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PIOTR CYCH

Department of Sport Science, University School of Physical Education in Wrocław, Poland

POSSIBILITIES OF AND CONSTRAINTS ON THE APPLICATION OF GPS DEVICES IN CONTROLLING ORIENTEERING TRAINING

Key words: orienteering, control, GPS.

ABSTRACT

Orienteering belongs to a group of sports that are most difficult to observe. To enable coaches to “get into action” different methods are used. Thanks to the Global Positioning System it is easier now to identify the actual position of an orienteer in action, but there are some constraints on the application of such a system in orienteering. The goal of the research was to consider the possibility of applying modern GPS miniature receivers for recording orienteering routes covered in an afforested area as well as the parameters of training loads. It has been stated that the quality of the record of the covered track is not sufficient to effectively control the quality of task implementation in orienteering. Nevertheless, there are methods of control as well as forms of training in which the application of GPS enhances the diagnosis and registration of training loads.

INTRODUCTION

Orienteering is one of endurance sports [10]. It differs, however, from other types of sports by the circumstances surrounding the physical effort consisting of intellectual processes on a scale unknown elsewhere [2]. Orienteering competitions are usually held in an afforested area of variable configuration, and orienteers mostly run off-road between successive checkpoints. Observations made during the Polish Orienteering Championships show that the elite competitors run only 10% to 15% of the distance on the track [4]. Each competitor realizes their own variant of overcoming the distance between the checkpoints, and the orienteer's choice of the variants depends on many factors such as the competitor's energy potential, capability of orientating oneself in the given type of area, the level of mastery of the running technique,

the level of one's muscle strength, etc. For this reason, the competitor's preparation for competition must be of truly versatile character.

Many authors point to the problem of training control in orienteering [3, 5, 14]. This applies to both training charges and the real distance covered during training, the pace of the run and other factors (the way of implementing motor tasks, errors committed on the route, etc). Trainers try to make it up for these obstacles in various ways. When a run is completed with a specialist map, the length of the covered distance can be measured with a curvometer – a simple mechanical device for measuring distances on maps. The condition is, however, that the competitor must be fully aware of the route he (she) has covered and be able to reproduce it on the map. It is, however, not so in all cases. The less experienced the competitor is and the more difficult the terrain for training or

competition, the greater will be the divergences between the supposed and the real route, and consequently the traveled distance. If the distance is measured correctly, we can indirectly measure our running pace based on it, knowing the total running pace. Increasingly more often, thanks to the use of electronics in sports, we can get to know the running pace on the individual legs of the race between the checkpoints during, both competitions and training. The use of the Sport-Ident or Emit system stations makes it possible to record the so-called split-times. These systems have been already widely used in orienteering competitions. They are also used more and more frequently in practical training, as they provide information that is so much needed by coaches. The application of electronics in orienteering training has also made it possible (so far only experimentally) to apply miniature video cameras [11]. The cameras mounted on the competitor's head enable a detailed record of the traveled route, which facilitates a later analysis of committed errors. The control of training in a forest environment often comes down to the trainer following the competitor and observing (sometimes also registering) the latter's behavior. This procedure is not, however, free of drawbacks. The main disadvantage is that the possibility of observation is confined to one competitor only. Another problem is the factor of direct observation made by the trainer near the competitor, which under the orienteering rules should never take place. In addition, the trainer's presence usually affects the competitor's unnatural behavior. For instance, it may have an impact of the orienteer's excessive caution once a variant is chosen, or one's emotional state inadequate to the situation and the resultant errors which the competitor could have avoided were he (she) not under direct observation.

The emergence of miniature satellite location devices on the world market several years ago began with the U.S. government's decision to make the system of 24 spying satellites available for other uses. These satellites, disposed equally around the globe, emit signals that allow precise description of the position of a device or object equipped with a receiver of these signals. Their accuracy amounts to several meters but it depends on a number of factors. It is limited by natural factors such as mountains, trees, clouds, buildings or other artificial edifices. The possibility of non-restricted purchase of GPS (Global Positioning System) receivers and their increasingly greater minia-

turization have enormous potential in orienteering training control.

