

A Global Review of Current IPB Technology and Research

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Abstract

Bicycling provide many environmental, social, health, economic and transport-related benefits. The main challenges to wider acceptability of bicycle transport in North America (NA), are the perceived comfort, safety and practicality of cycling compared to driving. The most recent technological development in this area of research is the Instrumented Probe Bicycle (IPB). In this study, previous IPB research from around the world is outlined and a survey of predominantly North American researchers is conducted. Finally, an IPB research plan for NA is proposed.

Objective

1. Explore the need for IPBs in bicycle safety and comfort research.
2. Summarize published IPB research around the world.
3. Explore the current state of IPB research in NA.
4. Propose an IPB research plan for NA.

Literature Review

RESEARCHER	INSTRUMENTS UTILIZED WITH PROBE BICYCLE
Divera Twisk SWOV Institute for Road Safety Research Netherlands	Speedometer, potentiometer (steering sensor), GPS, Go-Pro 3 Silver video camera, ProMove 3D (Inertial Measurement Unit)
Marco Dozza Chalmers University of Technology Sweden	GoPro Hero, Hero2 video camera, Phidget IMU 1056 (Inertial Measurement Unit), Phidgets GPS 1040, Flexi-force resistive force sensor (Brake force sensor)
Yizhai Zhang* Rutgers University United States of America	8 Bonica cameras from Vicon Inc. (motion capture), Inertial Measurement Unit - Motion Sense Inc., handle bar force/torque sensor, seat force/torque sensor, pedal force sensor, EEG sensor, EMG sensor, eye tracking sensor, CompactRIO - National Instruments Inc. (controls pneumatic actuators that support the bicycle frame)
Joachim Vanwalleghem Ghent University Belgium	Velocity sensors, Force sensors including handlebar force sensors
Shinhye Joo Hanyang University Republic of Korea	Inertial Measurement Unit, GPS
Hideo Yamanaka The University of Tokushima Japan	SHARP GP2Y0A02YK0F (PSD distance sensor – lateral distance sensor), MicroStone MA3-04AD (Vibration Sensor), Race Technology DL1 (Data logger and GPS), speed sensor, braking sensor – displacement sensor, steering sensor – string sensor, video camera and microphone
Ian Walker University of Bath United Kingdom	Massa M-5000/95 (Ultra sonic distance sensor), Video Camera, laser (to assist cyclist with maintaining fixed distance from edge of pavement)
Marilyn Johnson Monash University Australia	Oregon Scientific ATC3K Action Camera (Helmet Mounted camera)
Tina Gehlert German Insurers Accident Research Germany	ACME FlyCamOne eco V2 (front and back camera), SM Modellbau GPS-Logger (GPS), SM Modellbau Unilog2 (Wheel Sensor and Altimeter)

Table 1. Summary of IPB researchers and the IPBs used by each [1, 2, 3, 4, 5, 6, 7, 8, and 9]
*Stationary IPB (not all sensors were mounted on the bike)

