GPS HRN
The GLOBAL POSITIONING SYSTEMS in Health Research Network

NEWS UPDATE

June 2010

Measuring time outdoors with GPS

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The majority of studies to published using GPS have relied upon analysis of the data in a geographical information system (GIS). However spatial analysis within GIS requires considerable technical resource and individual expertise that may not be available in many groups. To address this we have been interested in using GPS without the need for a GIS, and are investigating whether GPS data can provide an objective measurement of time spent outdoors.

The amount of time that children spend outdoors is one of the stronger determinants of physical activity, and has recently been associated with development of obesity. However time outdoors is usually measured either by self-report or indirectly by parental proxy, methods that are relatively imprecise. In Bristol we have used the Garmin Foretrex 201 in the PEACH project, a longitudinal study of environmental influences on children's physical activity. At the time of starting this study in 2006 the Foretrex was probably the best personal GPS receiver available for our work, since it was small and easily wearable by the children, yet had a large memory that could record data at 10 second epochs, allowing matching with accelerometer data recorded at the same frequency. By current standards the Foretrex has a relatively weak GPS receiver, losing contact with the satellite network within buildings, and we realised that this could allow us to use the instrument to measure only time spent outdoors.

We have recently published out first paper using the GPS-derived time outdoors variable (IJBNPA, 2010, 7:31). This paper shows that GPS measured time outdoors declines throughout the evening and is higher in the summer months than winter, in line with expected patterns of children's outdoor time. In addition, using accelerometer data matched with GPS we segmented the activity data points to either outdoors or indoors. Outdoor physical activity was over 2.5 times higher than that indoors and also showed seasonal variation, whilst indoor activity was constant throughout the year. These data are consistent with the GPS providing an objective measure of time outdoors that could be used both in observational studies and potentially to measure the effect of interventions to increase time outdoors in children.

There are a number of issues still to be resolved. The GPS records data when in motorised transport, and thus time outdoors includes car and bus travel. We have reduced this by excluding data recorded above 15kph, but there will be some further data from slow moving traffic that we cannot remove at this point. Additionally, the present generation of GPS receivers have greater sensitivity than the Foretrex 201 and record data inside buildings. We are investigating potential methods for removing these indoor data. One approach may be to use satellite inclination and strength data provided by some instruments (e.g. the QStarz BT100X) to discriminate between indoor and outdoor data. A second approach that we are exploring is to return to the GIS to exclude data which falls within buildings. Overcoming these limitations appears to be feasible, and minute by minute patterning of GPS and physical activity data may be a useful tool to investigate environmental influences on children's physical activity that could be useful to evaluate public health interventions.

Note from the editor

Hello everyone

I hope you are having an enjoyable 2010. Thanks to all who attended the informal get-together in Toronto last month. It was great to speak to many of you in person and hear of the exciting work happening around the world.

This issue of the GPS-HRN newsletter features an article by Dr Ashley Cooper from the University of Bristol in which he describes his experiences estimating time spent outdoors using GPS. We also highlight the work of Dr Cooper's research team in the member profile section. In addition, Christina Ergler (University of Auckland), Prof Robin Kearns (University of Auckland), and Assoc Prof Karen Witten (Massey University) have contributed an article comparing 'hot start' times in three common GPS units.

As always, if you come across any GPS-related news, updates, or recent publications, please don't hesitate to post them on the website (www.gps-hrn.org).

All the best

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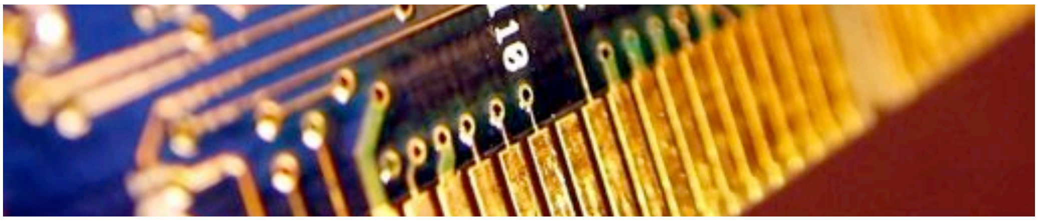

Technology update: Qstarz upgrades portable GPS data logger

Qstarz BT-Q1000XT

The recently released BT-Q1000XT improves on the BT-Q1000X by doubling data capacity and by adding two new features: a vibration sensor and a time scheduling function.

