

## Learning from Successes and Failures of Registration of Patent Applications Based on Physical Ergonomics Research

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**Objective:** The present study suggested practical measures for successful patent registration based on a review of success and failure cases of patent application filed based on inventions obtained from physical ergonomics research.

**Background:** The protection of intellectual property (IP) contributes to economic growth and competitiveness and facilitates innovation and creativity. IP rights are pursued on research findings for effective technology transfer and commercialization; however, a patent application can be rejected if patentability requirements such as patent eligible subject matter, utility for industrial application, novelty, or non-obviousness are not satisfied.

**Method:** Three successful and three failed cases of patent applications based on physical ergonomics research were reviewed, critical reasons for their successes and failures were examined, and measures were proposed to avoid failures in patent registration.

**Results:** The following measures were identified based on the patent application case review. First, abstract ideas including logical procedures and/or mathematical formulas need to include use of tangible apparatus and methods in idea realization. Second, the provision of grace period inventor disclosure exception needs to be properly followed in case an invention is disclosed before filing of patent application. Lastly, a comprehensive analysis of prior art published or publicly known anywhere in the world and a claim preparation of distinguished, non-trivial features compared to prior art solutions are needed to avoid possible violation of novelty and non-obviousness.

**Application:** The proposed measures can help to prepare a patent application with patent eligibility.

**Keywords:** Patent registration, Physical ergonomics, Patentability, Invention

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### 1. Introduction

The patent system is to protect intellectual properties of nations and companies and to strengthen their competitiveness. A patent is a set of exclusive rights granted to encourage inventions by promoting their protection and utilization to the development

of technology and industry (Patent Act, 2015). Advanced countries such as the United States, European Union, and Japan have legislated and revised patent laws and established organizations specialized in patent laws to protect their own patents (Oh and Kim, 2015). Furthermore, companies have encouraged application to facilitate technology innovation as well as to gain competitive advantages over their rivals (Suh and Oh, 2015). Accordingly, the number of patent applications has increased more than twice for past 20 years since 1990 (Lee et al., 2011).

Patents can be classified into original, defensive, and promotional patents by their purpose (Park, 2015). An original patent is to acquire the originality of a new technology that has not been disclosed in the past. A defensive patent is to prevent a patent acquisition or market penetration of its competitors by disclosing the originality of the technology. Lastly, a promotional patent is to advertise a product in brochure or pamphlet for marketing and sales rather than acquisition of an intellectual property right.

Requirements for patent registration are categorized as inventorship requirements related to an inventor, patentability requirements related to an invention, and procedural requirements related to a patent application process as described by the Patent Act (KIPO and KIPA, 2015). First, inventorship requirements describe legal eligibilities and administrative procedures for inventors in patent application. Second, patentability requirements are classified in detail as affirmative and passive requirements. As for affirmative requirements, an invention should be (1) an advanced creation of technical idea using the laws of nature as specified in the Article 2 of the Patent Act, (2) potentially applicable to manufacturing, agricultural, forestry, and farming industries, (3) novel so that the invention is not same with a technology disclosed in the past, and (4) non-obvious so that the invention cannot be easily developed by referring to existing technologies. As for passive requirements, an invention should not provide any negative influences on public order, traditional custom, and public health even the invention meets the affirmative requirements. Lastly, procedural requirements specify procedures of patent application, conformability to drafting guidelines of patent specification, scopes of invention, and the originality of technology. The aforementioned requirements have been legalized for protecting, promoting, and utilizing inventions for advancement of technologies and industries.

The present paper is intended to suggest practical measures useful when preparing a patent application for successful patent registration based on a review of successful and failed patent applications filed with inventions produced from physical ergonomics research. The research team of the present paper filed 51 patent applications (41 domestic and 10 international patent applications) and 11 design applications from ergonomic research of product design and development for last 13 years. Out of the applications, 32 patents (28 domestic and 4 international patents) and 10 designs were issued, 6 patent applications (3 domestic and 3 international patent applications) were denied for registration, and 3 patents were licensed for commercialization. The present paper reviewed, of the inventions produced by the research team based on physical ergonomics research, 3 successful patent applications (anthropometric product design method and media, swiveling mechanism for vacuum cleaner handle, and apparatus for measuring and treating dysphagia) and 3 failed patent applications (representative human model generation method, driver's workload analysis system based on electrocardiography, and physical brain fitness system with ergonometer) and then proposed measures applicable to preparation of a patent application for successful patent registration.

