

STUDY ON EQUIPMENT FOR SHOT PUT SOUND SIGNAL FEEDBACK**Jintian Yang¹, Yintian Yang², Jie Du³, Suqing Yin³ and Wei Zhang³****¹Shanghai College of Physical Education Post Graduate Cultivated Station,
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There are not many articles about the structure of putting, especially on the dynamic study. At present nobody applies instruments and equipments to measure dynamic parameters in the course of putting. The result of this study is to make an electronic pressure device fixed inside a shot. According to non-electric measuring principles, a computer is used to analyze the acquired signals after their amplification, taking sample and A/D transmission so as to measure the dynamic parameters that shot-putters have strength on their arms. They may work as theoretical basis of teaching and training. In the meantime they can also help coaches to give technological diagnosis of shot-putters and make a scientific plan of training. Only in this way can shot-putters in China catch the advanced level of the world and win good scores at the Olympic Games.

KEY WORDS: shot, dynamic characteristics, testing system, making instruments

INTRODUCTION: Shot putting is a power-and-speed event based on strength and speed. The relevant documents inside and outside China show the dynamic researches on throwing events haven't gone far enough. The reason is that until now we haven't better equipment to measure the development of mechanic parameter of human body that takes effect on apparatus directly. In recent years with the growing mature of sensor technology, the Three-Dimensional Force Measuring Platform and the 6 Dimension Force Testing Platform made in China are widely used by more and more sport researchers in sport scientific research. In dynamic analysis force testing platforms are frequently used to measure the force and its changing relation between the human body and the supporting point, thus revealing the interaction law between human body and outside object. But the way of measuring should be static measurement under a kind of smooth and stable state, the size and the position of the platform would also affect the practical application, and therefore the three-dimensional force measuring analysis, force analysis as well as synchronous filming analysis would be very hard, so there are few researches on this field. The testing of human body space-acting force in throwing events is just the problem that physical education experts and researchers want to know and solve, but now we do not have this kind of equipment yet. Through cooperation with experts of physics and electronics, electron pressure unit inside the shot and the non-electric measuring principles that are used to analyze the signal, we may get the dynamic parameter of human body that takes effect on apparatus. Through testing and analysis of excellent athletes inside and outside China we have found out technical movement of optimization and offered the training and education theoretical basis.

METHODS: How to gather electronic signal and transmit those signals into sound signals or signal curve and to help the athletes improve and perfect their techniques by establishing a correct feedback of sound signals are as follows. First, dissect the shot and fix an electron pressure unit in it through wire or wireless way. Second, transmit the signal through signal amplifier. Then the athletes can judge the quality of their movements through the sound signal from the earphone. The researchers can depict the received electric signal wave into sound signal curve and analyze it at the same time. When completing technical movement, we can use camcorder and force measuring platform to get the kinematics parameter of throwing speed and angle. Synchronize kinematics parameter and dynamic parameter, measure the excellent athletes to establish best technical movement model and coaches compare the collected data with movement model, so that they can transmit the reasonable technical movement sound signal to make the athletes improve and perfect their techniques through the establishing of correct sound signal feedback system.

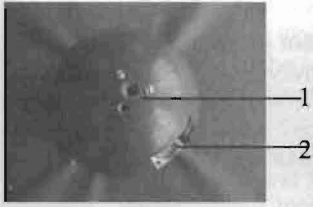


Figure 1



Figure 2

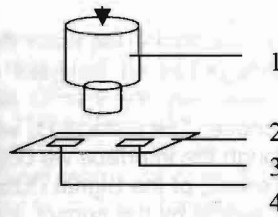


Figure 3

1. The General Design of the Shot Sound Signal Feedback Equipment (see Figure 1). As picture shows, to empty the center of the shot and put the electron pressure unit in the hole, in order to keep the weight of the shot unchanged, the researchers make the column conductor in the electron pressure unit equal to the weight of taken-out part. The sending out of the electron pressure unit outputs through the output interface 1, and then amplify, transmit to the computer to be processed. After the installation of the shot, fix the hole with screws to avoid the damage of the electronic unit inside.

2. The Structure of the Shot Sound Signal Feedback Equipment (see Figure 2)

As the picture shows, shot sound signal information feedback equipment inside structure is composed of electron pressure unit (see the principle Figure 3, 1 -- column conductor; 2 -- elastic sensing element; 3, 4 -- resistance strain gauge R1, R2; the opposite side of the elastic element 2 has resistance strain gauge R3, R4.)

Because of the small volume and the thick thickness of the shot, the researchers consider that size of the electronic device should be small in size and light in weight and the sensitivity should be high under the situation of small resistance variation. Considering all the elements above, we choose to use the strain resistance transducer to be the major device of the electron pressure unit. The working principle can be seen in picture 3.

This electronic pressure unit is composed of column conductor 1, elastic sensing element 2 and resistance strain gauge R1, R2, R3, R4. Strain gauge was welded onto the elastic element fixed inside the shot by screws. When the pressure force changes, the elastic sensing element 2 can produce elasticity because of the pressure force. At the same time, the strain gauge on the elastic sensing element 2 has the same change, so the resistance of the strain gauge changes too. Join the strain gauge with the bridge circuit, and then the changing of the resistance will be transformed to voltage, thus showing the changing of voltage in this way.

