

Information System "Bicycle Coach Assistant"

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Abstract

Currently, the question of the informatization of the sports industry is relevant. To achieve the highest results in sports, it is necessary to constantly improve the system of preparation and training. A part of such a system is both modern simulators and variously composed training processes. Thanks to modern simulators, which are equipped with various sensors, it became possible to more accurately receive objective information about the quality of the formed motor skills of cyclists at different stages of pedaling technique improvement. Automation of storage and processing of training data for each athlete on the Wattbike bicycle ergometer is relevant. It is necessary to develop an algorithm for estimating the coefficient of pedaling technique (CPT) based on information about training. Based on CPT, the following scale for assessing the level of formation of the pedaling technique of an athlete can be drawn up: beginner, intermediate and professional levels of an athlete. This algorithm is implemented in the information system of the cycling assistant coach. A structural diagram of the information complex "Cycling Coach Assistant" has been drawn up. For this complex, a database has been designed, filled with initial data. The software implementation is done: the database is implemented in MySQL Workbench and the front-end part in the QT framework in C ++. The obtained information system gives an objective assessment of the quality of the athlete's pedaling technique, which allows improving the training process.

Keywords 1

Information system, database, MySQL, QT, pedaling technique, polar graph, training process control

1. Introduction

The relevance of creating an information system for an assistant coach in cycling is because at present it is necessary to automate the storage and processing of a large amount of data from the training of each athlete.

Here, for ease of use, a simple, easy-to-learn interface is created for loading, processing, and storing data from training.

Goal relation of the information system "Bicycle Coach Assistant".

To achieve this goal, you must complete the following tasks [1, 2]:

- 1) develop an algorithm for calculating the coefficient of an athlete's pedaling technique;
- 2) design an information system;
- 3) design a database (DB), including various tables;
- 4) develop and implement an algorithm for processing the received data;
- 5) develop and test software.

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2. Features of the Pedaling Technique of an Athlete a Cyclist

The instruments used to measure the physical or physiological quality of a person have already become part of the daily life of many people. While such simple devices output mainly statistical values of the measured quantities, the requirements in sports are more stringent. The values of interest should be measured over a wider range, with greater precision, and with a higher sampling rate.

Modern technical devices can also be used in cycling since the process of studying the quality of pedaling and an objective assessment of the formed motor skills is important in preparing an athlete for competitions in a cycling sport [3]. An athlete's motor skills in this sport appear and improve with repeated repetition of pedaling.

Let us consider in more detail the features of training an athlete - a cyclist on a bicycle ergometer. The ergometer is a more advanced and intelligent analog of an exercise bike with a high-tech electromagnetic system that provides accurate digital information about the speed of rotation of the pedals, calorie consumption, and other indicators of the athlete's body.

All further research was carried out on the example of the Wattbike bicycle ergometer [4] in the regional center for the identification and support of gifted children "Polaris-Adygea", Maykop.

In the framework of these studies, the analysis of the athlete's pedaling technique was performed using the Polar View visualization (polar graph) [5, 6]. Polar View shows a graphical representation of the technique in real-time, which shows exactly where the force is lost when you press the pedal, how much power each leg produces, and the angle of maximum force. Two examples can be considered: the schedule of a beginner athlete and a professional (Figure 1).

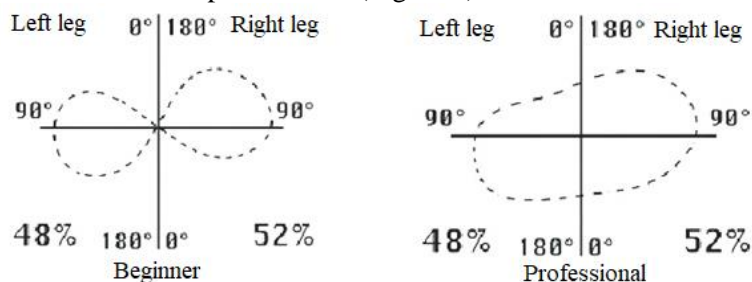


Figure 1: Pedaling Techniques for Beginner Athlete and Professional

As a result, test data about the athlete's training were collected (Figure 2).