The extra data allows 400,000 waypoints to be recorded, equivalent to approximately 40 days of monitoring (5 sec interval, 12 hours per day).

The vibration sensor can be configured to place the unit in sleep mode if motionless for more than 10 minutes.

The time scheduling function turns the device on and off based on preconfigured times or dates. This could potentially lessen participant burden for studies of free-living activity.

The BT-Q1000XT currently retails for US$130.

Key features (from website):

- MTK II chipset (165dBm and 66-Channel tracking)
- Up to 42 hours of battery life
- Less than 15 s A-GPS fix support: download almanac data to achieve faster TTFF under warm start
- Log up to 400,000 records (approx 40 days)
- Beeper function to notify status of device
- Vibration sensor for managing power and waypoint saving
- Time schedule function to automatically start and stop logging
- Update rate 1~5 Hz changeable by utility provided
- G-Mouse + Bluetooth in one: wired and wireless GPS receiver
- Cold start 35 s, warm start 33 s, hot start 1 s
- Personal/Portable Navigation (PDA, Smartphone, PC, etc.)
- DGPS (WAAS+EGNOS+MSAS) support

Recent Research

AR Cooper, AS Page, BW Wheeler, M Hillsdon, P Griew & R Jago

Patterns of GPS measured time outdoors after school and objective physical activity in English children: the PEACH project.

International Journal of Behavioral Nutrition and Physical Activity, 2010, 7(31): doi:10.1186/1479-5868-7-31.

R Quigg, A Gray, A Reeder, A Holt & D Waters

Using accelerometers and GPS units to identify the proportion of daily physical activity located in parks with playgrounds in New Zealand children.

Preventive Medicine, 2010, 50(5-6): 235-240.

PJ Troped, JS Wilson, CE Matthews, EK Cromley & SJ Melly

The built environment and location-based physical activity.

American Journal of Preventive Medicine, 2010, 38(4): 429-438.

M Oliver, HM Badland, S Mavoa, MJ Duncan & JS Duncan

Combining GPS, GIS and accelerometry: Methodological issues in the assessment of location and intensity of travel behaviors.

Journal of Physical Activity and Health, 2010, 7(1): 102-108.

AR Cooper, AS Page, BW Wheeler, P Griew, L Davis, M Hillsdon & R Jago

Mapping the walk to school using accelerometry combined with a global positioning system.

American Journal of Preventive Medicine, 2010, 38(2): 178-183.

PA Gonzalez, JS Weinstein, SJ Barbeau, MA Labrador, PL Winters, NL Georggi & R Perez

Automating mode detection for travel behaviour analysis by using global positioning systems-enabled mobile phones and neural networks.

IET Intelligent Transport Systems, 2010, 4(1): 37-49.

Assessing "hot start" for three portable GPS devices

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Our interest in portable GPS units arises from a current project investigating children's outdoor play activity in two Auckland neighbourhoods. For this project we evaluated three units: the Qstarz BT-Q1000X (BTX), the Telespial Trackstick (TS) and the Garmin Forerunner 305 (F305). In evaluating these units we came across manufacturers' specifications of cold, warm and 'hot start' times. These specifications implied that these units acquire satellites signals quite quickly (often between one seconds and one minute). However, no information on 'hot, warm and cold start definitions' were included in the specification description of the units in question. We emailed the manufacturers to find out how they define them. All replied with widely varying definitions. For example, for Garmin products a hot start means that the device was turned on that day and the almanac is current. According to their definition an almanac expires after 2 weeks. Alternatively, for the TS manufacturer, a hot start means the batteries have never been removed prior to a GPS lock. The BTX needs to remember its last calculated position and the satellites in view as well as the almanac used and the Universal Time Coordinated (UTC). However, a hot start is only regarded as 'within the previous 5 minutes' otherwise it would be considered a 'warm start'.