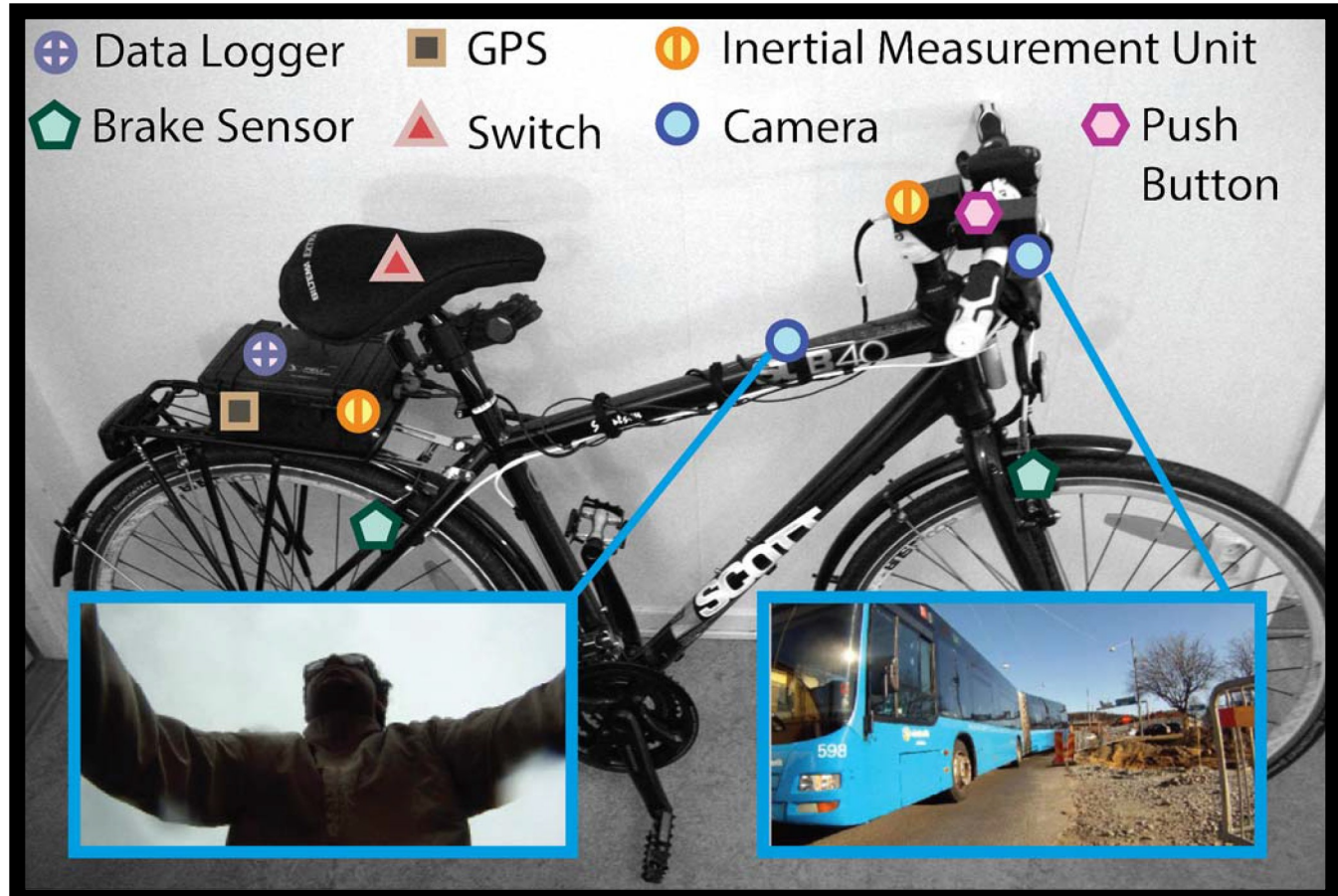


Fig 1. IPB by Chalmers University of Technology [3]

