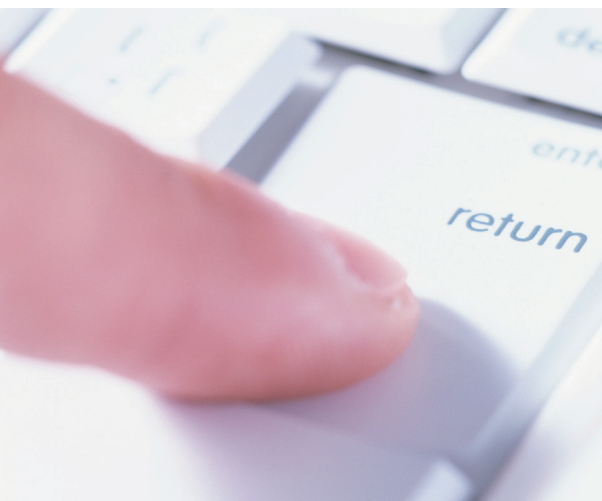


THE APPLICATIONS OF IOT IN SPORTING GOODS

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Internet of Things, IOT, means that the contacts among or between people and objects can be done via the internet. We also make use of the internet to have objects connect with each other. IOT integrates all kinds of sensor devices and internet connections. The usage information of all sorts of objects can be obtained instantly at any time; that is, the realization of object information and inter-connections and sharing. Over the recent years, IOT has been flourishingly developed. The main reason is that the installation of the internet and wireless transmission has been gradually completed. The electronic technology of sensor devices has also grown maturely, which also brings

up the wearable technology. Rising with the mobile tech, wearable devices have a closer relationship with us in daily life. People started to use convenient sensor devices or mobile app to record daily activities, such as the total walking steps, the cycling speed, or sleeping quality, etc. Using the quantization method to record and give feedbacks, people make changes in their lives and behaviors. Through it, they are happy about the achievement which they realize themselves in a better way. Everyone uses numbers to write a diary. According to estimates by Gartner, an international research institute, the industrial value of global wearable tech devices will reach 10 billion US dollars. The major applications of wearable devices, apart from the second monitor of smart phones, also provide information and messages functions. Sports and leisure activities and health-managed field are especially significant applications. NIKE, Adidas and some other more companies in the traditional sports industry have already actively invested in the development. Even the internet tech companies such as Apple and Google are also acknowledged with this potential market and put considerable R&D into the sports industry. Their

investments all indicate that this market has great economic value.

IOT can connect not only people and objects but also objects and objects via the internet. In the past, wearable technology mainly refers to the sensor devices worn by people collecting the physical data and giving feedbacks through quantization method. With the progressive sensor technology, quite a few applications are to place wearable devices inside the sports equipment. Sports shoes embedded with a uniaxial accelerometer module and capable of recording physical activities through wireless transmission technology can be transformed into high value-added intelligent shoes. The earliest development of intelligent shoes dates back to 1986 when Puma released the Puma RS100 computer shoe, a smart running shoe which recorded walking steps and kept users updated about their walking steps. Until now, the best two examples are the series of Nike+ launched in 2006 and the series of Adidas 1. Through the sensor inside the shoe and a micro-mechanical structure, Adidas 1 can sense the strength of every step and change automatically the proper heel hardness so as to achieve the best anti-shock effects. The same pair of running

shoes (see the following picture) can make auto adjustments to different shocking levels of sports based on the user's weight, running speed, and the hardness of running surface. They are a pair of auto-adjusting shock-absorbing intelligent shoes. Nike+ can collect all kinds of information like speed, distance, stepping frequency and physical activities, etc., during the running process via accelerometer sensors and pass all the instant information to the smart phone through wireless transmission (see the following picture). Moreover, Nike+ gives voice messages to the runner about distance, timing, step distance, consumed calories, etc. After a run, the runner also can upload the

running information via personal computer. Apart from knowing one's own records, the runner can also know the information shared by the other global runners. On the internet, there are irregular group running competitions such as the running competition between men and women by comparing users' accumulated distances online or the competition on the total runs among participating countries. The used-to-be individual sport is now developed into an interactive team sport that genuinely motivates people to take part in it. In 2012, Nike introduced a new generation of Nike+ system, added with an embedded pressure sensor (EPS) which provides more information on jump height, total jumps, sole pressure distribution and motion modes, etc.

The concept of intelligent shoes is to enhance the



Adidas 1 Sole Breakdown Structure (source: www.aididas.com)



Nike+ mid-sole embedded with an accelerometer sensor (source: www.nike.com)