## 2. Lessons from Successful Patent Registration

### 2.1 Success Case 1: Method of anthropometric product design and media that can record computer program for method the same

An invention relating to an anthropometric product design method and a system operating the computer program of the proposed design method was patented in both South Korea and the US. The related study (Jung et al., 2007) of the anthropometric design method invention was published for the first time at the fall conference of the Ergonomic Society of Korea in May 2007. The patent application of the invention along with the corresponding conference proceedings as a prior art reference was submitted

to the Korean Intellectual Property Office in December 2008, revised once, and then registered (Korean Patent No. 10-1053284, 2011) in July 2011. The patent application was also filed in the US in November 2009, revised twice, and registered (U.S. Patent No. 8,954,299, 2015) in February 2015.

The anthropometric design method invention consists of an anthropometric product design method and a computer system, and is of use to determine the optimal design of a product using anthropometric data. The proposed anthropometric design method includes (1) expressing the geometric relationships between human body dimensions and design variables into design equations, (2) generating a group of representative human models for the target population, (3) estimating postures according to changes in design dimensions by computer simulation which utilizes the design equations and representative human models and performs a sensitivity analysis by comparing estimated postures with a defined reference posture, and (4) determining an optimal design value based on sensitivity analysis result. The relationships between body dimensions and design variables are analyzed in a systematic way using a design structure matrix, a group of persons statistically representing the target population are generated, and then postures are estimated which minimize loss scores calculated by the equation  $\text{posture threshold} \times |\text{estimated posture} - \text{reference posture}|$  where posture thresholds are defined by considering comfortable ranges of motion. Lastly, the invention is able to design the product fitting to users by applying diverse body sizes and product use postures into the design process as shown in Figure 1 and to provide an optimal design of minimizing loss scores as a function of design value.

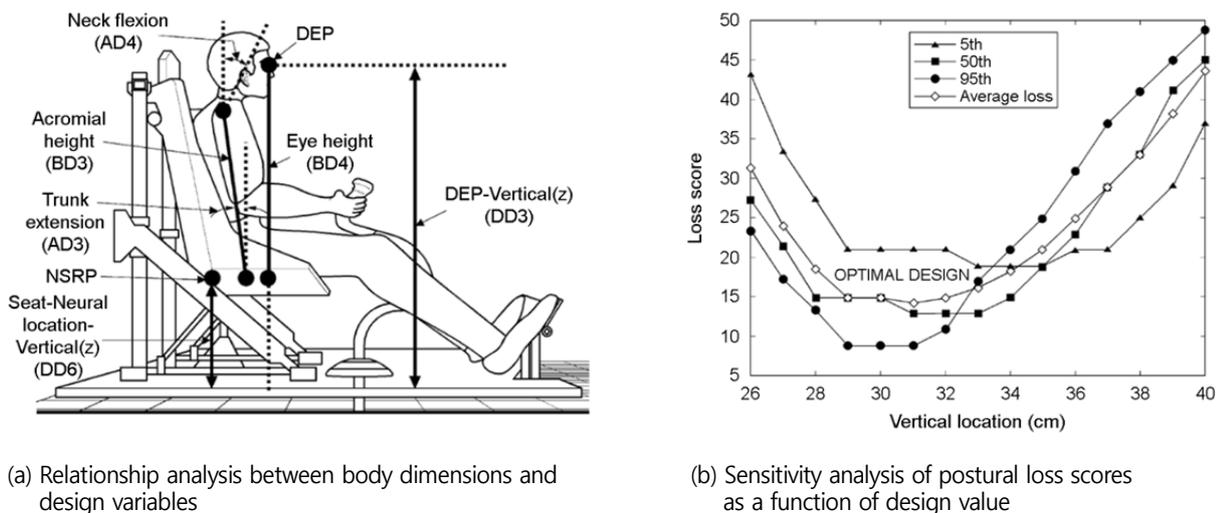


Figure 1. Application of anthropometric product design method (illustrated)

## 2.2 Success Case 2: Swiveling mechanism for vacuum cleaner handle

A cleaner handle assembly rotatable in all directions was invented to reduce muscle forces applied by adduction and abduction of the wrist during cleaning tasks and to decrease users' discomfort due to wrist deviation from the neutral. The swivel handle invention was applied to the European Patent Office (EPO) in December 2007 and registered in August 2008 (European Patent No. EPO 08162113.8, 2008) and also applied to United States Patent and Trademark Office in May 2008 and registered in December 2010 (U.S. Patent No. 7,854,039, 2010).