A number of studies have been carried out to harness the GPS system for recording the physical effort during orienteering. Osterburg et al. [12] pointed to the possibility of using the method of registering respiration parameters during a run in field conditions, and of assessing metabolic changes with respect to the route profile. Thanks to the obtained information it would be possible then to choose more precise training charges in endurance sports in which frequent altitude changes take place. To observe the competitors' behavior in orienteering, Schutz and Herren [13] applied a more expanded version of the GPS system with a view to define the parameters of an effort made in the field. They used a modified system, currently functioning under the abridged name of dGPS (differential Global Positioning System). This system provides a still greater precision of location (0.3 m), but it requires an additional receiver of differential signals emitted by a surface station. According to the authors, this receiver weighs about 500 grams, and appropriately mounted it does not hamper the performance of all routine actions. It provides the possibility of recording the parameters measured in the time of its functioning and of referring them to the competitor's current speed. The results of such measurements produced many interesting conclusions concerning training of orienteering competitors [7].

The above mentioned investigations proved, however, to be very expensive and at present there is no possibility of implementing them in practical training. It is different in the case of GPS miniature receivers, the cost of which does not exceed € 160. Observations made by means of these devices were to provide an answer to the question about the possibility of using the GPS system to control orienteering training.

The present study was aimed at defining the possibility of application of modern GPS miniature receivers for registering the track traveled in an afforested area and the parameters of training charges in orienteering. The following research questions were formulated:

1. Is the accuracy of the recorded traveled route sufficient for estimation of the quality of realization of training tasks?
2. Which training parameters in orienteering can be effectively controlled with the use of miniature GPS receivers?

METHODS

The registration of training contents was made on five competitors. This group included the author of this article (aged 37, 1st-class orienteering coach with twenty-year competitive experience), and four competitors of the orienteering section of the WKS Śląsk Wrocław sports club, aged 17-25. The subjects were highly trained and advanced orienteers (e.g. medalists of Junior World Championships). The subjects' average orienteering experience amounted to 11 years.

Subject to registration were 20 training units with different contents: from a continuous run without a map, through various types of training forms with a map, to multiple participation in the competition. Almost all trainings were recorded in parks or forests in a terrain with diversified landscape features. The recording was made with Garmin GPS receivers of the Forerunner 201 type (a U.S. made 12-channel receiver with 1/s data refreshing frequency and the location accuracy to 15 meters). The weight of the device amounted to 78 grams [15].

To determine the recording accuracy, the route marked on the map by the investigators after the end of training, or the actual route of the competition, was compared with the GPS record and electronically processed using the Forerunner Logbook 2.1. software. Thus the competitors' record was assumed to be the reference point. In addition, the record of training contents showed easy routes and terrains in which the competitors had no doubts they had correctly marked the traveled track. Additionally, the training was registered when the competitors were moving only on the beaten track, so as to rule out any doubts about the applied method. Next, after the map was scanned, the GPS record was superimposed on the image of the actual route traveled by the competitor. The differences between both records determined the level of the GPS error. In this case, no statistical method was applied to assess the error level, as the Delphian method, also called experts' method, was used [1]. Such a choice was justified, since for people interested in the practical use of GPS (orienteering coaches) the recognition of usefulness of the route record was more important than statistical significance.

RESULTS

On the basis of the observations a comparison was made between the actual routes (drawn by orienteers on their maps) and the route recorded by the GPS Forerunner 201 unit.

Fig. 1 and Fig. 2 show examples of different terrains and different maps. Fig. 1 depicts a hilly terrain on a map on a scale of 1:10000, whereas Fig. 2 shows a map on a scale of 1:15000 where the forested area is mostly flat. This comparison emphasizes the difference in the quality of signals recorded by the GPS unit and the data for analysis. The routes fixed for these two maps had approximately the lengths between 4500 m and 5500 m, respectively. The GPS signal often vanishes in a hilly terrain, thus a straight line on the map representing the GPS track can be noted (Fig. 1). The track registered by the GPS is only an estimation of the runner's actual position, which involves a number of measurement errors. In such cases no statistic method is necessary to state that there are too many breaks of the GPS signal to reflect the actual route chosen by the orienteer. It is impossible to state which way the runner took. Sometimes these breaks are longer than a few seconds. Some of these breaks are longer than 1 minute, which means that a dozen or so orienteer's actual positions in the forest can be lost. Fig. 2 shows that the representation of the route recorded by the GPS unit in a flat terrain is of much better quality and quite similar to the actual one, though the GPS signal sometimes disappears because of foliage.