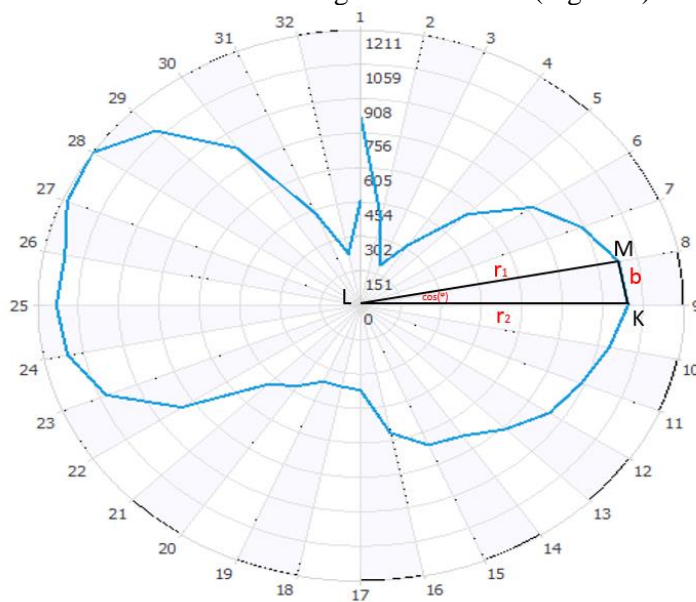


Figure 2: Polar power graph

Based on this information, the athlete's pedaling technique coefficient can be calculated using the following algorithm (figure 3) [7, 8]:

1. Let's calculate the area of the full circle:

$$S = \pi R^2$$

π – constant 3.1415926, R – radius.

2. The distance between two points M and K (the length of the segment) is calculated by the cosine theorem:

$$b = \sqrt{r_1^2 + r_2^2 - 2r_1r_2 \cos \varphi}$$

r_1 - is the radius of the n-sector;

r_2 - is the radius of n + 1 sector;

$\cos \varphi$ - the angle of this sector $360/33 = 11$.

3. Next, we find the semi perimeter of one sector (triangle) by the following formula:

$$p = \frac{r_1 + r_2 + b}{2}$$

4. The area of a triangle (sector) is calculated by Heron's formula:

$$S_{MLK} = \sqrt{p(p-a)(p-b)(p-c)}$$

5. The area of the constructed figure is calculated by the following formula:

$$S_{\omega} = \sum_{i=1}^{33} S_{MLK i}$$

$S_{MLK i}$ - area of one sector (triangle).

6. The athlete's pedaling technique coefficient is calculated as follows:

$$cpt = \frac{S_{\omega}}{S}$$

To analyze the level of formation of the sportsman's motor actions technique, a methodology for assessing the pedaling technique was developed and the coefficient of the pedaling technique (cpt) of the athlete was calculated. Based on the cpt , the following scale for assessing the level of the athlete's pedaling technique formation can be drawn up:

- 0 - 0.3 - beginner level;
- 0.3 - 0.4 - average level;
- 0.4 - 1 - professional level.