The swiveling mechanism of vacuum cleaner handle was developed based on an ergonomic analysis on human motion and

muscle force while conducting cleaning tasks. The characteristics of motion and muscle force were analyzed for 15 female users aged 30s to 40s using the motion capture system Falcon 240 (Motion Analysis Corp., Santa Rosa, CA, USA) and the EMG analysis system Telemyo 900 (Noraxon Inc., Scottsdale, AZ, USA), respectively. The handles of existing vacuum cleaners resulted in more deviated adduction and abduction angles at the wrist, higher EMG signals at the wrist-related muscles, and higher discomfort at the wrist than the swiveling handle (Chang, 2007). The swiveling handle consisting of a two-axis hinge (part no. 181 in Figure 2) which allows the handle to move in the up, down, left, and right directions and an elastic plate inside the handle (part no. 191 in Figure 2) which restores the swiveled handle to its neutral position required less muscle force and deviation motion at the wrist as manipulated to the forward, backward, left, and right directions as shown in Figure 3 (Chang, 2007).

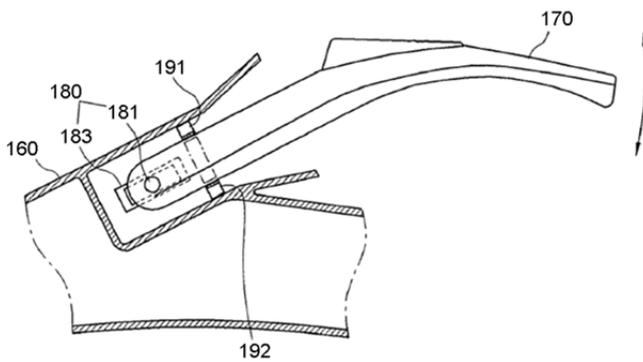


Figure 2. Swiveling mechanism of cleaner handle

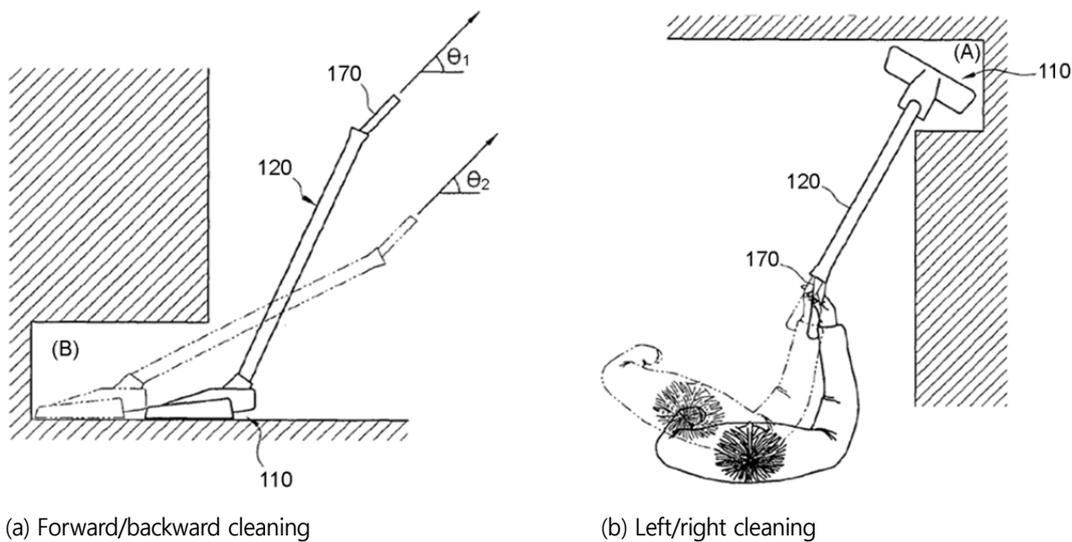


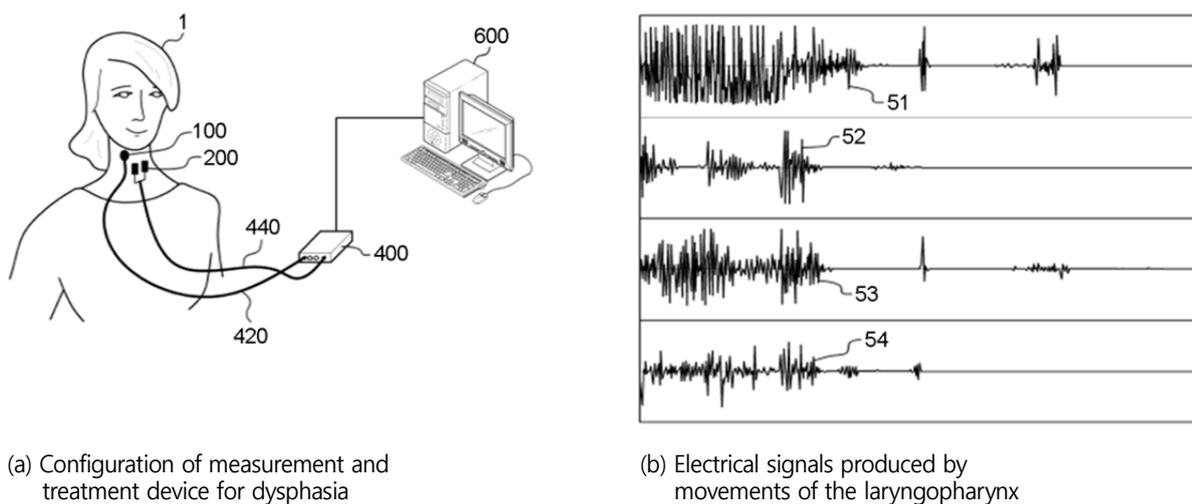
Figure 3. Swiveling of cleaner handle for cleaning forward, backward, left, and right directions

### 2.3 Success Case 3: Apparatus for measuring and treating dysphagia

A portable device consisting of an ultrasonic Doppler sensor unit for measuring movements of the laryngopharynx during

swallowing and a stimulation electrode unit for treating a swallowing disorder in real-time was invented to support the diagnosis and treatment of patients with dysphagia. The dysphagia measurement and treatment invention was applied to the Korean Intellectual Property Office in August 2011 and registered in August 2013 (Korean Patent No. 10-1302193, 2013), the United States Patent and Trademark Office, the European Patent Office, and the Japanese Intellectual Property Office in February 2014 (U.S. Patent Application No. 14/235,842, 2014; European Patent Application No. EPO 12820271.0, 2014; Japanese Patent Application No. 2014-523844, 2014).

