Development of Fitness Cycle System Using Google Streetview

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Summary
These days people exercise much less than in the past, and many people consciously put aside exercise time to maintain and enhance physical fitness. People prefer to use machines like a cycle or a running machine for aerobic exercise at home or fitness clubs that have little constraint of time, space and weather. However, it is often hard to continue the exercise due to lack of motivation. Interesting new equipments are introduced at home and abroad that combine UT elements with equipments for aerobic exercises. But, often they lack interesting contents and cost much. This research suggests a health cycle training system that is equipped with a sensor to communicate with PC-based Google Maps API. The system controls Google Maps and StreetView, to present panoramic, and life-like images to exercising people.

Key words:
Google Streetview, Fitness Cycle, RFID, Sensor.

1. Introduction

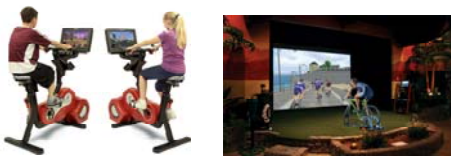
With economic development and prosperity, people rely more on convenience facilities. This has led to substantially less amount of exercise, and many people try to do extra exercise to maintain fitness, watch weight and for other purposes such as leisure and rehabilitation. As the trend began to shift from anaerobic to aerobic exercises in 2000s, more people are using cycles or running machines at home and fitness clubs. The indoor equipments for aerobic exercise have benefits of taking small space and available in all weather conditions; but the lack of continued motivation might quickly wear off the initial excitement of indoor exercise.

Many IT-combined exercise equipments are being introduced at both home and abroad, but they often lack interesting contents, while remaining costly due to high manufacturing cost. In the 21st century, the IT trend—so-called Web 2.0—encourages individuals' participation through open technology, and conveys information between individuals[1]. Recently, the community information services tend to provide additional information, including a variety of online map services such as high-resolution satellite images, StreetView, traffic information and location contents. These provide open API for the general public's access. Open API is an open programming interface that allows service access from the outside as well as within the designated site. It helps to converge various kinds of services, and emerging as a technology for new business models[2].

2. Related Work

2.1 Fitness Cycle System

It is desirable to do aerobic exercise regularly and steadily. Many people lose interest in the exercise because of boredom, long hours and misguided methods. To address these problems many types of exercise and assistant equipments have been developed. In 1982, a U.S company Atari introduced Fuffer to the market, a prototype of an interactive cycle game for exercise. It was a game system for purpose of exercise, using 8-bit computer and interactive interface in shape of a real bicycle[3]. The system displays effect of exercise in numerical values so that the users can check the time and intensity of the exercise. However, the system was quite costly, and the functions were limited. Interactive Fitness Holdings designed Expresso Bike that combined virtual reality with a fitness bicycle[4]. It included more than 30 tour contents and games, and also provided phase training so that the users can gradually get familiar with a right way of cycling. In addition, users registered on Expresso Live can have cycling matches, engage in SNS and update their profiles.



(a) Expresso Bike (b) TruFortius Screen Cycle

Fig 1. Fitness cycle products

Tack's TruFortius screen cycle guides users to ride a bike along the roads of virtual images. It adopts VR Cycle System, and on an uphill, the users have to step on the pedals harder[5]. The information including speed and pressure of fitness cycle is processed on Bushido real-time, and transmitted to a display system. Professional cyclists use TruFortius for training, and they can have cycling matches on the network. As these examples show,

Manuscript received February 5, 2011
Manuscript revised February 20, 2011

companies, home and abroad, are developing cycling products that combine TV, VR and CR to attract users' attention. Nonetheless, the contents are often not entertaining enough and manufacturing costs remain high.