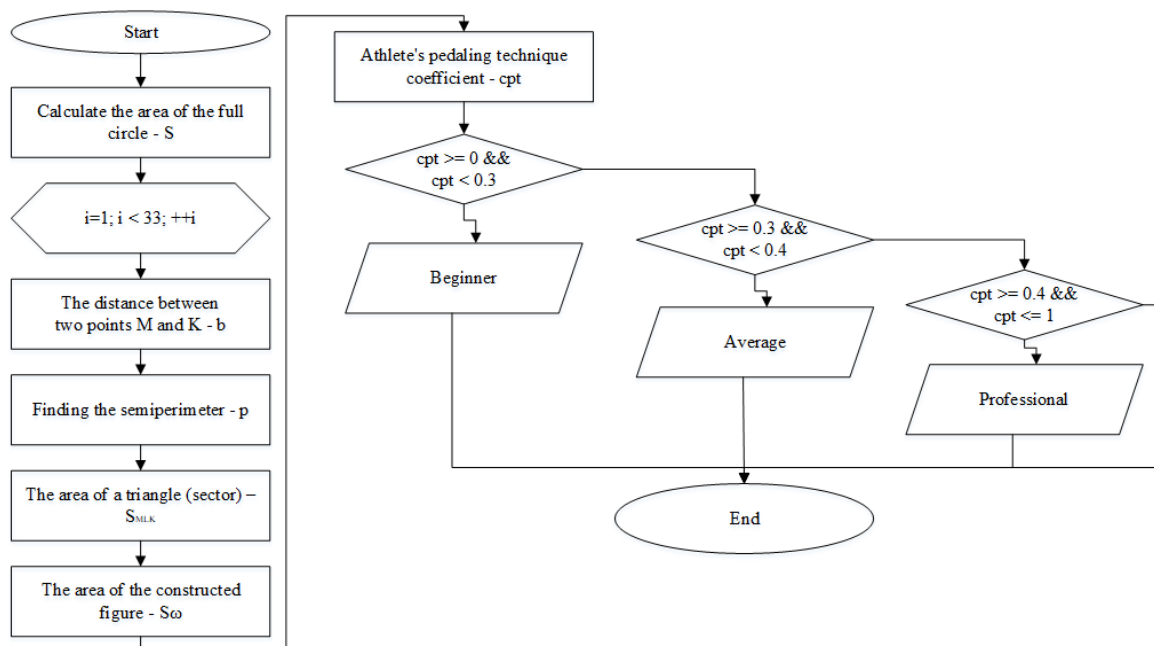


Figure3: Algorithm for calculating the coefficient of pedaling technique

Thus, the specified algorithm for assessing the level of formation of the athlete's pedaling technique can be implemented within the information system "Bicycle coach assistant".

3. Design of the Structural and Software Complex of the Information System "Bicycle Coach Assistant"

The structure of the information system (IS) [9, 10, 11] software complex is shown in Figure 4 and consists of the following main blocks:

1. Block for entering information. Designed to convert information received in physical quantities (force, displacement) into an electrical signal, and then into a digital format. Optical markers are attached to the athlete, with the help of which the athlete's kinematic locomotion during pedaling is tracked, namely, the angular and linear movements and velocities in the hip, knee, and ankle joints. The training is recorded in the video file of the Video Analysis-3D Biosoft program. Then the data is transferred to the Ortho-3D program, where video analysis takes place, the three-dimensional coordinates of the marks are calculated. The obtained coordinates are entered into a file with the *.CSV extension. Then the *.CSV file is sent to the system interface.

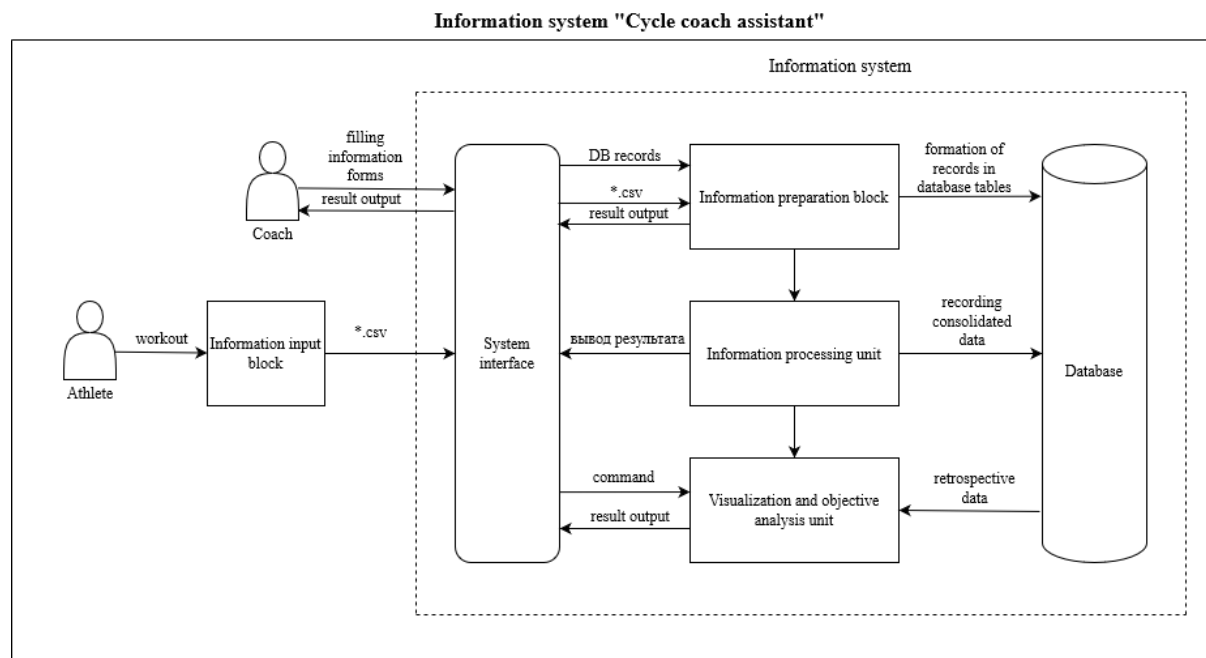


Figure 4: Structural and software complex information system "Bicycle Coach Assistant"

2. Block of preparation of information. It is intended for converting the incoming information into the database format, which is filled in by the trainer.

Two types of information are received at the entrance:

- long-term information guides about athletes, coaches. The coach fills in the basic data about the athletes (personal data, date of birth, grade, anthropometric indicators). The Infobase is updated as needed, all records are stored in the database.