The invented device for dysphagia is composed of (1) a sensor unit including ultrasonic Doppler receivers and transmitters attached to the neck of the patient for measuring a swallowing disorder, (2) a stimulation electrode unit for treating the swallowing disorder by electrical stimulation to the neck of the patient, and (3) a control unit for controlling the ultrasonic sensor unit and the stimulation electrode unit and analyzing collected signals. As shown in Figure 4, the dysphagia invention measures laryngopharynx movements (Figure 4.a) during swallowing using the ultrasonic Doppler receiver and transmitter attached to the neck of the patient, evaluates the presence and severity of a swallowing disorder by analyzing electrical signals collected (Figure 4.b), and treating the swallowing disorder in real-time by providing electrical stimulation.



**Figure 4.** Portable measurement and treatment device for dysphagia

### 3. Lessons from Failed Patent Registration

#### 3.1 Failure Case 1: Method of representative human model generation

The human model generation method invention relates to a generation method of human models that properly represent the diversity of the body size distribution of a design target population for anthropometric product design and evaluation. The study by Jung et al. (2006) related to this invention had been presented at the fall conference of the Ergonomic Society of Korea in October 2006, and the patent application was filed (Korean Patent Application No. 10-2007-0037881, 2007) with the attachment of the study as a prior art reference in April 2007. However, referees rejected because the application insufficiently described technical means and specific methods for the proposed generation method of representative human models.

The generation method of representative human models in this invention consists of (1) determining a design target population, (2) setting a target accommodation percentage of the design target population, (3) converting from body sizes of the design target population to normalized squared distances, (4) forming a boundary zone that accommodates the target accommodation percentage of the design target population using the normalized squared distances, (5) conducting a cluster analysis on the people within the boundary zone and determining a minimum number of clusters that satisfy the target accommodation percentage. This invention has unique characteristics which includes converting the body sizes of the design target population into the normalized squared distances using Eq.1, forming a boundary zone of statistically accommodating the target percentage of the design target population as shown in Figure 5.a, applying cluster analysis on the people in the boundary zone, and selecting representative human models from each cluster as illustrated in Figure 5.b.