The implementation of the GPS unit in running sessions outdoors, but not in an urban area, yielded very good results. The recorded data such as total distance and average speed were almost identical with these calculated on the map. The error was usually less than 2% of the measured distance.

DISCUSSION

On the basis of the comparison results, it can be unanimously stated that the quality of the record of the traveled route is not sufficient to control the quality of task implementation in orienteering. All the records made during training with a map or during competitions contained substantial inaccuracies and differences related to the actual traveled route (marked by the competitors on the map after

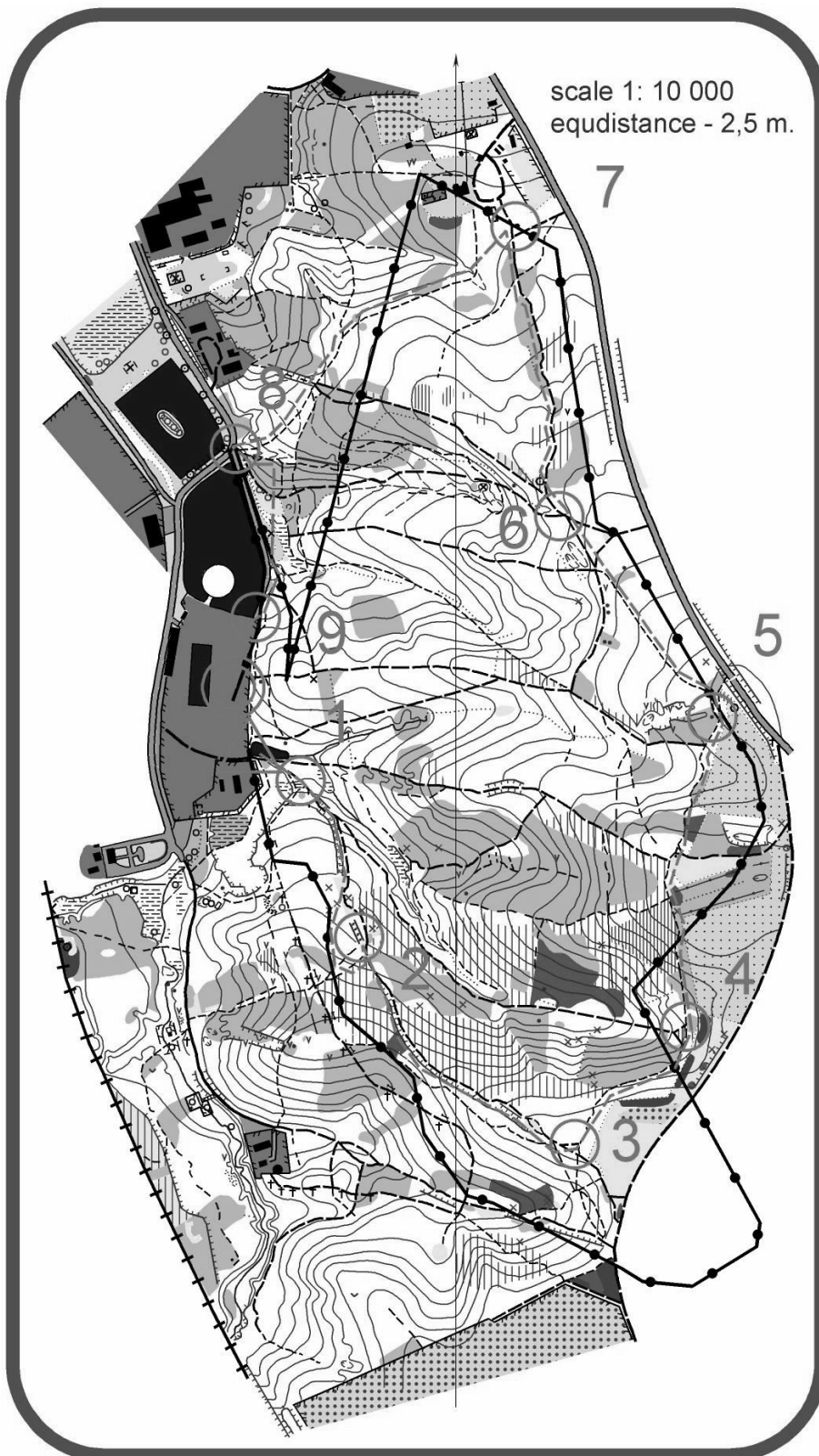


Figure 1. Hilly terrain on the map on a scale of 1:10 000 with breaks and errors in the recorded GPS signal