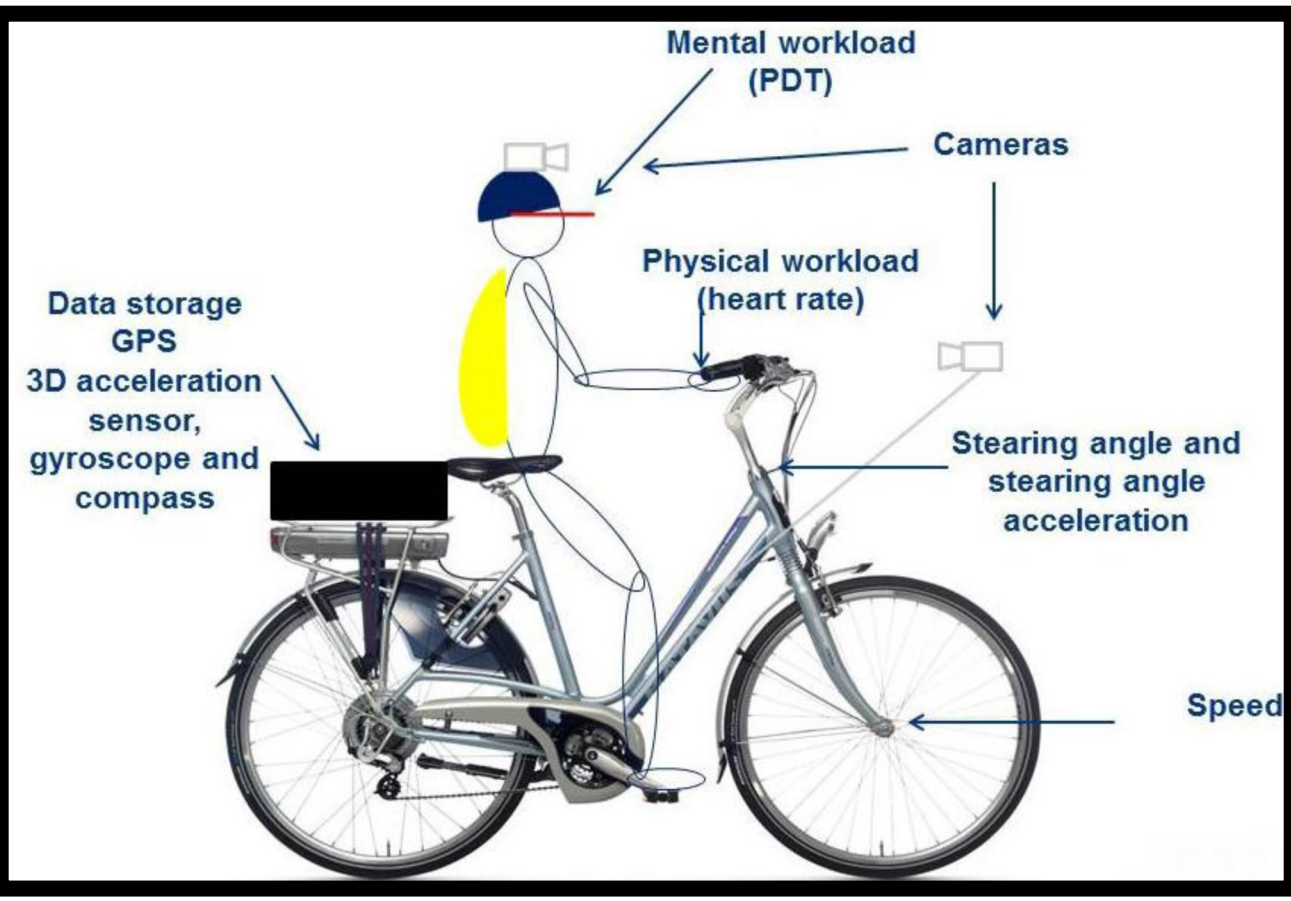


Fig 2. IPB by SWOV Institute for Road Safety Research[4]

