

mobile sensing for ubicomp & persuasive computing

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present applications in the areas of persuasive computing /
ubicomp

mobile sensing is the key technology enabler

playful tray

playful toothbrush

playful bottle / mug tree

watchful glasses

convenience probe

pipe probe

ntu collaborators

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many people may be familiar with ubicomp

but what about persuasive computing?

quick definition: use digital technology to motivate people to change their behaviors

the focus is **not** to use technology to automate (replace) people's actions, but to (let people perform their actions) help people perform better, e.g., more healthy, efficient, creative, etc.

not just instrumenting a smart environment with a lot of sensors and actuators, but empower **smart people** and help them develop better habits

playful tray (2006)

encourage good eating habits in young children

sense recognize behavior

weight sensor underneath the tray to sense eating actions

eating actions as game input

feedback play to engage behavior change

interactive games: coloring cartoon character



phone-version playful tray (2007)



water-proof cover



bluetooth weight
sensor



penguin fishing
game

playful toothbrush (2008)

encourage proper and thorough brushing for young children

sense recognize behavior
webcam detects brushing motions
brushing actions are game input

feedback play engage behavior change
start with a mirror image of dirty teeth.
physical brushing maps to virtual plaque removal
brushing order is important



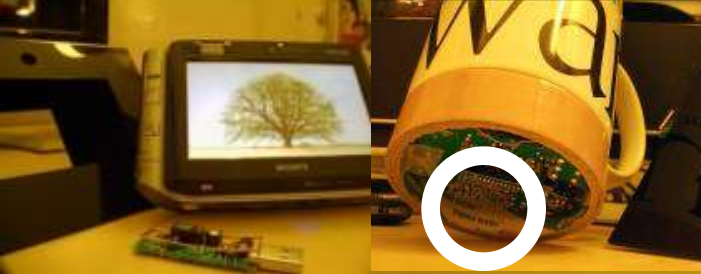
phone-version playful toothbrush?

Back in 2008, phones did not have enough processing power to perform real-time brushing activity recognition.

Now, many smart phones have GHz processors, so possible to build phone-version

Use a suction cup to fix a phone on the mirror for easy system deployment





tilt sensor



mug tree (2007)

encourage healthy water drinking habit

sense: recognize drinking action

tilt sensor to detect drinking action

feedback: use tree metaphor shown in a digital photo display to remind users

phone-version mug forest (2009)