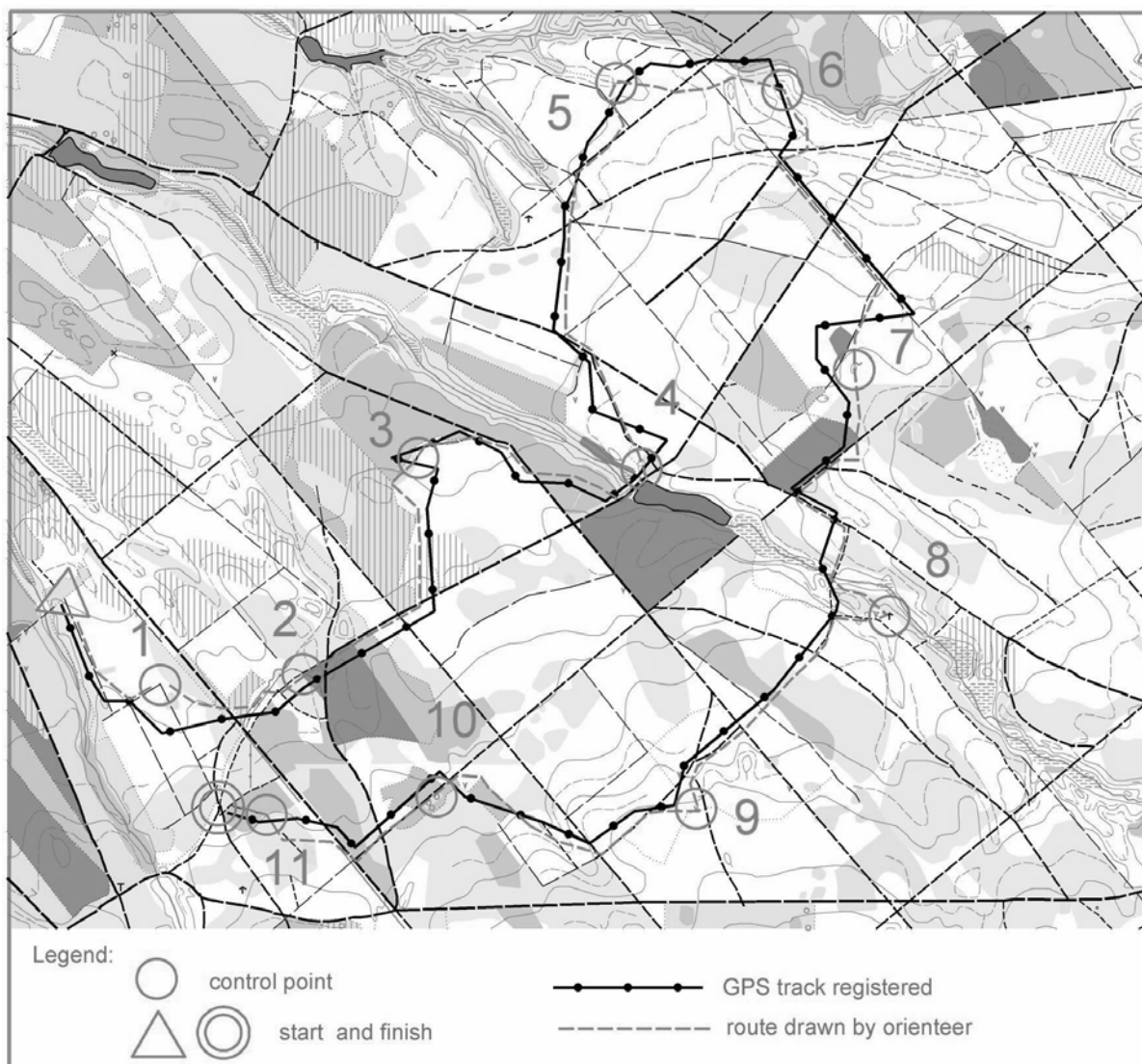


Figure 2. Flat terrain on the map on a scale of 1:15 000 with good quality of the recorded GPS signal