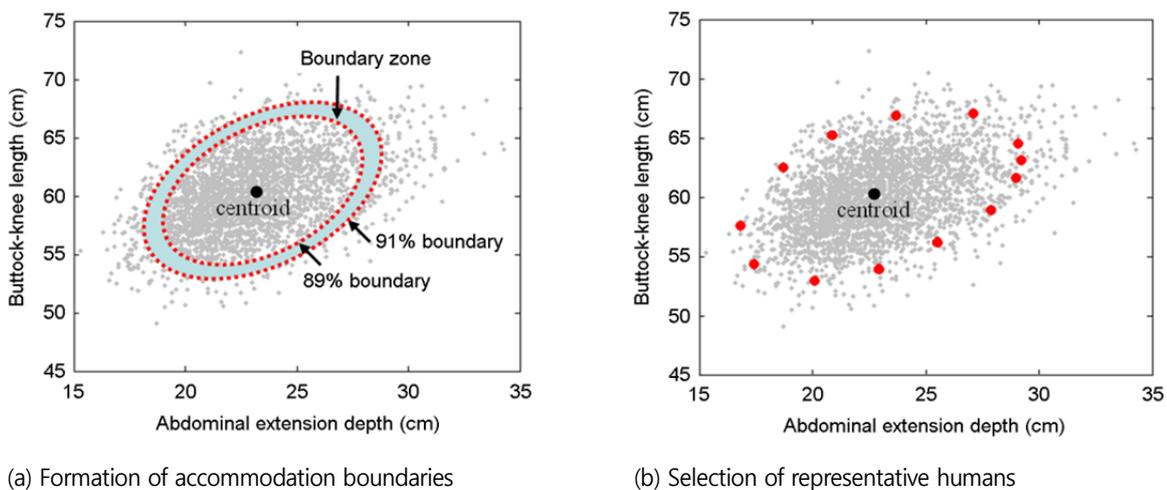


Figure 5. Generation process of representative human models

$$D = (AD_1 - \mu_{AD_1}, AD_2 - \mu_{AD_2}, \dots, AD_n - \mu_{AD_n}) \Sigma^{-1} \begin{pmatrix} AD_1 - \mu_{AD_1} \\ AD_2 - \mu_{AD_2} \\ \vdots \\ AD_n - \mu_{AD_n} \end{pmatrix} \sim \chi_n^2(1-p) \quad \text{Eq. 1}$$

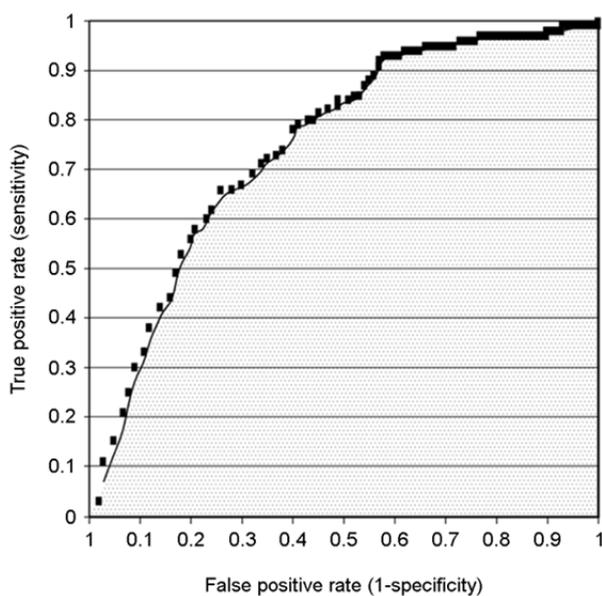
- $D$  = Normalized squared distance,
- $AD_n$  = Size of  $n^{\text{th}}$  anthropometric variable,
- $\mu_{AD_n}$  = Average of  $n^{\text{th}}$  anthropometric variable,
- $p$  = Target accommodation percentage,
- $\Sigma$  = Covariance matrix of anthropometric variables