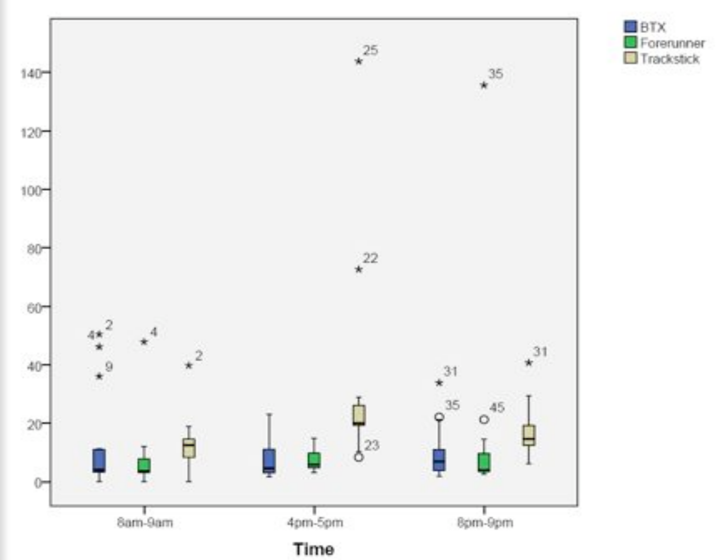
With these varying definitions we designed a small test to establish how hot starts vary over the course of a day. Our aim was to determine whether the time to acquire a satellite signal varies during the time children are usually awake and active and if that may have an influence on our data. Therefore, we were interested in how the units react simulating entering and leaving a building at different times of the day.
We applied the BTX Definition for "hotstart" as a guideline. We tested four times a day (8am, 12pm, 4pm, 8pm) how the units react while simulating entering and leaving a building for one hour. The units were tested in an inner courtyard at the University of Auckland. We switched each device on and recorded how long it took to acquire a signal. Then we switched the device off and waited for 5 minutes. Then the next testing phase started. On the testing day the weather was sunny and the sky was clear for the first two tests, whereas the weather during the last two tests was cloudy (approximately 75% - 80% coverage).

The BTX and the F305 seemed to work fine with widely varying acquiring times within each hour and during the day. The TS broke down in the middle of the test, although new batteries were used. We replaced them to be able to continue with the test. However, this is only compounding earlier problems we experienced with TS. Our tests reveal that although only a small sample was used, none of the medians met the manufacturers' specifications. However, the minimums of the TS were all below the nine second marker and the BTX has one minimum close to one second and two close to two seconds, whereas as the F305 has two close to one second and two close to three seconds.

For our analysis we removed the second timing phase (12-1pm) as this was the one the TS failed. Generally, the TS took longer to acquire a signal than the other two GPS units. Comparing the outliers, the TS and F305 had more problems acquiring a signal in the afternoon and evening when it was cloudy (e.g. the TS and the F305 needed more than two minutes to acquire a signal in these two phases), whereas the BTX had more difficulties during the sunny morning and cloudy evening testing phase, but especially in the morning these outliers are comparable to the outliers of the F305 and TS. The F305 has a smaller interquartile range in the morning and afternoon than the BTX and TS, whereas in the evening the interquartile range for the TS is the smallest and the F305 the greatest. The median for the TS is always two to four times higher than each of the other two units tested. In the morning the median of the BTX and F305 is quite similar. In the evening the median of the Forerunner lies below the one of the BTX, whereas in the afternoon it is reversed.