the run). In addition, the records of the GPS receivers contained gaps caused by the competitor's loss of contact with the satellites (Fig. 1, 2). This frequent reason for record distortion was mainly caused by the diverse configuration of the terrain (Fig. 1). Wherever there were high hills, the quality of the record differed from reality, although in afforested flat areas significant inaccuracies of the recorded "track" were also noted, making it impossible to state in an unambiguous way which route the competitor really took (Fig. 2). These two distorting factors (mountains and foliage) are also mentioned by other authors [8, 9, 14]. Also the

scale of orienteering maps is of great significance as far as the quality of the recorded route is concerned. During competitions, where the maps with scales 1:15000 were used, recording errors were relatively smaller, because on these maps 1 cm corresponded to 150 meters in the field, while during competitions held in parks more accurate maps were applied – on a scale of 1:5000. On these maps, 1 cm corresponded to 50 meters only. The recording error, when both "tracks" are compared, will, therefore, be higher than on the 1:15000 maps.

In orienteering, many parameters of training loads may be subject to control. The two most often

recorded parameters in this sport, with reference to its endurance nature [10], are certainly the duration of training and the traveled distance. The latter is in many cases not easy to measure in forest conditions. Competitors very often run far away from the route, and the non-linear nature of the traveled distance hampers its precise assessment, even with the use of the aforementioned device for measuring distances on maps. A GPS receiver can, therefore, be helpful in the assessment of the distance traveled during training or competition. This distance is usually measured with satisfactory exactitude, with the measurement error not exceeding 10% of the entire distance length. This error is much more frequently assessed in minus in relation to the actual distance, this being a result of a fading signal. In a mountainous or hilly terrain the possibility of using the GPS receiver to estimate the traveled distance is, however, substantially restricted, and the measurement error can be much greater. Another tested parameter is overcoming hills during the run. Also in this case, the quality of measurement will depend on the features of the landscape. Unfortunately, in areas where the measurement of this parameter would be most valuable, the exactitude of assessment is not, in experts' opinion, sufficient. For a proper definition of the altitude above the sea level and its changes, the GPS receiver needs a signal from at least 4 satellites (to define the horizontal position, a signal from 3 satellites is enough), which is often impossible in the mountains where the GPS does not receive the appropriate number of signals in deep ravines and valleys, unless it has an in-built barometric altimeter function (Forerunner 201 is not equipped with a barometric altimeter).

During the preliminary training, but also at the competitive level, orienteers undergo training sessions in various types of terrain. Such sessions are not always carried out with a specialist map. Very often the so-called "crosses" are exercised in terrains, where the competitor has no such map at his (her) disposal (for instance, at sports camps). Then the use of a GPS receiver can make it easier for the competitor to carry out the training contents and help control one's own position with reference to the spot where the training began or to the points stored in the GPS receiver's memory. One can also take advantage of the "return to the start" option and choose it after having run half of the distance in order to return following the same track. The GPS receiver can be also used to control the competitors' capability of assessing the distance in the

field. Such capability is necessary in orienteering. Thanks to the application of GPS, an orienteer can receive feedback information on the distance traveled between selected points and compare this distance to the one assessed by himself (herself). This GPS function seems very helpful in the development of orientation skills, and its significance has been already discussed by Cych and Kozłowski [3] as well as Mleczek and Trzmielewski [9].

As the GPS Forerunner 201 receivers have been available on the market for a relatively short time now (one year), it has not been possible to test them more thoroughly – even in terms of defining the relationship between the fastening position of the receiver or the competitor's moving speed, and the quality of recorded data. It seems also desirable to test the receivers made by other manufacturers (e.g. FRWD); however, it depends on their availability on the Polish market and the financial possibilities of the test supervisors. The FRWD is a new measurement tool released by a Finnish company in 2004. It is designed and built for a completely new purpose: the FRWD is a sports computer. The manufacturer assures that in practice its accuracy is much better than regular real-time GPS due to an advanced mathematical algorithm built into the FRWD Replayer PC Software. This algorithm is responsible for all GPS/sensor/HR-data processing and calculations when opening and analysing the recorded performance file [16]. The usefulness of this device and some other ones will certainly be the subject of the author's further investigations.

The results of the study lead to the following conclusions:

1. The exactitude of the record of the traveled track by a GPS receiver used in the study is not sufficient for controlling orienteering training.
2. In spite of the discussed constraints on the application of GPS receivers in controlling orienteering training, there are a number of control methods and forms of training in which the application of GPS enhances the diagnosis and registration of charges, and also facilitates the implementation of training tasks and contents.

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