Journal of Advanced Sport Technology
DOI: 10.22098/JAST.2025.14573.1336
Received: 1 February 2024 Accepted: 21 January 2025

ORIGINAL ARTICLE

Open Access

Preliminary Design of Smart Glove with the Ability to Vibration Measuring System in Shooters

Ebrahim Piri [1], AmirAli Jafarnezhadgero [*2]

1. Department of Sports Biomechanics, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran.
2. Department of Sports Biomechanics, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran.

Correspondence
Author's Name:
AmirAli Jafarnezhadgero
Email:
amiralijafarnezhad@gmail.com

How to cite
Piri, E., Jafarnezhadgero, AA. Preliminary Design of Smart Glove with the Ability to Vibration Measuring System in Shooters. Journal of Advanced Sport Technology. (2025. DOI: 10.22098/JAST.2025.14573.1336

A B S T R A C T

The purpose of this exploratory study was to Preliminary Design of Smart Glove with the Ability to Vibration Measuring System in Shooters. In this Smart glove, four sensors with the ability to vibration measuring are placed on the proximal band of the index finger, middle finger, wrist and deltoid, respectively. In this exploration were used vibration sensor model SW-18010P with dimensions of 14x14 mm. Furthermore, the device has the ability to save data on a Micro SD card. The device software is written with the programming language C. Lithium Polymer batteries (LiPo Battery) is a small sized, little weight and rechargeable battery. The data recorded in each time period were saved and transferred to the researcher's mobile via Bluetooth. Bluetooth is a wireless technology standard for exchanging data over specific distances. This Bluetooth module can achieve serial wireless data transmission between microcontroller with the mobile or computer system the glove. It's a small DC motor. The primary function of the vibration motor is to inform the users of receiving the signal by vibrating. Vibrating motors represents dots in braille system. Upon receiving a character, the pattern of vibrating represents the character in braille system. The commutation points are arranged in alternating polarity pairs, so as the rotor moves; the coils are constantly reversing polarity as they pass over commutation points. In this way, the motor continually rotates, and at a speed that is proportional to the applied voltage. It seems that coaches and athletes can be useful by discovering information about shooters' hand tremors during shooting and providing a suitable training program to improve the shooting quality of athletes.

K E Y W O R D S

Smart glove, Vibration measuring system, Shooters, Archery athletes, Technology.

Introduction

One of the growing sporting achievements is shooters. Shooters are a precision sport that requires consistency and stability of movement so that the arrow is accurate [1, 2]. The characteristics of Shooters are releasing arrows through a certain trajectory towards a target at a certain distance [3]. Shooters is one of the measurable sports and the accuracy of hitting the target is the most absolute thing. In shooting sports, each athlete must be able to throw or shoot their arrows at a predetermined target [4]. The physical components needed in Shooters include muscle strength, muscle endurance, and balance is a component needed in Shooters because it must be able to hold the body, while on the other hand aiming to release the shot [5]. Balance is an integral part of all movement. Balance is defined as the ability to maintain motion. The International Shooting Sport Federation defines the stages of shooting movements as movement stability, aiming accuracy, and firing fluency. Previous studies have suggested that movement stability is positively associated with shooting performance [6, 7]. Additionally, movement and postural stability directly influence athletic performance. Previous studies have reported that balance is an important factor in both daily physical activities and professional sports [8]. Balance is achieved through the integration of the visual, proprioceptive, and vestibular sensory ability systems [9], which are adjusted according to the situation, tactile sense, stimulation, and information obtained through body shaking assisted by lower limb muscle strength [10]. Elite shooters have found that their dependence on posture control and muscle strength consumption when receiving external stimuli can be reduced through balance [11, 12]. The reduction of dependence on posture control and balance ability in the movement process enables better competition performance [13]. Strength and conditioning experts should consider the aspect of sensory nervous system integration in different balance exercises. However, most studies focused only on stability and balance in shooting movements; muzzle trajectory and temporal parameters during the movements were seldom analyzed. The stability of movements is affected by insufficient lower-limb muscle strength. Through training interventions, lower-limb muscle strength can be effectively improved, leading to better athletic performance. For example, effective training methods such as vibration training and unstable surface training (UST) have special auxiliary effects in specific sports.