2.2 Google StreetView

Google provides Maps API for easy MashUp service. MashUp is a complex-type software that puts together contents from multiple sources. It provides a tool for Google and Amazon and the like to easily combine a variety of data and online maps. Google Maps is doing very well in the area of digital maps, as more than 10 MashUp coming out each day. It offers an environment to add powerful tools and useful functions of Google Maps to web sites and applications through various APIs, and to add personal data[6]. Google Maps API contains powerful contents named StreetView that presents 360-degree view of streets, taken from 9 cameras loaded on a car. By using StreetView, users can survey and explore virtual places, and many other additional services are provided. Google uses modified tricycles to provide views of less accessible places such as castles, zoo, coastal areas, cultural relics and golf courses. It provides an update for various parts of the world. During the 2010 Vancouver Winter Olympics, it used camera-equipped snowmobiles to take pictures of the Mt. Whistler and ski slopes. Recently, Google Art Project launched to show interior images of 17 prestigious art museums in the world. A real estate web site, Trulia, adds StreetView images to its properties to provide more information to home buyers[7].

Fig 2. Google streetview

3. Fitness cycle system using StreetView

This research introduces Fitness Cycle System to suggest methods for efficient exercise, and how to maintain and enhance physical fitness more systematically. The system includes a control box that perceives StreetView simulator, speed, direction, users on Google Maps JavaScript API platform in PC environment. It provides resource tools to operate simulator and personal training analysis information. The simulator controls Google Map and StreetView, and adds fun to exercise with realistic, panoramic views of the streets.

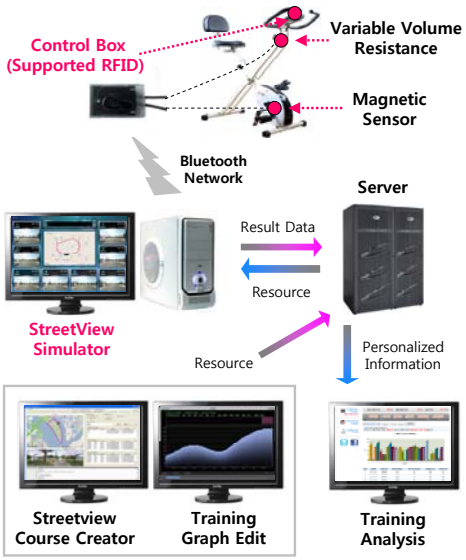


Fig 3. Overall configuration of the system

3.1 Fitness Cycle Interface

A Fitness Cycle consists of magnetic sensor to measure speed, variable volume resistance to perceive direction, and RFID to identify a user. For this research, magnetic sensor and variable volume resistance were applied because they are relatively less expensive, and thus control device can be developed at an affordable cost.

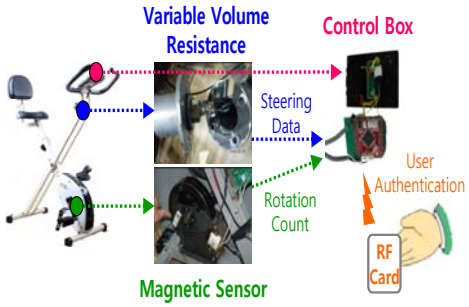


Fig 4. Fitness cycle interface

The magnetic sensor is attached to a rotating disk to convey signals to the control box. It calculates distance of travel by unit time to measure speed. The disk rotation sends signals to the switch, and the counting values are converted to signal data for speed. To measure speed, parameters of wheel's size(w), time of a disk's single rotation(t) are needed, and the following equation can be used to calculate distance of travel (L) for unit time (s).

$$\frac{2 \times \pi \times w \times \sec}{t} = L_{m/\sec} \quad (1)$$

Variable Volume Resistance was attached to the stem that is connected to a handle for direction change. The amount of rotation was coded as a number between 0 and 255. At the initial system operation, the cycle and control module were reset to adjust initial error of steering angle in the handle. The RFID tag was inserted in the control box, connected to the server to provide customized information for effective exercise, based on registered physical data and groups of body type. FirmSYS's Mini Reader was used, with tag type ISO 14443A. The control box receives analog signals from the sensor and makes wireless transmission to the system. The table shows specifications of the RFID Reader.