use social pressure for persuasion

sense: recognize drinking action

accelerometer to detect drinking action

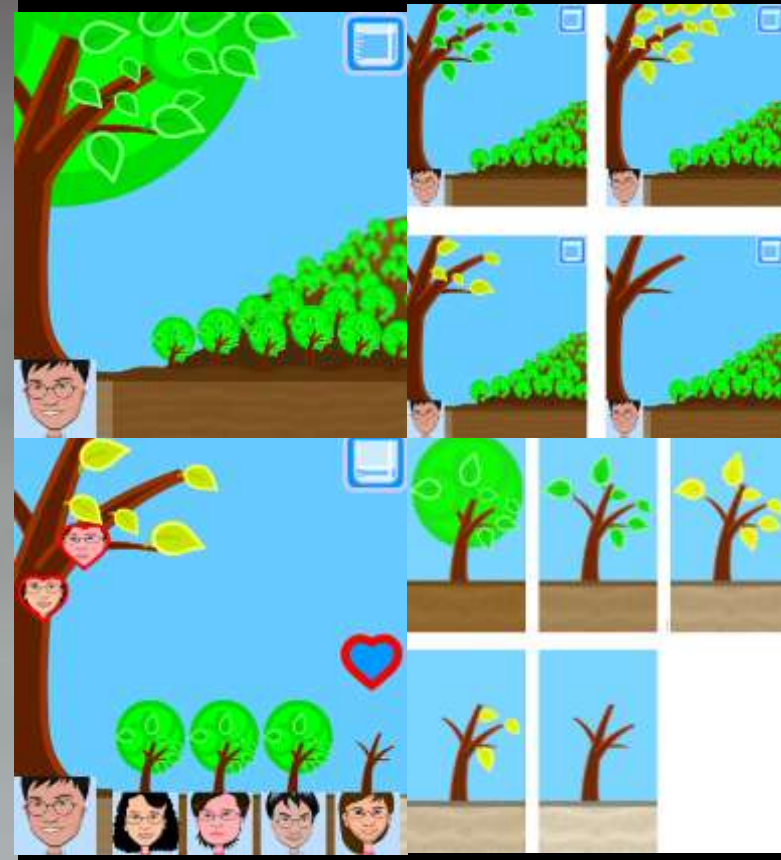
camera to detect water level

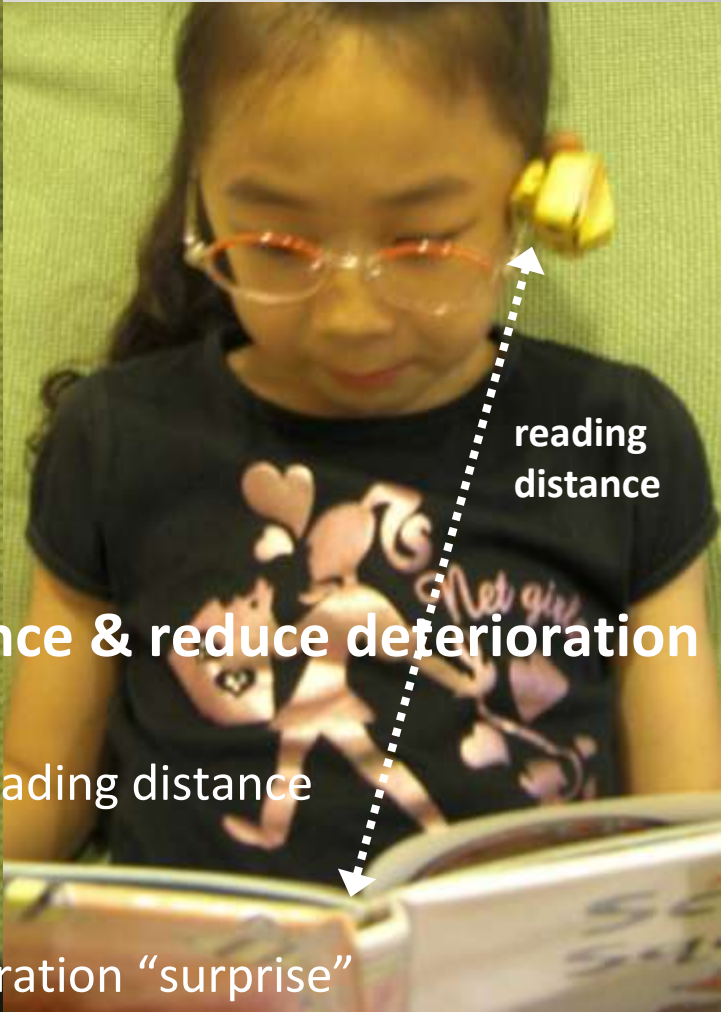
Feedback: use "social pressure" to engage behavior change

camera



water level





watchful glasses (2010)

help children maintain proper reading distance & reduce deterioration of near-sightedness

wearable device attached to the glasses & measure reading distance
ophthalmologists (eye doctors) recommend > 35 cm
tiny vibration reminder to prevent slump
slumping occurs when a child is tired & sleepy and vibration “surprise”

near-sightedness is epidemic among taiwan's children

1st grade ~ 10%

6th grade ~ 50%

9th grade ~ 75%

univ freshmen ~ 90%

ntu freshmen ~ 93%

similar situations in

hk,

singapore,

japan

台灣近視人口佔總人口比例世界第一，大學生九成以上戴眼鏡，高於日本的八成，美國的不到三成。近視人口中 19% 是高度近視（600 度），比例也高踞世界第一；更可怕的是，得近視的年齡逐年降低，85 年全國視力調查發現，國小一年級近視率 12%，比 10 年前的 3% 激增三倍多。↓

到了國小六年級，台灣一半的學童是四眼田雞，校園內到處可見學童戴著眼鏡。↓
國中則是近視率增加最快的階段。超過 75% 國三學生得戴眼鏡，高中、高職生的近視率則高達 85%。↓

到了大學階段，更有九成以上的人看不清楚。國立台灣大學今年初曾針對大一新鮮人做體檢調查，就發現 93% 有視力異常。龍的傳人，幾乎全都成了「田雞」的傳人，林隆光搖頭說。↓

書田診所眼科主治醫師吳仁斌在大學畢業時，全班 140 人，僅剩 5 人沒近視。↓

登上「近視王國」的寶座↓

一直密切注意國人視力保健的台大醫院視力保健中心主任林隆光更說，隨著升學主義愈演愈烈、以及國人觀念錯誤的耽誤，台灣早已取代日本成為「近視王國」。他還擔心，高度近視人口日增，將是造成愈來愈多人失明的主要原因。↓

what cause this near-sightedness epidemic?