Previous studies on vibration stimulation reported that the g-force produced stimulates the major end of the muscle spindle (Ia afferent), thus activating and recruiting more α-motor neurons. This state leads to muscle tetanic contraction, which is known as tonic vibration reflex (TVR) [14, 15]. Pluhar et al, reported that individual sports require greater concentration and sensitivity to physical and psychological change during games, due to anxiety [16]. Inappropriate training for athlete health conditions leads to inconsistent performance for every game. In order to help the athlete with consistent performance during real games, the coaches need to make immediate analyses of the changes in the athlete’s conditions. Therefore, health monitoring systems have received great attention from the coaches to monitor all the possible criteria of athletes, including real-time monitoring of the athlete's health conditions [17]. The combination of multiple sensors from the monitoring system can detect the psychological parameters and assist the coaches to monitor and record the athlete's overall health level. Besides that, the monitoring system can compare the previous data of athlete performance before, during and after the gaming sessions. A study in China discussed the significance of wearable health monitoring systems facilitating the coaches in analysing the athletes' conditions and performances [18]. Accurate understanding of movement characteristics and improvement of athletic performance by certain methods have become key points in developing athletic skills.

Shooting is a competition sport in which one aims and shoots on fixed or moving targets. The control of weapon stability is a distinctive feature in this sport. Tang et al. emphasized that a controlled grip of the weapon and hand in harmony is the most essential fundamental for shooting accuracy [19]. According to the contents, good and effective hits are made with perfect trigger control, not with perfect sight control. Probably be useful to design a tool that can provide information about the shooters hand vibration. Therefore, it takes a lot of training to improve this skill. As seen in the resources, all these conditions are about the hand and fingers holding the pistol and shows the

importance of the hand and fingers holding the pistol. Sports scientists, researchers and coaches have to find new and efficient methods to enhance and maintain success by boosting the athlete's performance. Therefore, the aim of the present study is the preliminary design of a smart glove for measuring the vibration of shooters hands.

Anxiety in Athlete Performance

Every sport has specific requirements for winning. Athletes' success, whether in the beginning, intermediate, or elite categories, can be primarily determined by their performance during competitions. However, good performance does not rely solely on skills. Instead, how to overcome anxiety helps athletes

produce more consistent performance. According to prior studies, athletes who compete in individualistic sports report feeling more anxious than those who compete in team sports [20]. Individual athletes are more engaged in their skills and abilities without depending on team athletes. Anxiety, motivation, stress, selfconfidence, general activation, attention, and team cohesion are all psychological factors that influence athletes' performance and well-being. For this reason, athletes must work on psychological skills to perform better. A psychological component is crucial for an individual sport requiring high accuracy or concentration levels, such as darts, rifle shooting, or Shooting or all sports related to shooting.

Conventional monitoring systems from the coach's practices commonly fail to identify athlete health conditions during the early stages of physical or emotional changes. The intense emotional and physical pressure the game can bring can hinder athletes' ability to focus on their opponents. In other words, if athletes lose concentration during games, their performance will decline [13]. After all, poor or inconsistent sports performance will show that the athlete is not in good condition during the games. Due to this, technological is necessary for sports trainers to monitor and track athletes' health status during practice or competitions. The dataset of health status was gathered by placing the sensors on the athlete's body, and collecting useful information throughout all the athlete's movements during gameplay. Many studies are concentrating on a wearable device-based health monitoring system to improve and enhance sports performance among all levels of athletes.

A preventive monitoring system encourages a healthy lifestyles or habits by reducing the risk of significant illness by automatically identifying and notifying athletes about unhealthy practices. Utilizing monitoring system technologies in athletes as assistive devices has contributed to incorporating additional devices that improve physical resistance and players' health. A responsive system is capable of providing ongoing monitoring and early detection of users' health issues before they deteriorate significantly. A responsive system can detect health conditions early and provide various health options based on the normal situation. A study in Spain revealed that the monitoring systems consists of multiple sensors that detect a possible mistake during any movement of basketball players [21]. The device alerts the player when the reading parameter exceeds the optimum index. Thus, this monitoring system could detect possible faults while performing movements, and the device would alert the player throughout the game session. Monitoring systems commonly used by the athletes, sports trainers and coaches during training and games. These monitoring systems are essential in obtaining real-time readings from the athlete's body.