- *.CSV files with kinematic and dynamic data obtained during the current workout. This data is added to the database regularly, after each workout.

All these data enter the database and form records in the database tables.

3. Block of information processing. Designed for processing and calculating integrated data values.

The information comes from the information preparation block. The data for plotting the graph and total parameters are calculated, the power and other computational actions are calculated (the number of circles, the search for absolute values, the calculation of the amount of force).

Writing consolidated data to the database.

4. Block of visualization and objective analysis. It is intended to provide information to the trainer in a graphical form and the form of analytical indicators, to obtain an objective analysis of the pedaling technique. The final data (current workout) comes from the processing block. The retrospective data comes from the database. It is cumulative training data. The result of the work of the visualization and objective analysis unit is the demonstration on the interface of the constructed polar graph, which shows the force applied to the pedals during the pedaling bicycle, as well as obtaining objective information about the biomechanical characteristics of sports equipment. Further, there is a comparison with the model characteristics of the pedaling technique.

4. Database Design

The choice of a DBMS is a complex multi-parameter task and is one of the important stages in the development of a database. The software product chosen should be easy to scale.

The physical structure of the database, implemented in the MySQL Workbench DBMS [12, 13] and shown in Figure 5, consists of 11 main entities (sports school, coach, training, athlete), which are presented in tables. The necessary attributes are selected for each entity, all entities are linked by a one-to-many relationship. Data types and sizes of fields are defined.

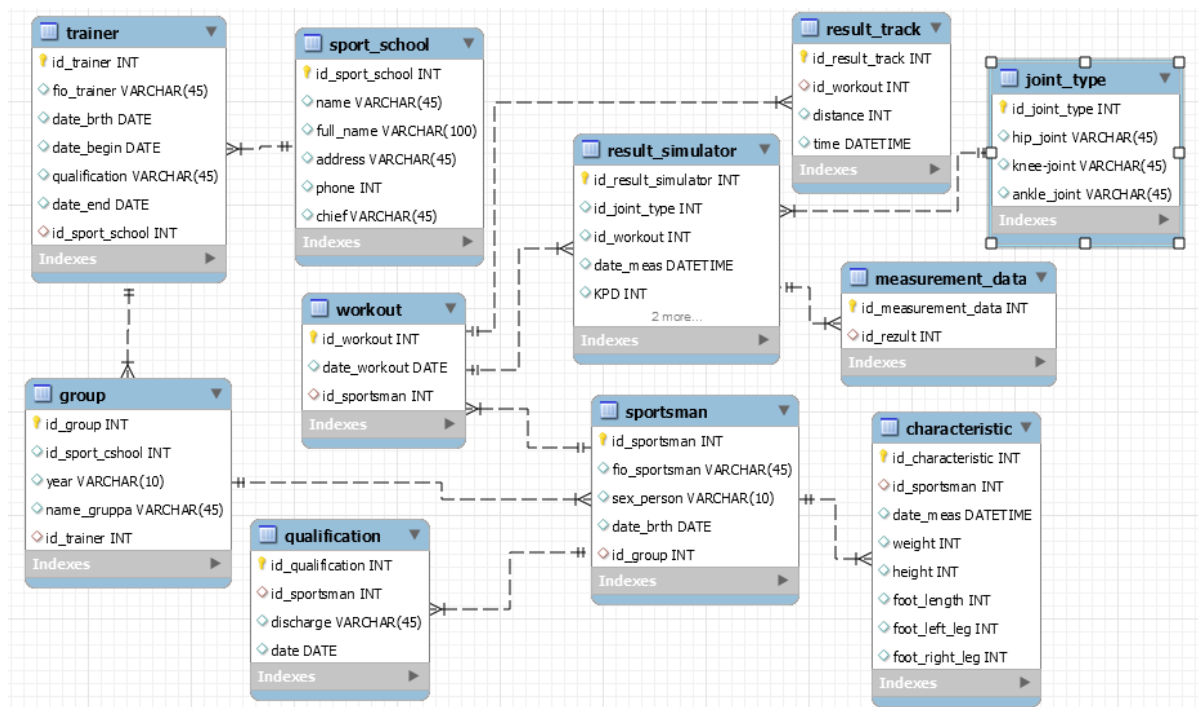


Figure 5: The physical structure of the database

5. Software Development

Using the Qt framework [14, 15, 16, 17], an information system interface has been developed. The implemented database in the MySQL Workbench DBMS is connected to the software product, with which it is possible to view and analyze the training results. This reduces the time that the coach spends processing the athlete's data.