Table 1: FirmSYS mini reader specifications

Frequence	13.56Mhz
RF Data Rate	ISO 15693 266.6kps ISO 14443A 105.9kps
Read Range	80mm ~ 100mm
Antenna	50ohm External Antenna
Interface	TTL(UART), RS-232
Power	DC 3.3V ~ 5V
Dimensions	30 X 24 X 3.8 mm

3.2 Resource Tools

The research suggests two resource tools that form StreetView Link from a user's path using StreetView Course Creator, and help to reach target exercise amount using Training Graph Edit. The generated resource is provided through the main server to cater to user properties. The users can share the courses, upon which StreetView simulator operates.

3.2.1 StreetView Course Creator

StreetView Course Creator lets a user select preferred path and explore StreetView of the path at a given velocity, without considering movement of the cycle handles.

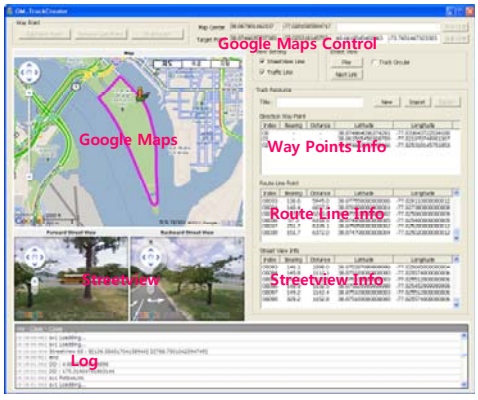


Fig 5. Streetview course creator

The user can create a course by entering starting and ending points with an address, parks, buildings or other main attractions. Or a user can designate as many as 25 points on a map to create a course. Google Maps provides real-time overlay of the roads in a blue line, over the StreetView images. StreetView Course Creator lets a user to explore only areas within range of StreetView service, marking locations in different colors. The red zone cannot be included in the path. A users' chosen points are given numbers and connected in straight lines. The information is transmitted to the Google server to receive course information Figure 6.

Fig 6. Course information using points

Google StreetView has limitations of not including all the regions. Some courses might be missing StreetView images, which StreetView Course Creator identifies and skips. After exploring the entire course, information is stored including latitude and longitude of the location, distances and angles between the StreetView links Figure 7. On the simulator, the stored StreetView links are navigated according to the received speed data.

```
#TITLE          Eiffel Tower Grow
#DISTANCE       248.3
#COMPLETE       1
#CENTER         48.856054031891254      2.297805547714233
#ZOOM           18
#CIRCULAR       0

@Way Point----------------------------------------------------------------
#WP00  48.855743431835918       2.297784090042114
#WP01  48.856237567381761       2.297698259353638
#WP02  48.855722254489223       2.297784090042114

@Route Line---------------------------------------------------------------
#RL00000  48.855750000000000    2.297780000000000       65.9    0.0
#RL00001  48.855800000000002    2.297950000000000       49.8    13.6
#RL00002  48.855920000000005    2.298160000000000       32.6    34.0
#RL00003  48.856270000000002    2.298500000000000       317.7   80.3
#RL00004  48.856480000000005    2.298210000000000       236.6   111.8
#RL00005  48.856250000000003    2.297680000000000       220.7   158.3
#RL00006  48.856120000000004    2.297510000000000       203.7   177.4
#RL00007  48.855850000000004    2.297330000000000       140.9   210.2
#RL00008  48.855680000000007    2.297540000000000       65.2    234.6
#RL00009  48.855750000000000    2.297770000000000       65.2    253.2

@Street View--------------------------------------------------------------
#SV00000  48.855733999999998    2.297710000000000       66.1    0.0
#SV00001  48.855784999999997    2.297885000000000       56.3    14.0
#SV00002  48.855860000000000    2.298056000000000       46.1    29.1
#SV00003  48.855947999999998    2.298195000000000       38.8    43.2
#SV00004  48.856034000000001    2.298300000000000       27.4    55.5
#SV00005  48.856175000000000    2.298411000000000       31.0    73.2
#SV00006  48.856268000000000    2.298496000000000       318.7   85.2
```