Material and Methods

Design of Smart glove

The primary goals of the monitoring systems are to monitor the vibration and to alert them of the need for precaution when they are in training or in competitions. Numerous sports currently apply athlete monitoring equipment to prevent injuries as a standard practice. The overall view of the device illustrated in Figure 1.

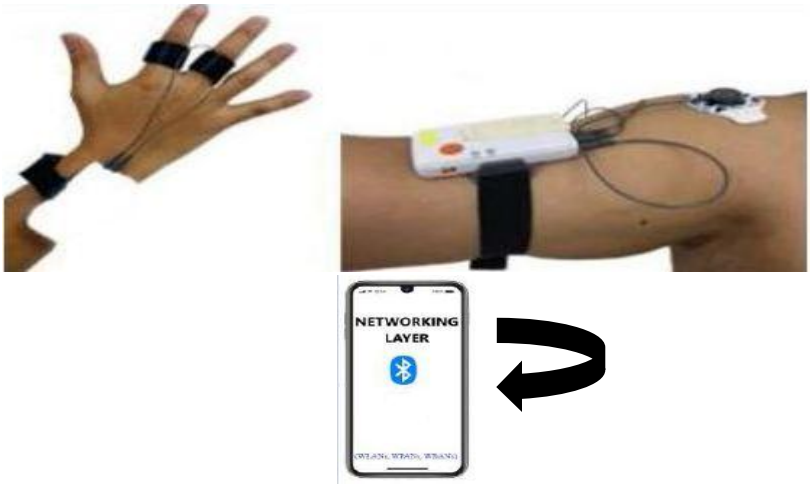

Figure 1. Multiple sensors located for measurement and evaluation of hand vibrations.

In this Smart glove, four sensors with the ability to vibration measuring are placed on the proximal band of the index finger, middle finger, wrist and deltoid, respectively. In this exploration were used vibration sensor model SW-18010P with dimensions of 14x14 mm. Furthermore, the device has the ability to save data on a Micro SD card. The device software is written with the programming language C. Lithium Polymer batteries (LiPo Battery) is a small sized, little weight and rechargeable battery. The data recorded in each time period were saved and transferred to the researcher's mobile via Bluetooth. Bluetooth is a wireless technology standard for exchanging data over specific distances. This Bluetooth module can achieve serial wireless data transmission between microcontroller with the mobile or computer system the glove. We chose Bluetooth because it achieves all of the requirements, (Easy to use, Suitable size, lower cost, Less energy consumption).

Figure 2. Bluetooth Module CH-06, and LiPo Battery.

The primary function of the vibration motor is to inform the users of receiving a signal by vibrating. In some applications, vibrating motors represent dots in the braille system. Upon receiving a character, the pattern of vibrating represents the character in braille system. Figure 3 shows, the internal construction of the vibration motor. The commutation points are arranged in alternating polarity pairs, so as the rotor moves; the coils are constantly reversing polarity as they pass over commutation points. In this way, the motor continually rotates, and at a speed that is proportional to the applied voltage [22]. Figure 4 shows the peak vibrations during shooting.

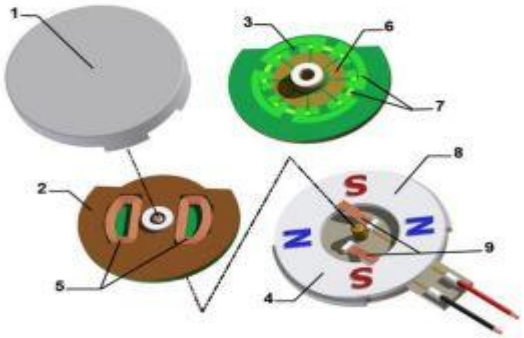

Figure 3. Vibration motors, :(1) Enclosure top, (2) Rotor (view as mounted), (3) Rotor (inverted view), (4) Enclosure bottom, (5) Coils, (6) Commutation points, (7) Alternating power supply circuits, (8) Ring magnet (showing representative polar zones), (9) Power supply brushes.