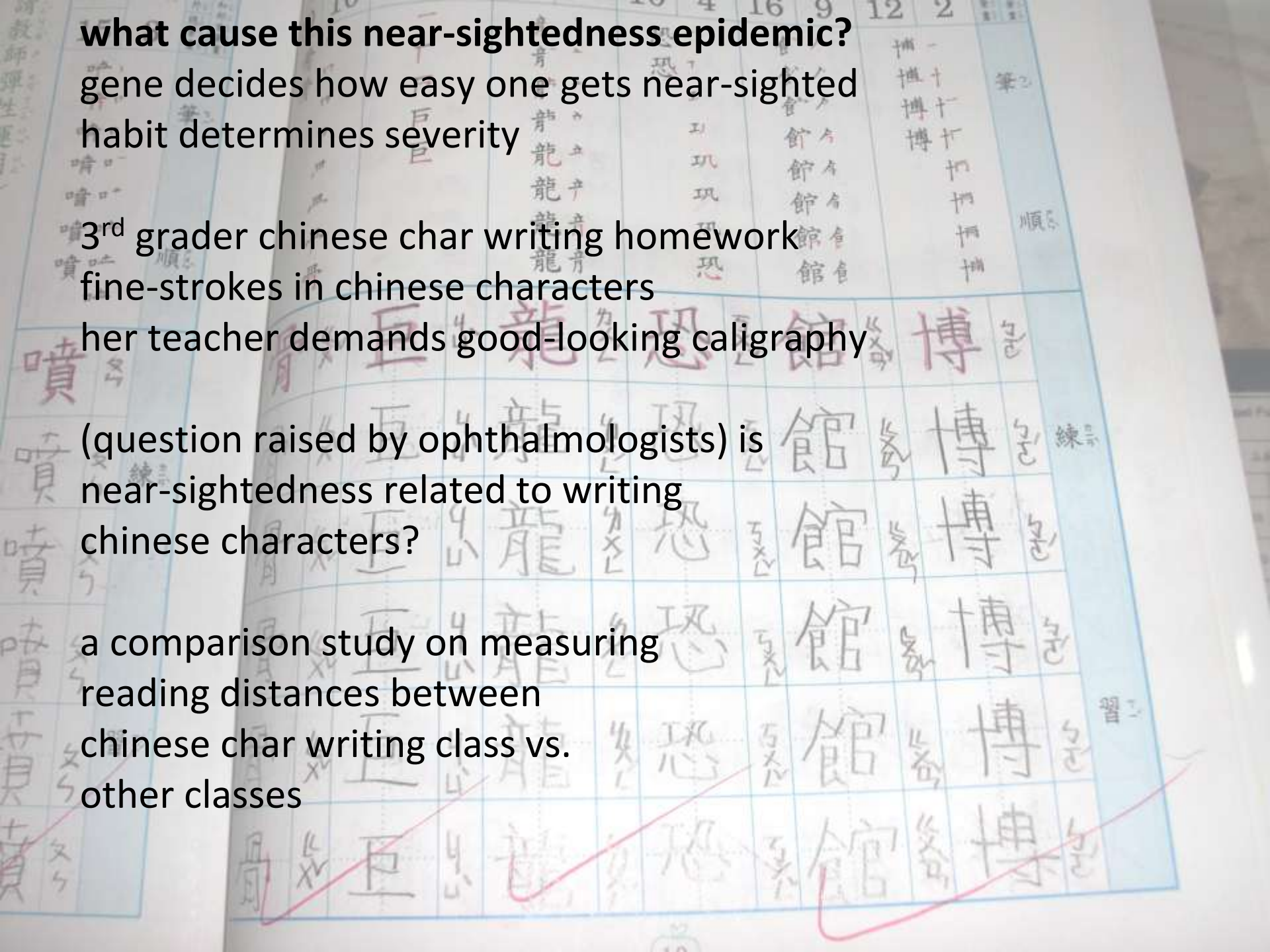
gene decides how easy one gets near-sighted
habit determines severity

3rd grader chinese char writing homework
fine-strokes in chinese characters

her teacher demands good-looking calligraphy

(question raised by ophthalmologists) is
near-sightedness related to writing
chinese characters?