Although opinions were submitted against the patent rejection reason for technical idea using the law of nature, the patent application was rejected due to lack of description for specific technical means and methods. It was argued that this invention is not merely depending on human judgment and artificial decision because it uses the technical ideas using the law of nature like converting body sizes of the design target population into the normalized squared distances, forming a boundary zone that accommodates  $100p\%$  (accommodation percentage  $p = 0 \sim 1$ ) of the multivariate body dimension distribution from the centroid,

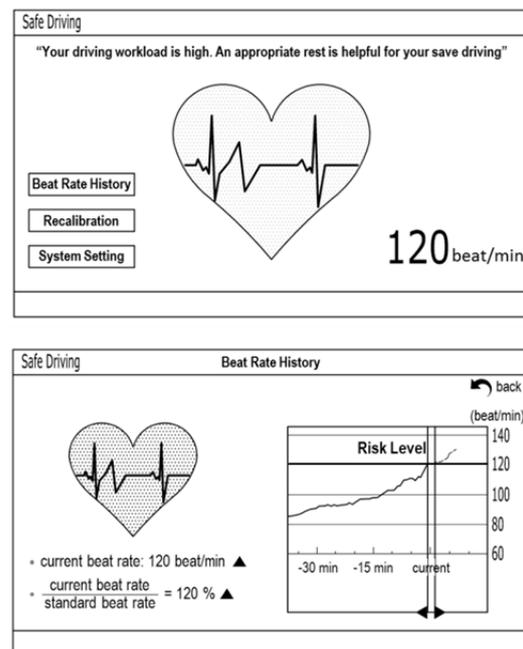
applying the normalized squared distances which follow  $\chi^2$  distribution (Johnson & Wichern, 1988), and conducting cluster analysis to form a minimum number of clusters that satisfy the target accommodation percentage. In addition, it was claimed that this invention is based on the technical idea and has industry applicability because it relates to the generation method of representative human models that statistically represent the design target population, and this method can be utilized in anthropometric design and evaluation of workspace such as bus and overhead crane. However, the application was eventually rejected because it did not include the description on record media that stores computer program of the proposed method.

### 3.2 Failure Case 2: Driver's workload analysis system based on electrocardiography

An invention regarding a system which presents the workload level of a driver based on an optimized analysis of individual electrocardiography (ECG) signal was rejected due to lack of novelty and inventive step compared to its own antecedent academic disclosure. A conference paper related to this invention was presented at the spring conference of the Ergonomics Society of Korea on May 26, 2011 (Hong et al., 2011), and the invention was applied to the Korean Intellectual Property Office on May 22, 2012 (Korean Patent Application No. 10-2012-0054439, 2012) without including the proceeding paper as a reference of the invention. Thereby, the patent application was rejected in July 2013 due to lacking novelty and inventive step, because the application was compared to the conference paper presented by the same inventors. By referring to Article 30 of the Patent Act of Korea, an inventor can request an exception of public disclosure, so that its own antecedent academic publication (e.g., conference proceeding, journal, and thesis) will not be considered as a publicly known invention. An invention should be applied within 12 months (a grace period) from the publication date and corresponding publications should be included as references. A grace period exists for protecting an inventor from its own academic disclosure and promoting researchers to publish their academic research for industrial applications (Patent Act, 2015).



(a) Analysis of performance of driver's workload estimation based on sensitivity and specificity



(b) Display of driver's ECG and workload level

Figure 6. A driver's cognitive workload analysis system (illustrated)