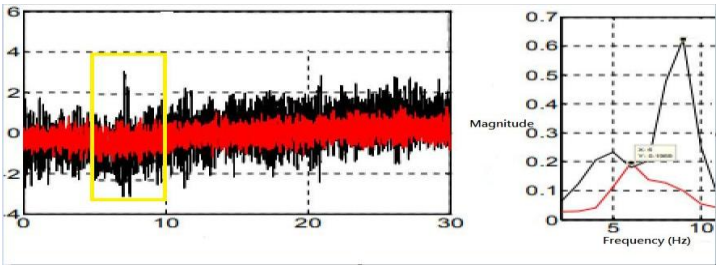

Figure 4. Evaluate Hand Motion in during Shooting.

Discussion

The purpose of this exploratory study was to Preliminary Design of Smart Glove with the Ability to Vibration Measuring System in Shooters. Every sport has its own set of criteria for determining victory. Multiple preparations are required for an athlete to become an expert in the sport in which he or she participates. Experienced athletes believe that physiological and psychological preparation are critical to maintaining consistent performance during training or competitions. For example, the sport shooters necessitate intense concentration to ensure that is aims at a particular target [23]. Excessive anxiety has become a significant barrier to athlete performance [24]. Identifying early changes in both elements of anxiety is essential to optimize the overall performance of the athletes in the competitions, so that they can play with their optimal performance in the competitions. For example, the shooters require a high focus to ensure that each archer is on a set target. Psychological factors such as anxiety, mind concentration, and body temperature and physiological parameters such as heart rate level, muscle activation, and skin conductance need to be given attention by athletes [25]. If these two main parameters are not achieved at optimal levels, the athlete will face inconsistent and debilitative performance and vice versa. Coaches are concerned about these basic parameters in determining their athletes' performance, reported that the athletes' ability to maintain and consistently perform throughout each training session would benefit from excellent monitoring of the critical parameter data [26]. Therefore, the anxiety monitoring system may gather all the necessary parameter readings from the bio-signal sensor by incorporating IoT technology. Athletes and coaches more accurately gather data from the parameters with the help of sensor devices as sports technology advances. The review shows that the sensors can retrieve and analyse digital data from multiple parameters. By comparing and studying the IoT devices in sports anxiety monitoring systems, we can better understand that the configuration of the IoTs for health monitoring systems is different for each purpose. Researchers have focused on implementing and designing IoT sports health monitoring systems to enhance the current services for athlete performance and helping the coaches to analyze their athletes' conditions.

It is possible to find studies in the literature that investigate the correlation between shooting competitions and shooting success. Scores are the result of shot groups (shot distribution) and everything we shot on the paper is the result of how we performed on the firing line. Erdogan et al. found in the study in which they investigated the effect of handgrip strength for shooting performance that as the handgrip strength of female student shooters increased, the scores they had in the competition also increased [27]. For an accurate shoot, keeping the pistol and hand under control in harmony is essential. As it is seen, literature studies support our findings as well.

Conclusion

This study was conducted to evaluate hand motion on shooting accuracy. An answer has been found to the hypothesis put forward in the light of the primary purpose of our investigation. According to the contents: It seems that coaches and athletes can be useful by discovering information about shooters' hand tremors during shooting and providing a suitable training program to improve the shooting quality of athletes.

Funding

The authors reported there is no funding associated with the work featured in this article.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Acknowledgment
None.