3. Internal Shot Measuring Circuit

In this electronic pressure unit, the elastic sensing element has four strain gauges. Under the stress, while R1 and R2 resistances reduce, while R3 and R4 resistances increase. In this way, a differential bridge is formed as Figure 4(internal shot measuring circuit) shows.

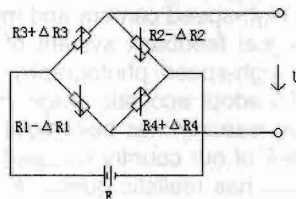


Figure 4

According to the stress of the strain gauge, the four strain gauges can be divided into one group (R1, R2; R3, R4), and R1 and R2 are pressed while R3 and R4 are pulled. Since the elastic sensing element is even to the column conductor, $\Delta R1 = \Delta R2 = \Delta R3 = \Delta R4 = \Delta R$, $R1 = R2 = R3 = R4 = R$, so form an equal arm bridge. The export voltage is:

$$U_0 = -\Delta R / R \cdot E$$

From the formula above, we know that U_0 and $\Delta R / R$ have a linear relation which shows that differential bridge has no nonlinear error, and its voltage sensitivity $K_u = -E$ is rather high. And it can also play the role of temperature compensation. That is why we use 4-arms differential bridge. The voltage U_0 we measured through the circuit is the voltage we want to collect. Through the interface we output the voltage U_0 and process and transform it.

4. The Processing of the Signal Output from the Shot

The signals output by the sensor are usually very weak, so we should amplify those signals to be processed in the next step. Because the electronic pressure unit outputs little voltage signal, measuring circuit should be 4-arms differential bridge, and the non-linear of the amplifier should be small and the common mode rejection should be large. Based on the above demands, we choose the amplifier A/D522 made by American Analog Devices.

The amplified signal voltage is the analog voltage, and the computer can only process digital signal, so we should transform the analog voltage to digital signal. In order to meet this we use the A/D transmission, a kind of transmission that transforms analog signal to discrete digital signal with the changing of time, therefore the digital signal is the value that collected in a series of special time (sampling time). But the transformation needs some time. During the transformation period, if the analog signal changes, it will lead to transformation error. To restrict this error, we usually add a sample and hold circuit to maintain the power level of the input signal and to make sure that the signal remains unchanged. After the A/D conversion we trace the changing of the input signal to ensure the next input signal should be a new one. After the conversion of A/D, the electric quantities can be processed by computer.

RESULT AND DISCUSSION: This instrument has been tested by three shot-putters coming from Grade 2 of Sports Training Department of Hebei Physical Education Institute. This test is completed under an experimental condition. To reduce the landing power of the shot, we covered the landing area with sponge mats/ cushions. Through the combination of dynamics information from the shot testing and the video records from the camera synchronism, we found out several obvious featured points in the force curve. Then we discovered some problems and found out some laws by jointing those featured corresponding sports features. The changing tendency of the shot forcing curve and the shot changing speed was basically consistent and in the course of the last putting movement, the force composition curve was in a two-summits shape.

This equipment is in the leading position all over the world. There are few researches on this field from the documents in China and the rest of the world. Only Doctor Su Dula did similar research in his thesis in 1992, but his research can only let athlete hear the sound signal in the course of shot put. This research can not only get the sound signal in the course of shot put, but also amplify, take sample, A/D transmit the sound signals, input the signals into the computer, and analyze those signals. Then we could get the dynamics parameter of the shot put and use it combined with the high-speed camera and myoelectricity. His research subject is the establishment of sound signal feedback system of track and field throwing events. Nowadays researchers use the high-speed photography and the three-dimensional force measurement in their analysis. To adopt acoustic image myoelectricity with kinematics and dynamics together to improve the research has become a new international tendency. This research can fill the research blank of our country on sport biological mechanics equipment. The sound signal feedback system has realistic guidance and theoretical research value in the technical improvement of our female shot and in the remaining of our leading position in Asia and in the making of breakthrough in winning the gold medal of the Olympic Games.

CONCLUSION: From the present condition for shot-putting at home and abroad, the research should be centered in the kinematics with the rapid development of technology. The technology of filming has been improved and perfected and the kinematics research will develop, but this kind of information feedback period is long and not so precise, so the dynamic research of shot-putting has become a tendency in the future research. Now there

are few researches on the dynamic research of throwing arm, so to have a better research of the dynamic feature of throwing arm has become the wish of many researchers. This research is the only solution to this problem, so it will have a wide application prospect. In addition, because of the severe competition inside and outside China, we should do everything to raise the record in the training. Intelligence training and testing system is what they need urgently in their training, and therefore this research accomplishment will have very wide application space. The research accomplishment can be widely used in the national team of track and field, province teams and school teams, or even in the 30 sports research institutes in China, 160 college PE departments in their training and research. Firstly, the production of this kind of equipment can create considerable economic value. Secondly, this equipment can be applied to high-level training and help them to get better achievement.

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