Fig 7. Streetview course infomation file

The course can be stored in different types; those with same starting and ending points, and the rest. On StreetView Simulator, the courses are repeated if the

starting and ending points are the same; if not, the course returns to the beginning point after reaching the ending point.

3.2.2 Training Graph Edit

The purpose of Fitness Cycle Training is to consume calories by fulfilling the target exercise amount. Training Graph Edit divides the exercise time into several sessions so that a user can consume enough calories due to his/her physical properties. The target speed is displayed in plain plots for easy understanding.

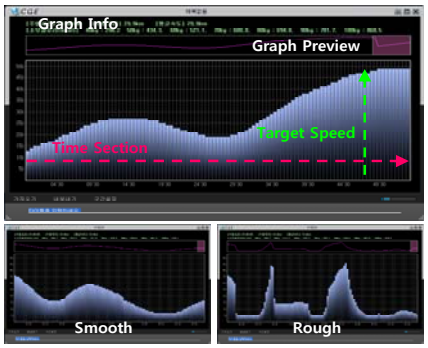


Fig 8. Training graph edit

The graphs can be modified by clicking or dragging the sections that are in intervals of 5 to 60 seconds depending on the user preference. Upon modification, distance of travel, average speed and consumed calories are immediately calculated and displayed on the graph information section. If a section shows rapid change of speed over 10km/h, the section is shown in rough gradation using Bezier Algorithm Figure 8. The complete graphs are stored in a file including amount of burned calories by weights between 40kg and 100kg. Cycling for one minute at 1km/h burns approximately 0.0022 calories. If altitude rises by 100ft, 22 more calories are burned each hour. The Graph Edit excluded altitude and intensity adjustment, and calculated the exercise effect as shown in equation 1. In the formula, w indicates a user's weight (kg), t, exercise time(minute), and s, distance of travel (km/h).

3.3 StreetView Simulator

The Simulator operates by linking StreetView Courses and Training Graphs generated from the resource tools. The resource can be either created by a user or provided from a server; it can be selected on the simulation resource select pages Figure 9. The StreetView Course provides preview of maps and StreetView for the selected course. Training Graph provides visual information of Speed Graph, exercise time, distance, burned calories by weights, as well as maximum and average speeds.

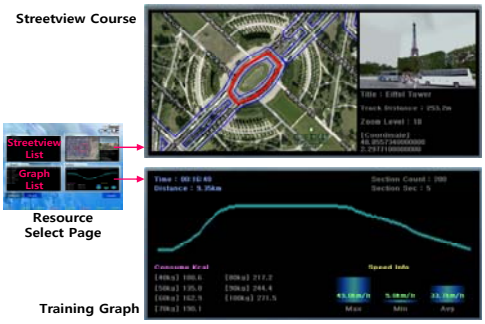


Fig 9. Resource select page

The system's simulators are divided into GX (Group Exercise) Mode to be used at fitness club for multiple users and Single Mode for individual users.

3.3.1 Single Mode

Designed for individual users, the Single Mode synchronizes variable volume resistance data on the handle of the fitness cycle with StreetView to rotate and move StreetView. The mode may deviate from the StreetView course, and the user can freely change the places by clicking Google Map on the screen.