a comparison study on measuring
reading distances between
chinese char writing class vs.
other classes



pipe probe (2010)

a tiny sensor droplet used to map 3d layout of (hidden) water pipes

leakage often occurs at pipes' turning points

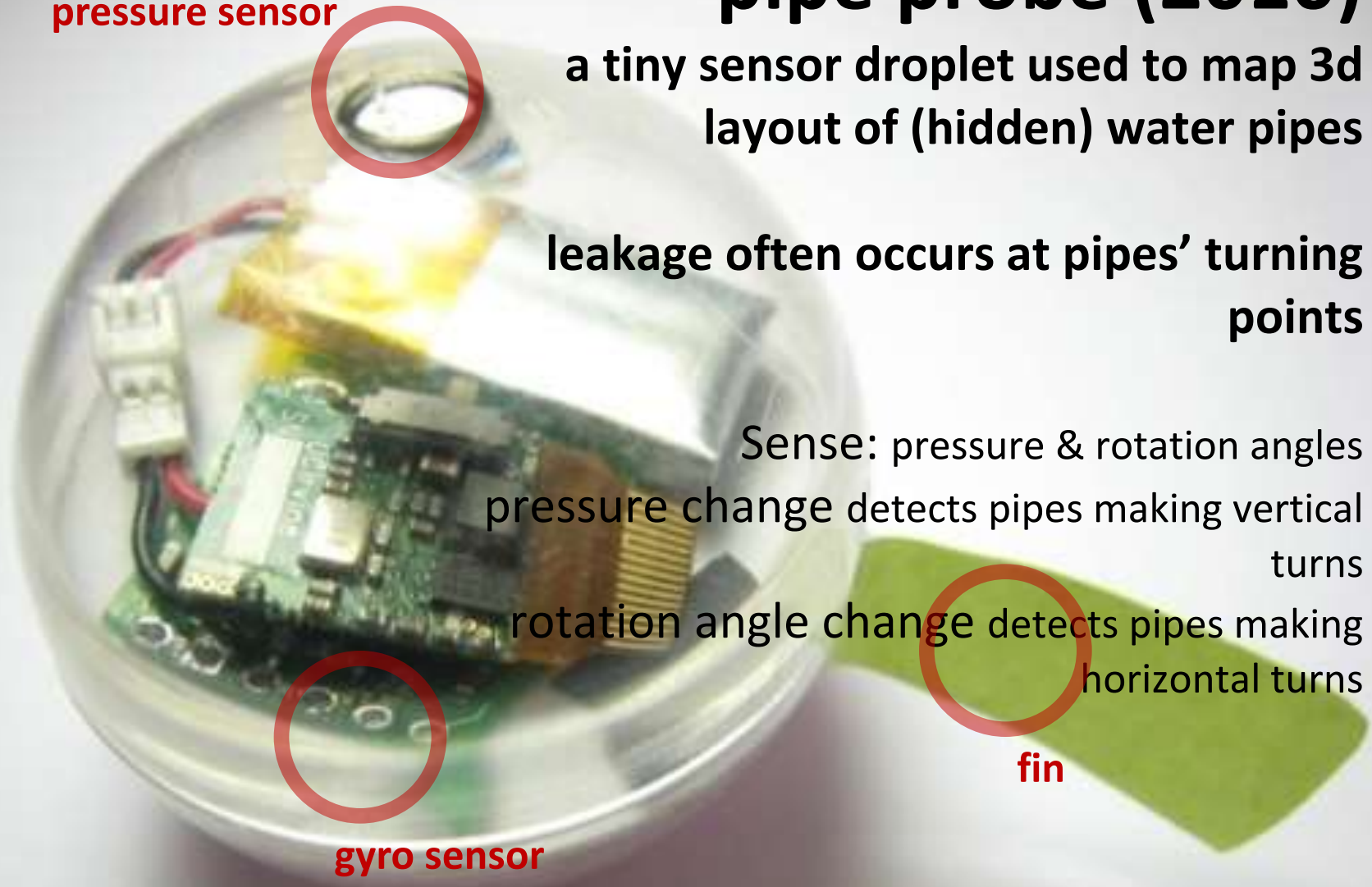
Sense: pressure & rotation angles
pressure change detects pipes making vertical turns