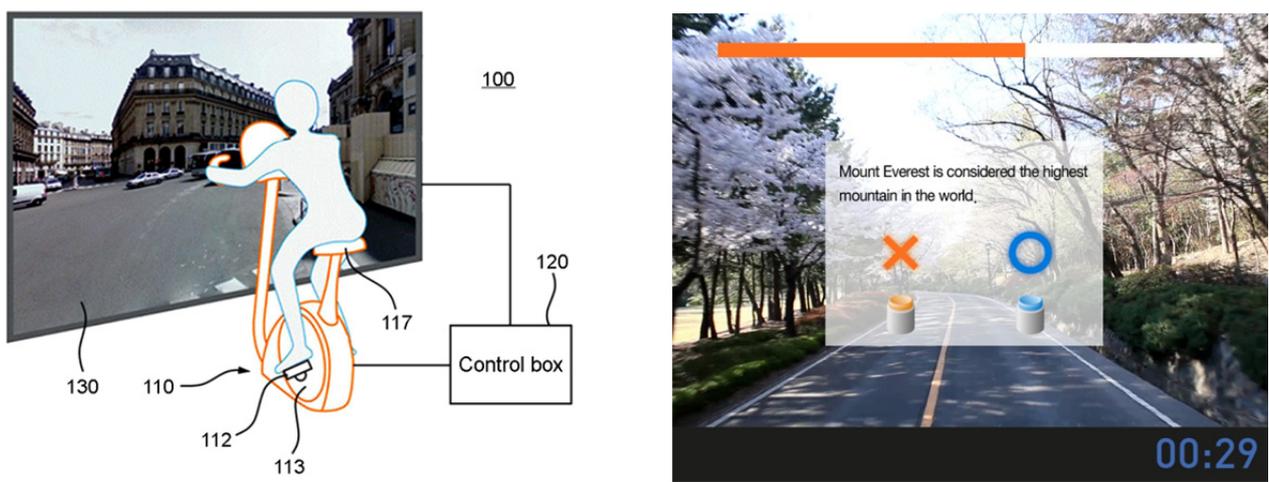
The present invention is a system which can analyze a driver's cognitive workload using ECG signal during driving task. The cognitive workload analysis system is composed of five modules: (1) a module for sensing inter-beat interval (IBI, a quantified ECG value) through photo sensors embedded in a steering wheel, (2) a module for quantification of IBI data into standard deviation of N-N intervals (SDNN), root mean of sum of squared differences (RMSSD), and root mean square error (RMSE), (3) a module for determination of optimized workload discrimination criteria based on statistical analyses, (4) a module for the real-time analysis of a driver's cognitive workload, and (5) a module for the display of a driver's workload level and provision of warning if the workload is higher than the predetermined criteria. By utilizing the workload analysis system, the driver's workload status can be statistically estimated (Figure 6.a) in real-time based on driver's ECG signals collected during driving and displayed through an in-vehicle display device (Figure 6.b) for safe driving.

For successful patent application and registration, an invention disclosed by an academic publication should be applied to a patent office within 12 months from the publication date with a request of the grace period. In the case of the driver's workload analysis system, the invention was applied within 12 months from the publication date, but the inventors did not request the grace period along with a submission of the related conference paper. Thus, the application was rejected by being compared with its own publication in terms of novelty and inventive step. A revised patent specification was submitted in September 2013 but could resolve only the novelty issue, not the inventive step issue, failing in patent registration.

### 3.3 Failure Case 3: Physical brain fitness system with bicycle ergometer

A bicycle ergometer for brain fitness was invented to provide elder people physical and cognitive training such as virtual bicycle tour and quiz taking. This invention was submitted to the Korean Intellectual Property Office in October 2010 and revised in October 2011 (Korean Patent Application No. 10-2011-0110745, 2011). However, the patent application was not registered because of insufficient inventive step compared with previous technologies.

The brain fitness ergometer invention provides virtual tour experience and physical training together by controlling video images according to the speed of pedaling on the bicycle ergometer (see Figure 7). After a virtual tour is over, a user takes a



(a) Virtual bicycle tour content

(b) Quiz content for brain fitness

Figure 7. Brain fitness system with bicycle ergometer (illustrated)

quiz about the information presented from the tour site, so that social, emotional, physical, and cognitive capabilities of the user can be trained and improved all at once. When a user start pedaling, a sensor on the actuator measures the number of pedaling, and a display plays a video according to the pedaling speed. Moreover, a user can also control the steering handle to browse virtual tour videos or to choose an answer of a quiz.

An opinion regarding novelty and inventive step compared to a bicycle simulation device invention published in Japan was asked from a patent examiner, but the novelty and inventive step opinion which the inventors submitted was not sufficient enough to persuade the examiner. The bicycle simulation device patent application includes technologies related to pedals, handlebars, displays for traffic safety, education, game, and training. The cited bicycle simulation invention intended to provide a bicycle simulation device which simulates realistic bicycle riding, whereas the proposed invention intended to provide a multi-modal brain fitness system which supports users improving social, emotional, physical, and cognitive capabilities by experiencing a virtual tour and taking a quiz. Although a differentiated configuration and a use scenario such as quiz taking and relay racing were appealed to emphasize differentiated utilities of the proposed invention compared to the cited invention, it was judged that an ordinary skilled person in the same field could produce the proposed invention with ease, and thus a registration for patent was finally rejected.