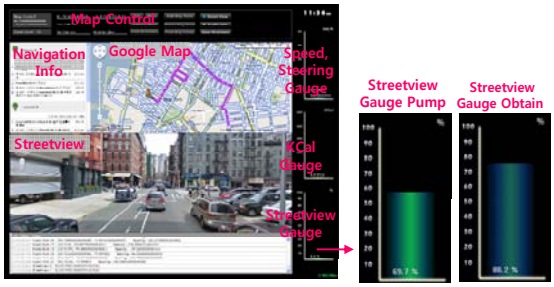


Fig 10. Single mode

Figure 10. shows Single Mode screen that contains Google Map data, path-selection control, path information, Google Map, StreetView, distance of the selected path and three Gauge Graphs. Speed & Steering Gague presents sensor data attached to the fitness cycle; KCal Gauge roughly estimates distance of exercise according to the user's weight by seconds. StreetView Gauge shows distance needed to be covered until the next StreetView link; if the distance is covered, the Simulator moves to the next StreetView link. On average, StreetView is located at 10m interval. If a user deviates from StreetView course, the amount of required distance for StreetView Gauge is set at 10m.

The StreetView marks currently available links in white lines; the user can check the white lines and move to them. If a user is moving toward an area not registered on StreetView and enough StreetView Gague is secured, the simulator automatically changes to the nearest link.

3.3.2 GX Mode

In GX Mode, maximum 8 users can be connected, and they compete on the designated StreetView Course to secure given exercise amount of Training Graph. Unlike Single Mode, handle data from the fitness cycle are not considered and the users may not get off the StreetView Courses; only the speed is considered. Figure 11. shows GX Mode display and Training Graph shows remaining time and target speed. StreetView Course is overlaid on Google Map, with marking of each user's location.

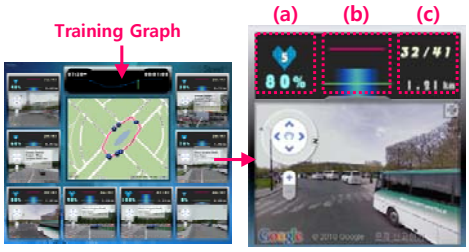


Fig 11. GX mode

In Figure 12, (a) on the right shows success rate of target speed for each section as defined in Training Graph; in (b), the red line indicates target speed of the current section, and the blue line shows the user's current speed. The green line gets shorter, indicating remaining time for the current section. (c) shows distance of travel. In the figure, the number 32/41 indicates that the user needs to go through the StreetView Course 41 times to fill the distance in Training Graph, and by far has completed 32 times.

Fig 12. GX mode result page

Upon completing the training, the result page shows up as shown in Figure 12. It shows distance of travel, average speed, consumed calories and section success rate by users, and categorizes their results in classes S~F. The data is immediately transmitted to the server, and recorded on users' training history.

3.4. Training Analysis Information

A user registers age, height, weight and body fat on the server, and the server classifies groups by body types. Based on the exercise result, the server provides analysis for each group. Figure 13. shows result of the user's exercise that includes exercise time, distance, speed, consumed calories and success rate. The result can be shown on daily, weekly or monthly basis. According to the users' body types, target for goal training distance and movement times are provided along with Training Graphs.

Fig 13. User training analysis webpage

4. Conclusion

The research conducted simulation by adding variable volume resistance and magnetic sensor to the fitness cycle to measure amount of rotating movement and acquire speed data; it also synchronized Google Map and StreetView data. The existing VR-based cycle training systems tend to cost much and while lacking interesting contents. In comparison, the suggested system that utilizes Google StreetView service can provide location-based contents with unlimited choice of courses, while making use of the available fitness cycle. The plan is to strengthen communication tools and competition among users, based on Google Earth API data on 3D images of the major attractions in the world, for better user environment and exercise efficiency. In addition, further research will be conducted on customized information of courses, locations and course sharing models, to establish SNS environment.

Acknowledgments

This research was supported the MCST(Ministry of Culture, Sport& Tourism), Korea, under the CRC(Culture Research Center) support program supervised by the KOCCA(Korea Culture & Contents Agency

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[7] http://www.trulia.com

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