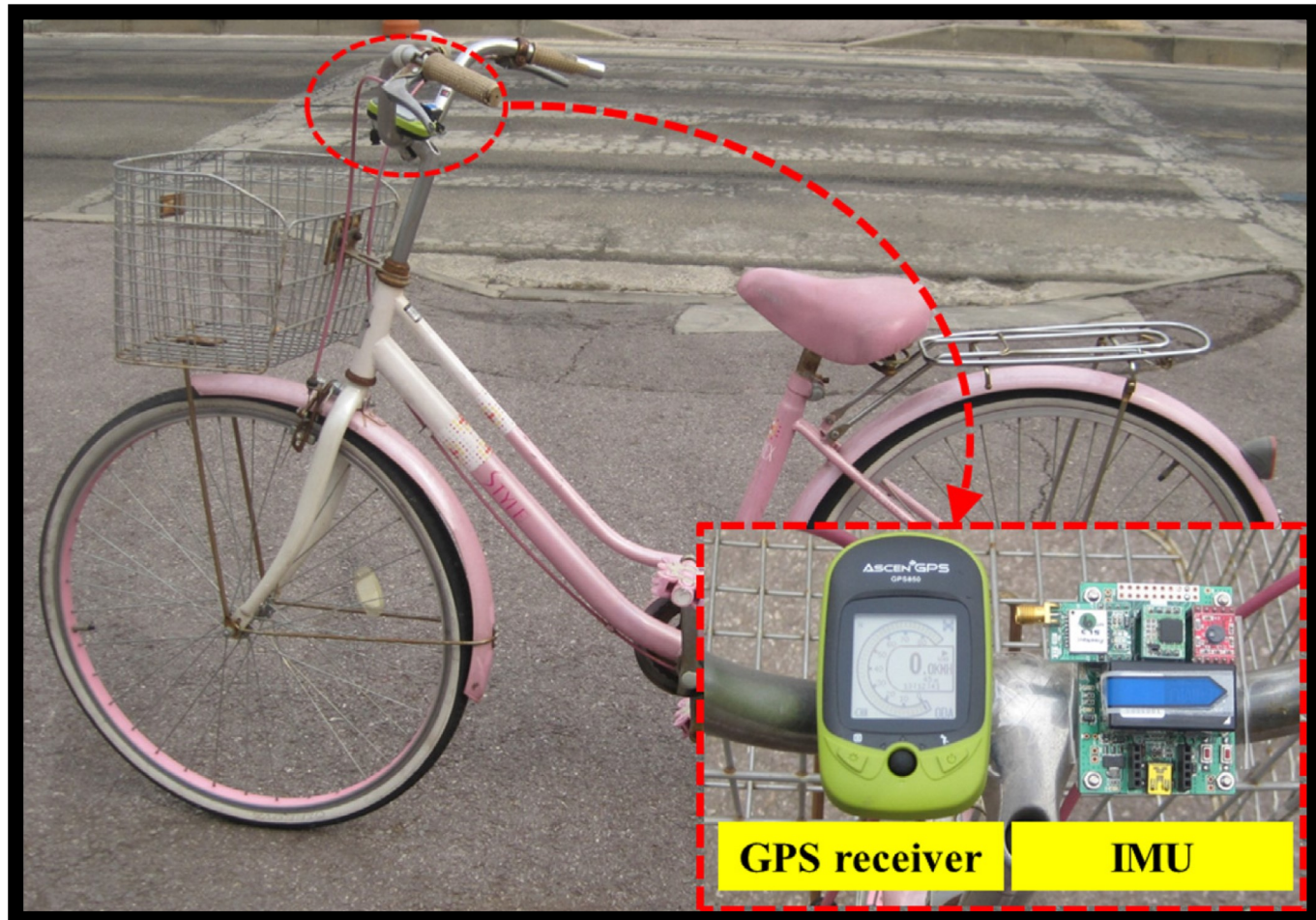


Fig 3. IPB by Hanyang University[1]



Fig 4. IPB by The University of Tokushima [2]

Survey

The objectives of the survey were to gain an understanding of ongoing IPB research in NA, opinions IPB research and on bicycle comfort and safety policies . 15 researchers from 11 institutions, one city, and one transportation authority across the U.S. and Canada were invited to complete the survey along with 2 lead IPB researcher in Europe.