References

1. Lo Presti D, Romano C, Massaroni C, D'Abbraccio J, Massari L, Caponero MA, et al. Cardio-respiratory monitoring in archery using a smart textile based on flexible fiber Bragg grating sensors. Sensors. 2019;19(16):3581.
2. Simsek D, Cerrah A, Ertan H, Soylu A. A comparison of the ground reaction forces of archers with different levels of expertise during the arrow shooting. Science & sports. 2019;34(2):e137-e45.
3. Sarro KJ, Viana TDC, De Barros RML. Relationship between bow stability and postural control in recurve archery. European journal of sport science. 2021;21(4):515-20.
4. Tan SL, Koh KT, Kokkonen M. The perception of elite athletes' guided self-reflection and performance in archery. Reflective Practice. 2016;17(2):207-20.
5. Kim D-K. The effects of the upright body type exercise program on body balance and record of archers. 2018;28(1):9-18.
6. Ball K, Best R, Wrigley T. Body sway, aim point fluctuation and performance in rifle shooters: inter-and intra-individual analysis. Journal of sports sciences. 2003;21(7):559-66.
7. Mononen K, Konttinen N, Viitasalo J, Era P. Relationships between postural balance, rifle stability and shooting accuracy among novice rifle shooters. Scandinavian journal of medicine & science in sports. 2007;17(2):180-5.
8. Hrysomallis C. Balance ability and athletic performance. Sports medicine. 2011;41:221-32.
9. Karmali F, Goodworth AD, Valko Y, Leeder T, Peterka RJ, Merfeld DM. The role of vestibular cues in postural sway. Journal of neurophysiology. 2021;125(2):672-86.
10. Chiba R, Takakusaki K, Ota J, Yozu A, Haga N. Human upright posture control models based on multisensory inputs; in fast and slow dynamics. Neuroscience research. 2016;104:96-104.
11. Croix G, Chollet D, Thouvarecq R. Effect of expertise level on the perceptual characteristics of gymnasts. The Journal of Strength & Conditioning Research. 2010;24(6):1458-63.
12. Ihalainen S, Kuitunen S, Mononen K, Linnamo V. Determinants of elite-level air rifle shooting performance. Scandinavian journal of medicine & science in sports. 2016;26(3):266-74.
13. Paillard T, Noé F. Effect of expertise and visual contribution on postural control in soccer. Scandinavian journal of medicine & science in sports. 2006;16(5):345-8.
14. Lamont HS, Cramer JT, Bemben DA, Shehab RL, Anderson MA, Bemben MG. Effects of a 6-week periodized squat training with or without whole-body vibration upon short-term adaptations in squat strength and body composition. The Journal of Strength & Conditioning Research. 2011;25(7):1839-48.
15. Wilcock IM, Whatman C, Harris N, Keogh JW. Vibration training: could it enhance the strength, power, or speed of athletes? The Journal of Strength & Conditioning Research. 2009;23(2):593-603.
16. Pluhar E, McCracken C, Griffith KL, Christino MA, Sugimoto D, Meehan III WP. Team sport athletes may be less likely to suffer anxiety or depression than individual sport athletes. Journal of sports science & medicine. 2019;18(3):490.
17. Naranjo-Hernández D, Roa LM, Reina-Tosina J, Barbarov-Rostan G, Galdámez-Cruz O. Smart device for the determination of heart rate variability in real time. Journal of Sensors. 2017;2017.
18. Zhao Y, You Y. Design and data analysis of wearable sports posture measurement system based on Internet of Things. Alexandria Engineering Journal. 2021;60(1):691-701.
19. Tang W-T, Zhang W-Y, Huang C-C, Young M-S, Hwang I-S. Postural tremor and control of the upper limb in air pistol shooters. Journal of sports sciences. 2008;26(14):1579-87.
20. Hossein S, Zahra H, Seyed RAH. Comparative analysis of competitive state anxiety among team sport and individual sport athletes in Iran. Физическое воспитание студентов. 2016(5):57-61.
21. Guembe IP, Lopez-Iturri P, Astrain JJ, Aguirre E, Azpilicueta L, Celaya-Echarri M, et al. Basketball player on-body biophysical and environmental parameter monitoring based on wireless sensor network integration. IEEE Access. 2021;9:27051-66.
22. Kaaresoja T, Linjama J, editors. Perception of short tactile pulses generated by a vibration motor in a mobile phone. First joint eurohaptics conference and symposium on haptic interfaces for virtual environment and teleoperator systems World haptics conference; 2005: IEEE.
23. Tomor N, Shah MM. Comparison of competitive state anxiety among senior boys and senior girls Archery players in India. International journal of physical education, sports and health. 2015;1:43-5.
24. Horvath E, Kovacs MT, Toth D, Toth L. A study of the relationship between anxiety, cognitive emotion regulation and heart rate variability in athletes. Journal of physical education and sport. 2022;22(2):528-34.
25. Qiu Y, Zhu X, Lu J. Fitness monitoring system based on internet of things and big data analysis. IEEE Access. 2021;9:8054-68.
26. Snyder C, Martínez A, Jahnel R, Roe J, Stöggl T. Connected skiing: Motion quality quantification in alpine skiing. Sensors. 2021;21(11):3779.
27. Erdoğan M, Sağıroğlu İ, Şenduran F, Ada M, Ateş O. An investigation of the relationship between hand grip strength and shooting performance of elite shooters. İÜ Spor Bilimleri Dergisi. 2016;6(3):1303-414.