The form for creating a workout with a graphical interface is shown in Figure 6.

It is necessary to choose a coach, group, athlete. Next, check if a workout has not been created, then you need to create a new workout. Load the file with the indicators of the current workout with the extension *.csv.

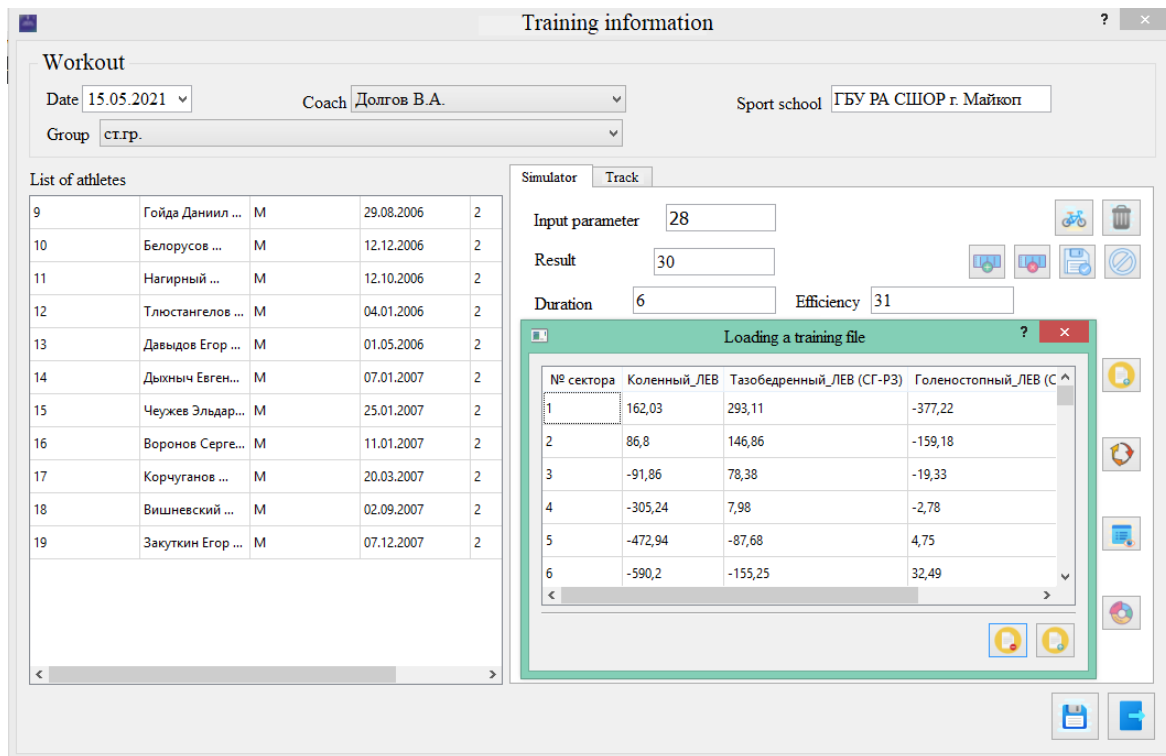


Figure 6: Workout creation form

Figure 7 a) shows the software implementation of the polar graph algorithm; graphs displaying the work of the knee (k), hip (h), and ankle (a) joints are plotted separately. Then the forces of the three joints are summed up and the polar power graph is obtained, presented in Figure 7 b). Scripts for executing software implementation are presented in Table 1.

Table 1

Source code

Knee graph	Graph for the sum of three joints
<pre> QLineSeries *series1 = new QLineSeries(); series1->setName(names[0]); for (int i = 0; i < wordList.size(); ++i) { x=wordList.at(i).n; y=wordList.at(i).k; series1->append(x,y); } </pre>	<pre> QLineSeries *series4 = new QLineSeries(); series4->setName(names[3]); for (int i = 0; i < wordList.size(); ++i) { x=wordList.at(i).n; y=wordList.at(i).sum; series4->append(x,y); } </pre>



Figure 7: a) Polar graph of the k.h.a. joints power b) Polar plot of joint power sum

6. Conclusion

The information system “Cycling Coach Assistant” has been designed, which is a convenient and easy-to-use interface for the coach's work. To implement the information system, a database was designed and implemented in the MySQL Workbench. The interface is developed in the QT framework in the C++ programming language. An algorithm for processing the received data has been developed and implemented, with the help of which the trainer receives objective information about the biomechanical characteristics of the sportsman's sports technique when pedaling.

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