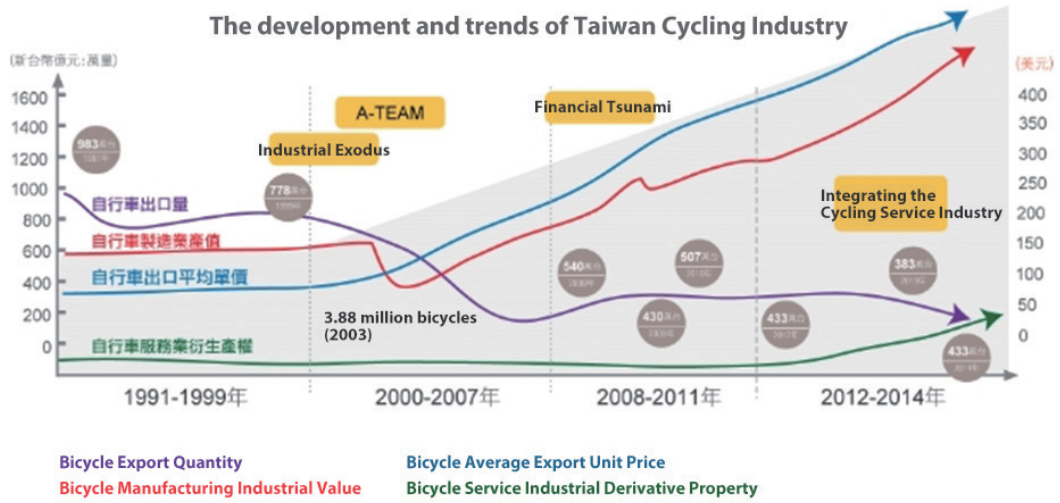


The intelligent shoes developed by National Taiwan Normal University to prevent from sports injuries.

performance of sports shoes with modern technological assistance or to let the user obtain extra information and functions. Currently, the smart shoes embedded with sensors can connect with the smart phones through various mobile applications which provide not only the training instructions to the user but also the detailed sports performance. Via the clouds tech, the user can share their sports achievement with friends and get to know the ranking among friends. As a result, social group users are more active in doing sports and enjoy the fun and benefits of sports. In addition, there are many other applications of sensors. For example, the spinning signal detected by a gyro could be used to inspect the spinning actions of the feet, to monitor the irregular actions of the feet and further to initiate a reaction or warning signals to remind the user of dangerous acts or the occurrence of fatigue. The research institutes in Taiwan have carried out R&D on intelligent shoes for many years (see the following picture). We believe that in the near future smart shoes will become smarter, much more popular, interactive and more proactive in preventing from sports injuries and enhancing sports performances.

In addition to the smart shoes that have succeeded in turning into high value-added intelligent products with embedded sensors, a bicycle is even more of an ideal product for sensor application in terms of the size and numerous parts. Compared with sports shoes and other sporting goods, a bike is a lot easier to integrate with wearable technology and step into the IOT applications. The cycling industry used to be regarded as the

sunset industry. Now the bicycle companies and manufacturers are making innovation efforts and aiming at new target markets with their R&D investment in high value added bicycles such as mountain bikes, folding mini bike, off-road bikes and e-bikes. Furthermore, the cycling industry has lifted its entire industry trend curve by focusing on the derivative services and made Taiwan reclaim its title as Bicycle Kingdom. Taiwan cycling industry is export-oriented. According to the statistics of Taiwan Transportation Vehicle Manufacturers Association, the export rate is 90%. The domestic sales were not up to 10%. In 2001, both the production and exports declined due to the exodus of the cycling industry to China, Vietnam and other regions. In 2003, the total number of bicycle exports was about 38.8 million, the lowest record. However, the total export output value climbed as the average unit price started to grow with the increase of high value added bikes (see the following picture). In 2015, the total number of bicycle exports was about 41.9 million valued 6.25 billion NT dollars. And the average export unit price continued to increase from NT\$13,570 in 2014 to a record high of NT\$14,932 in 2015. It shows that Taiwan cycling industry has succeeded in expanding international markets by providing high-valued bicycles and services to enhance the export industrial value.



On the current stage, Taiwan cycling industry looks for integration and breakthroughs. The industry targets on the top of the pyramid with high-priced mid-level bicycle. Based on the advantages of manufacturing, R&D and business operation modes, the industry incorporates innovative products and services into lifestyle, culture and cross-industry alliance. In the recent years, the cycling industry has also entered the application of IOT and integrated wearable tech devices and products into daily life. The sensors applied in bikes are mainly for measuring speed and distance (GPS and wheel tachometer) as well as cadence (crank tachometer). The data provided by sensors are recorded and uploaded to the clouds to gradually form a Big Data. However, there is a lack of riding-techniques data, for instance, pedaling force and pedaling power. Going with the popular concepts of scientific sports training, sports science becomes more familiar and welcomed. Dynamometer is the most discussed topic in the cycling industry and also one of the most representative scientific training equipment. Cycling dynamometer measures not only pedaling power but also riding techniques. Cycling dynamometer has been introduced since the early 80s. As it has gained popularity and acceptance over the years, cycling dynamometer is now an indispensable training tool in cycling science. The common dynamometers in the market today are chain-wheel type, hub type, crank type, pedal type and some other types. By attaching to one of the strain gauges on the bike, the dynamometer can detect the torque force and the power can be derived by multiplying the number of rotations. However, due to the high price, installation difficulties as well as battery power, it is only seen among the professional athletes and high-end consumers. Cycling sport is often involved in long bike rides. While riders enjoy cycling benefits such as more energy consumption and a metabolism boost, they are also easy to get injured if they don't have proper riding techniques and good control over the bikes. For example, improper cadence and pedaling workload can often lead to early fatigue, a common cause of cycling injuries. The knowledge of pedaling power has now drawn the attention of not only professional cyclists but also casual riders. How to develop an accurate and convenient dynamometer is indeed a pressing challenge and urgent breakthrough for the cycling industry.