#### 4. Discussion

The importance of patent is emphasized along a rapid change of the international environment related to patent. Companies specialized in intellectual property management have emerged and patent disputes have been intensified among nations and/or companies due to increase in global awareness of protecting intellectual properties (Yoon, 2008). In addition, the paradigm of patent has been shifting from pure means of technology defense to profit creation means by technology transfer and sales thought a technology trading market (Shim et al., 2013). Thus, efforts of patent application and registration as part of research and development become important to respond changes in the international patent environment.

As examined in the review of the successfully registered inventions developed from physical ergonomics research, technical inventions must demonstrate utilization of natural laws, usefulness in industry, novelty, and nonobviousness to be eligible for patent protection. Although abstract ideas (e.g., mathematical algorithms, logical principles), laws of nature, physical phenomena, and mental activities (e.g., business planning, insurance plan) themselves are not patentable, products and methods utilizing abstract ideas, laws of nature, physical phenomena, and mental activities to yield utilities in industry such as improved performance of a system function and better quality of a product are eligible for patenting. For example, the anthropometric product design method and the computerized system utilizing the proposed design method was patented by specifying the application of mathematical formulas and logical procedures to effective identification of an optimal workstation design. Note that a computer program itself is not patentable but a claim of an information apparatus operating with a computer program in hardware becomes patentable (KIPO, 2015). Next, an invention is considered novel if the invention has not been disclosed to the public in any format prior to filing a patent application or differs significantly from previous disclosures. For example, the vacuum cleaner handle rotatable in all directions was patented by proposing a swiveling mechanism of handle significantly different from existing cleaner handles. Lastly, an invention is not obvious over the prior art to a person having ordinary skill in the art to which the claimed invention pertains. For example, the swallowing measurement and treatment device was patented by proposing an ultrasonic Doppler sensor unit and a swallow signal processing unit specially designed to measure the movement of laryngopharynx although the generalized ultrasonic technology was utilized.

By considering the aforementioned failure cases in terms of patent examination criteria including (1) a content of the invention, (2) the grace period and request of exception of public disclosure, and (3) novelty and inventive step of the invention should be meticulously considered for successful patent registration. First, an invention utilizing laws other than the law of nature (e.g., data processing algorithm, design technique, logical methods, and mathematical formula) should include specific technical devices,

equipment, or methods applicable to practical use because an invention should be the highly advanced creation of a technical idea using the law of nature. As presented in the example of the generation method of representative models, the patent application was rejected because it described only a mathematic method for representative model generation but lacked the description on record media that stores a computer program of the proposed method. Second, the invention should be applied to a patent office within the designated period in the Patent Act (12 months from the first publication) for exception of public disclosure by following the corresponding legal procedure to avoid unnecessary comparison of novelty and intensive step of the application to inventor's antecedent publication in case of public disclosures of an invention through publication (e.g., conference proceeding, academic journal, and thesis). As presented in the example of the driver's workload analysis system, the invention was applied without the exception of public disclosure by a mistake of the inventors, and thus the application could not be registered as a patent due to its own publication. Lastly, when a patent application is prepared, the novelty and inventive step of the invention should be investigated by searching not only domestic but also overseas (e.g., USA, Europe, Japan) publications. A comprehensive review of published technical ideas all kinds of printed and on-line publications including patents is required for successful patent registration.

The analysis results of success and failure of patent application in the present study are based on an assumption that the examinations of patent applications are objective and accurate and thus subject to change depending on the quality of patent examination. As the number of patent applications is dramatically increasing and new inventions employ leading-edge and fusion technologies, the quality of patent examination can be negatively affected. A patent examination lacking in quality can incur substantial losses in cost and time to stakeholders. An improved patent examination process is needed in the Korean Intellectual Property Office (KIPO) because most of domestic patent examinations are concentrated on editorial errors such as improper scope of claims, missing information or containing inaccuracies rather than evaluating substantive validity requirements such as novelty and non-obviousness and the present KIPO examination system relies solely on decisions of patent office examiners (Lee et al., 2011). An open platform of patent examination which facilitates cooperation and cross-checking among examination reviewers, prior art investigators, and patent office examiners is proposed for better objectivity and dependability of patent examination and quality assurance (Lee et al., 2011).

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