Results

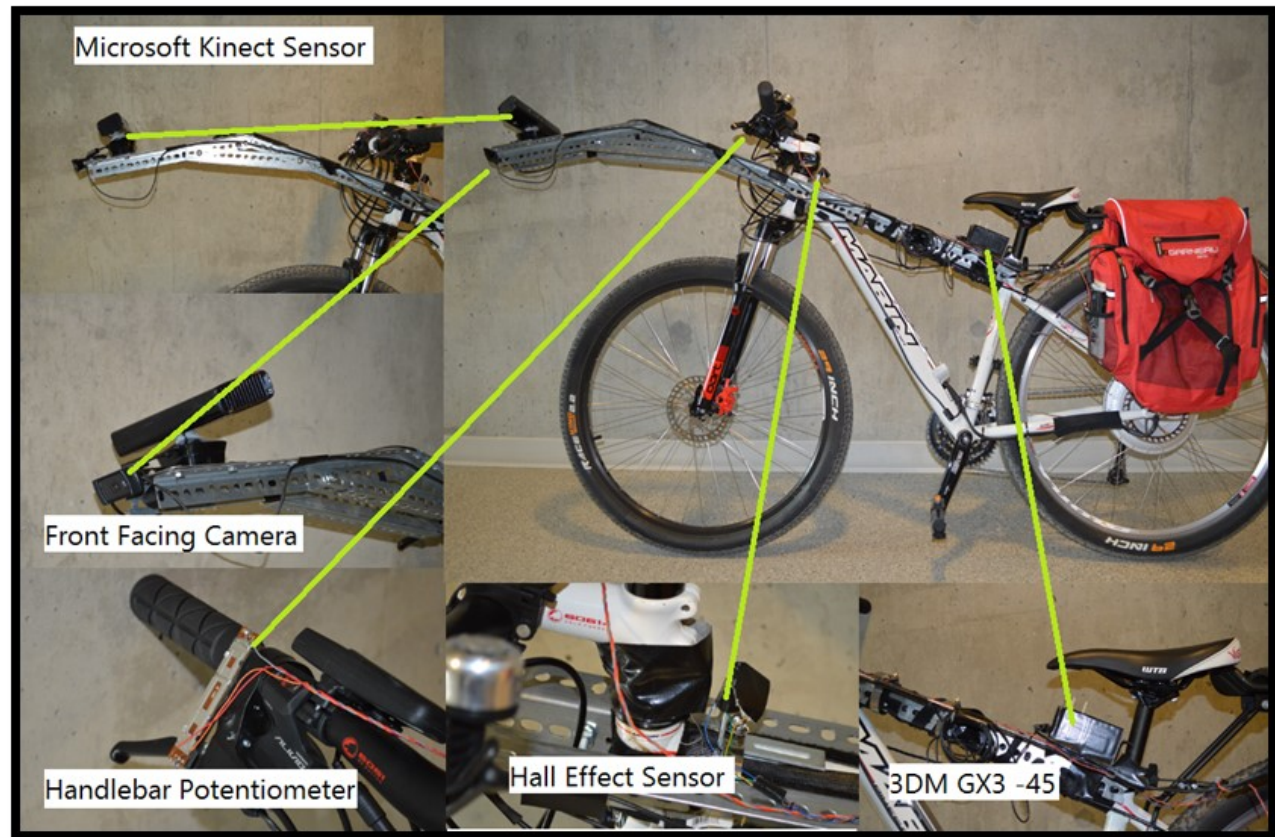


Fig 5. IPB by The University of British Columbia

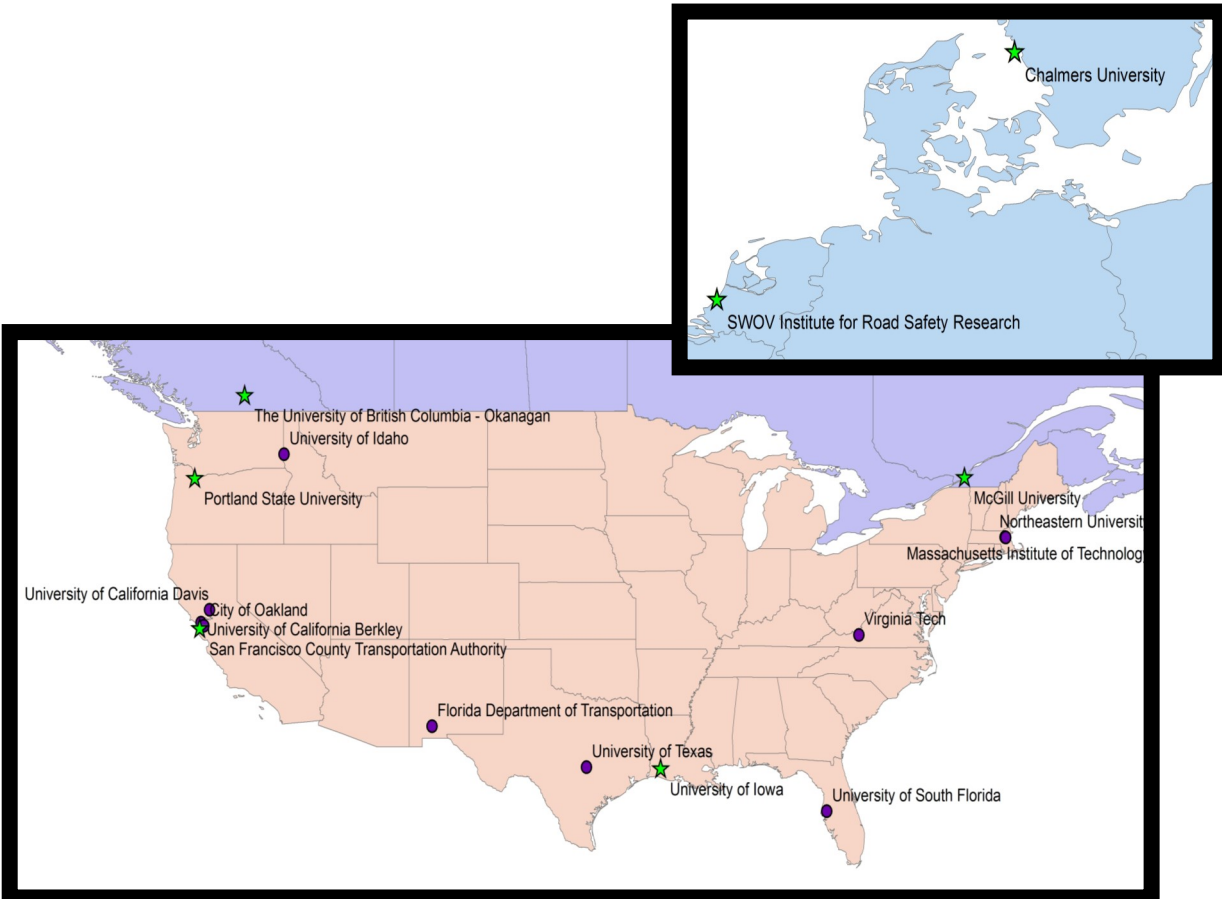


Fig 6 . ArcGIS map show the locations of institutions that were invited to complete the survey. A green dot indicates institutions that were able to complete the survey.

RESEARCHER	INSTRUMENTS UTILIZED WITH PROBE BICYCLE
Gordon Lovegrove University of British Columbia Canada	Microsoft Kinect, Kinect2 Camera, Logitech HD Pro Webcam C910, PTB6043-2010BPB103 Potentiometer (Hand-brake sensor), A1324 Hall effect sensor (Handlebar sensor), 3DM GX3-45 (GPS-Aided Inertial Navigation System)
Cara Hamann University of Iowa United States of America	GPS, Speedometer, camera
Krista Nordback Portland State University United States of America	No current IPB research
Elizabeth Sall San Francisco County Transportation Authority United States of America	Smartphone and associated applications
Marianne Hatzopoulou McGill University Canada	Air pollution monitors (TSI Condensation Particle Counter, Black Carbon Microaethalometer, TSI Dust Track, Harvard Impactor), GPS, Go-Pro Video Camera, Holter monitors (on cyclists)
Christopher Cherry University of Tennessee United States of America	Garmin GPS18xLVX (GPS) - mounted on 7 e-bikes and 6 regular bicycles, Smart Phones and associated applications

Table 2. Summary of researchers in NA and type of IPB used in their on-going research

CONCERN	OBJECTIVE
Challenges in post processing of data and synchronization of multiple data streams	Further research and development into improving IPB software technology.
IPB configuration and design standardization to allow for data comparability	IPB research may be allowed to develop independently from one another to promote diversity. Once the best design is determined, it can be standardized. Task-specific IPB design standards are necessary.
Lack of bicycle infrastructure quality and quantity	IPB research focusing on the development of safety and comfort prediction models. Introduce improved educational programs.

Table 3. Summary of main topics discussed and corresponding proposed plan

Conclusions

- IPBs are being used in NA for a wide range of research topics including comfort, safety, risk exposure, air pollution and travel demand.
- Common challenges include post processing of data and synchronization of multiple data streams. Further research and development into improving IPB software technology is warranted.
- On the topic of IPB standardization, research can be allowed to develop independently in order to promote diversity in IPB technology until the field has matured.

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