notifications about the hotspots, target and support etc. Moreover, when athlete approaches near the end of the leg, for instance when the athlete gets closer (few kilometers away, say 4 km) to the end of bike leg, they could be notified in such a way that they feel energised and motivated.

We propose different user interfaces for the athletes depending on the context of cycling and running, both utilizing the voice feedback for menu navigation and replying the queries of the user. User interface may be fitted on the bicycle handles where the athlete holds the bicycle.

The proposed user interface consists off our push buttons two in either side of the bike handle and speaker to notify the response (These push buttons are connected to Arduino ADK which is connected to the smartphone via Bluetooth. This way the, mobile device could receive the commands from the Arduino ADK).

Figure 2: Concept of User Interface for athletes' task

The two on the right hand side are for browsing the menu and two on the left are for selecting the menu action and cancelling or resetting the menu. So if the user pressed next the system would say for instance "Remaining current distance" and on pressing "Select" button, the system would send the query to the server asking about the remaining distance. After receiving the response it would say "6 kilometres remaining and 10 minutes to finish".

In endurance sports, when the user is running or cycling uphill, obviously (and increasingly) they will be tired and need more breath and it takes a lot of effort to speak. IM-host used voice recognition [8], which we think may be a vulnerable approach. Though IM-HOST claim the recognition rates above 90% (99% in ideal conditions) in outdoor environment, it simply may not be possible to establish a "normal" condition.

We believe that haptic interfaces with voice have some advantages over the voice recognition in our context. Unlike voice recognition, haptic interfaces do not essentially have recognition problems. In our case we have four buttons, which always perform different and well-specified tasks. We use voice feedback for and menu navigation technique instead of direct voice command. So, voice would guide the user notifying about their selection. It has one more level of interaction than that of voice recognition but still it is better than inaccurate recognition. MORA also implements a text-to-speech in order to reply the queries of the user along with timely notifications.

There are several mobile applications and devices, which are dedicated to athletes and available commercially in the market. Our survey indicated that those applications are more individually oriented and less collaborative in real-time i.e. collaboration at same time and different places. Most of them are like personal trainers. Obviously, the current technology uses different sensors to collect the necessary information and analyze them to give user, the feedback about the race, regarding health, progress and necessary recommendations. Many of the mobile applications have the provision to share the activities through their social networks, athletic communities or other social media like facebook, twitter etc.

Except mobile applications there are different sports watches specially designed for outdoor activities which have integrated several sensors and are able to provide collected information and log the whole activities for further analysis. Garmin, Polar, Sunnto are some of the popular brands for athletic activities. They are quite robust to the climatic conditions and of course quite handy and has good affordance.

However, we found that they would not support well collaboration between the users, which could take the athletic activities into next level. We also found that there is less focus being made regarding the affordance of the user, environmental conditions and real-time support for safety. Athletes would not like to use such applications. Though the information they get from the application can be valuable for future analysis, they do not have much relevance during the real race which could help the athlete finish the race faster or most importantly remain safe throughout the race. Also while using the application, the user have to compromise with the availability of space to use the mobile phone. In such extreme multisport competition, it is a burden even to carry/hold the mobile phone and interacting with it would be out of question. During a Norseman Triathlon we found very few people using sports watches along with heart rate monitor. We did not notice any athletes using a mobile application in the race.

7 Conclusion

After the first evaluation of the application in Trollveggen Triathlon 2011, the needs and requirements and problems of building such applications were reexamined. On the basis of that trial, in this paper we propose an improvement to the application, which further exploits the facilities provided by smartphones and other similarly advanced mobile devices, to provide an application that could be used in mountain-surroundings, for a triathlon application, or other application domains and context that need to withstand harsh climatic conditions and limited affordability. We propose a tactile user interface, which makes such application more robust and usable in the mobile context.

Problems similar to those faced in triathlon may be found as well in other team activities like hiking or skiing, which takes place in back country and in various climates. Topography, lack of visibility or accidents may lead to people getting lost from the team.

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