Summing up, manufacturers' specifications vary as well as their definitions. Although testing only the BTX definition on all units, the manufacturers' specification could barely be met in this small test. Meeting these specifications clearly depends on the circumstances of data collection and consequently how much time is taken to acquire a satellite (e.g., during the cloudy afternoon and evening times there were more severe outliers). Both the F305 and BTX acquire a signal over a duration that is probably tolerable for impatient young participants in all the tests. However, it is the outliers of more than two minutes measured with the F305 and TS during the cloudy period which may cause problems. Children may not like having to wait until the units acquire a signal. The quicker a unit connects with the needed satellites, the less data we lose when a child forgets to wait until the unit reacquires a signal. Consequently, the risk of missing data on important parts of children's outdoor play or losing the majority of data as the unit may not able to reacquire a signal is reduced when using a gadget which locates itself as fast as possible.

Boxplot of hot start acquisition times (in seconds)



Research Profile

From L-R: Pippa Griew, Laura Davis, Dr Angie Page, Dr Ashley Cooper

The PEACH research team is based within Exercise, Nutrition and Health Sciences at the University of Bristol, UK. The PEACH (Personal and Environmental Associations with Children's Health) project is funded by the UK National Prevention Research Initiative and the World Cancer Research Fund, and is investigating the environmental influences on children's physical activity across the transition from primary to secondary school. This transition is associated with the start of a progressive decline in physical activity toward adulthood, and PEACH is exploring what factors may potentially be important in influencing physical activity behaviour at this time. We are using accelerometers combined with GPS receivers to describe the level and location of physical activity across the city of Bristol.

The team is led by Drs. Ashley Cooper and Angie Page, and includes researchers from a range of disciplines and expertise. Ashley Cooper has a particular interest in the contribution of active travel to school to children's physical activity and fitness and within PEACH is using the combined accelerometer and GPS data to provide a detailed description of children's routes to school and the physical activity that occurs on and around these routes. We recently published pilot data in the February edition of the *AJPM* using accelerometry/GPS to show that physical activity levels during the walk to school are substantially higher than in the playground before school. Angie Page focuses on the behaviours linked to childhood obesity and the determinants of children's physical activity and eating behaviour, and her recent work published in the *IJBNPA* is based on a new approach to investigating children's independent mobility (their ability to go out unsupervised) and how this is strongly linked to physical activity behaviour and time spent outdoors.

Our team geographer is Dr. Ben Wheeler. Ben recently left Bristol and is now a research fellow with the European Centre for Environment and Human Health in Truro, UK. His main research interest is the influence of the outdoor environment on public health, with particular regard to health inequalities and informing health and environmental policy. He is interested in developing and applying methods using GPS/GIS in studying people's activities in different environments, and how this affects their health and wellbeing. He also applies GIS and spatial analysis methods using national and international secondary datasets to investigate environmental risks and benefits to population health.

Most important however are Pippa Griew and Laura Davis who have recruited the schools and collected the data from the children! Pippa has a particular interest in the influence of the school environment on physical activity and is translating her work on PEACH into a PhD.

IPEN — INTERNATIONAL PHYSICAL ACTIVITY AND THE ENVIRONMENT NETWORK

IPEN was launched by Professor Jim Sallis (USA), Dr Ilse DeBourdeaudhuij (Belgium) and Professor Neville Owen (Australia) at the International Congress of Behavioral Medicine in Mainz Germany in August 2004.

Physical activity habits are determined by multiple levels of influence – personal, family, social, environmental, economic and other factors. Ecological models of health behaviour have been used to synthesize research at these different levels, and to focus attention on relationships of particular physical activities with specific attributes of physical environments, including the built environment.

While physical activity environments will vary within countries, the greatest and most informative sources of variation in the relationships of environmental attributes with physical activity are likely to be between countries. The IPEN initiative seeks to stimulate, inform, and support systematic and rigorous studies of physical activity and the environment, in as many countries as possible.

Please contact Jacqueline Kerr (jkerr@ucsd.edu) or Nicole Bracy (nbracy@projects.sdsu.edu) if you would like more information.

www.ipenproject.org

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