نشریه فناوری ورزشی پیشرفته
DOI: 10.22098/JAST.2025.14573.1336
تاریخ دریافت: ۱۴۰۲/۱۱/۱۲ تاریخ پذیرش: ۱۴۰۳/۱۱/۰۲
Journal of Advanced Sport Technology
«مقاله پژوهشی»

طراحی اولیه دستکش هوشمند با قابلیت اندازه‌گیری لرزش در تیراندازان

ابراهیم پیری[۱]، امیرعلی جعفرنژادگرو*[۲]
۱- گروه بیومکانیک ورزشی، دانشکده علوم تربیتی و روانشناسی، دانشگاه محقق اردبیلی، اردبیل، ایران
۲- گروه بیومکانیک ورزشی، دانشکده علوم تربیتی و روانشناسی، دانشگاه محقق اردبیلی، اردبیل، ایران

چکیده

هدف از این مطالعه اکتشافی، طراحی اولیه دستکش هوشمند با قابلیت سیستم اندازه‌گیری لرزش دست در تیراندازان بود. در این دستکش هوشمند، چهار سنسور با قابلیت اندازه‌گیری لرزش به ترتیب بر روی بند ابتدایی انگشت اشاره، بند ابتدایی انگشت میانی، مچ دست و دلتوئید قرار گرفته است. در این مطالعه از سنسور با قابلیت اندازه‌گیری ارتعاشات دست از مدل SW-18010P با ابعاد ۱۴×۱۴ میلی‌متر استفاده شد. علاوه بر این، این دستگاه قابلیت ذخیره اطلاعات روی کارت Micro SD را نیز دارد. نرم افزار دستگاه با زبان برنامه‌نویسی C نوشته شده است از باتری‌های لیتیوم پلیمری LiPo Battery که یک باتری کوچک، کم‌وزن و قابل شارژ هستند استفاده شده است. داده‌های ثبت شده در هر بازه زمانی ذخیره و از طریق بلوتوث به تلفن همراه پژوهشگر انتقال داده می‌شود. با توجه به آن که بلوتوث یکی از روش‌های استاندارد فناوری بی‌سیم برای تبادل اطلاعات است، این ماژول بلوتوث به انتقال داده‌های بی‌سیم سریال بین میکروکنترلر با موبایل یا سیستم کامپیوتری دستکش مورد استفاده قرار گرفت. در این مطالعه از یک موتور DC کوچک که مسئول دریافت و انتقال ارتعاشات بود مورد استفاده قرار گرفت به نحوی که موتورهای ارتعاشی نشان‌دهنده نقاط در سیستم بریل هستند. پس از دریافت یک ارتعاش، الگوی ارتعاش در سیستم بریل نمایان می‌گردد. لرزش دستان در جفت قطبیت موتور متناوب مرتب تکرار می‌شود، به طوری که در پی آن روتور حرکت می‌کند. سیم پیچ‌ها با دریافت محرک‌ها دائماً قطبیت خود را معکوس می‌کنند. به این ترتیب موتور به طور مداوم و با سرعتی متناسب با ولتاژ اعمال شده می‌چرخد. به نظر می‌رسد مربیان و ورزشکاران می‌توانند با کشف اطلاعاتی در مورد لرزش دست تیراندازان در حین تیراندازی و ارائه یک برنامه تمرینی مناسب برای بهبود کیفیت تیراندازی ورزشکاران مفید واقع شوند.

نویسنده مسئول
نام نویسنده: امیرعلی جعفرنژادگرو
رایانامه:
amiralijafarnezhad@gmail.com

استناد به این مقاله:
ابراهیم پیری، امیرعلی جعفرنژادگرو. طراحی اولیه دستکش هوشمند با قابلیت اندازه‌گیری لرزش در تیراندازان. نشریه فناوری ورزشی پیشرفته. (۱۴۰۴). DOI: 10.22098/JAST.2025.14573.1336

واژه‌های کلیدی
دستکش هوشمند، سیستم اندازه‌گیری لرزش، تیراندازان، تیراندازی با کمان، تکنولوژی.

https://jast.uma.ac.ir/