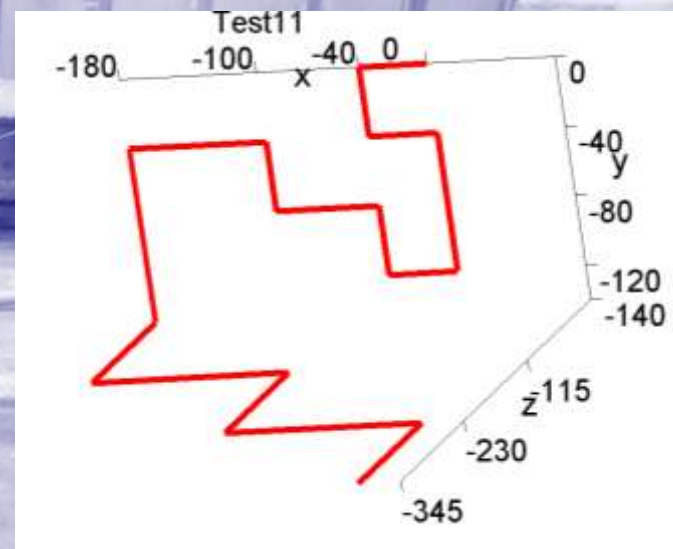
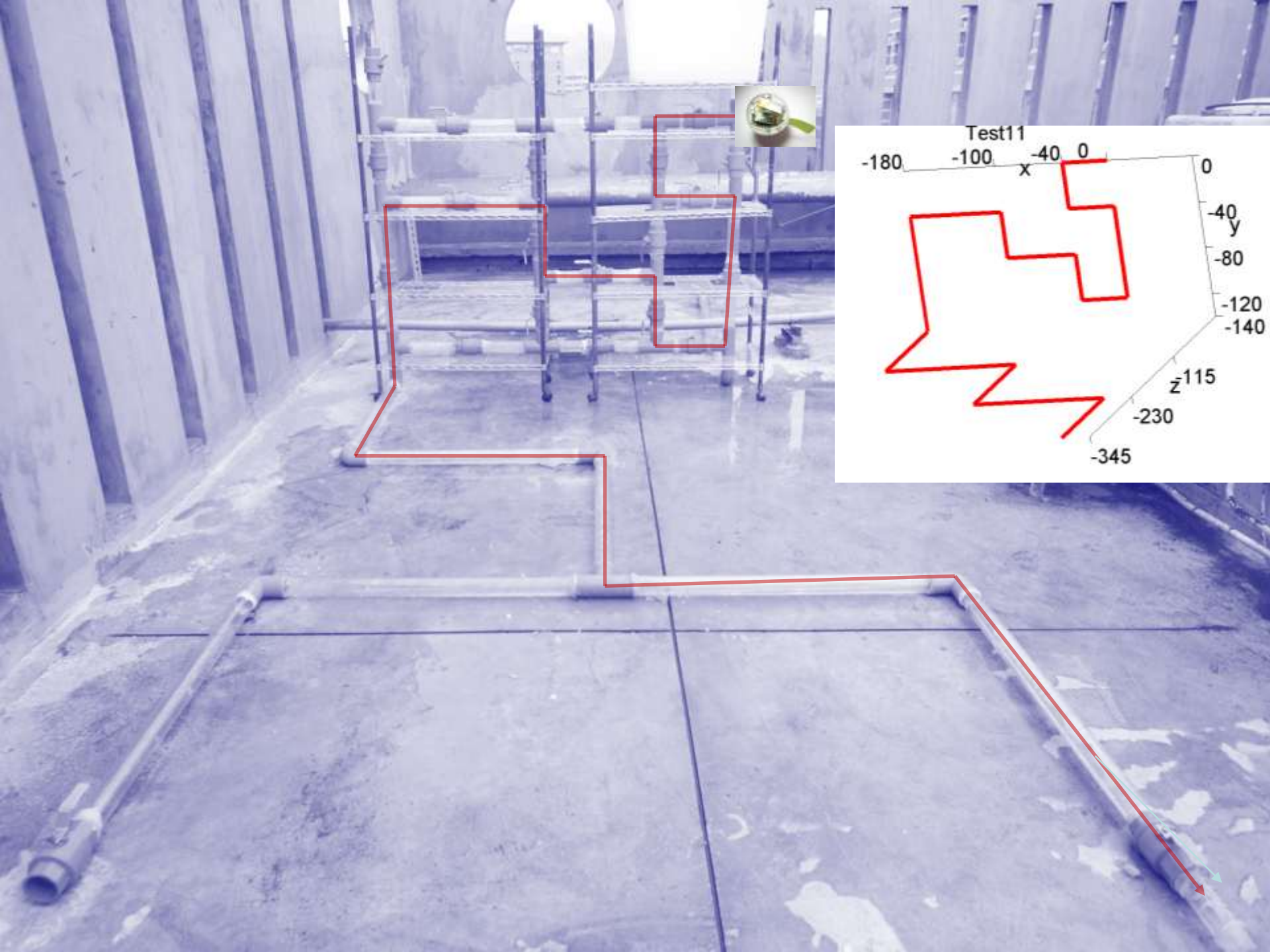
rotation angle change detects pipes making horizontal turns

pressure sensor

gyro sensor

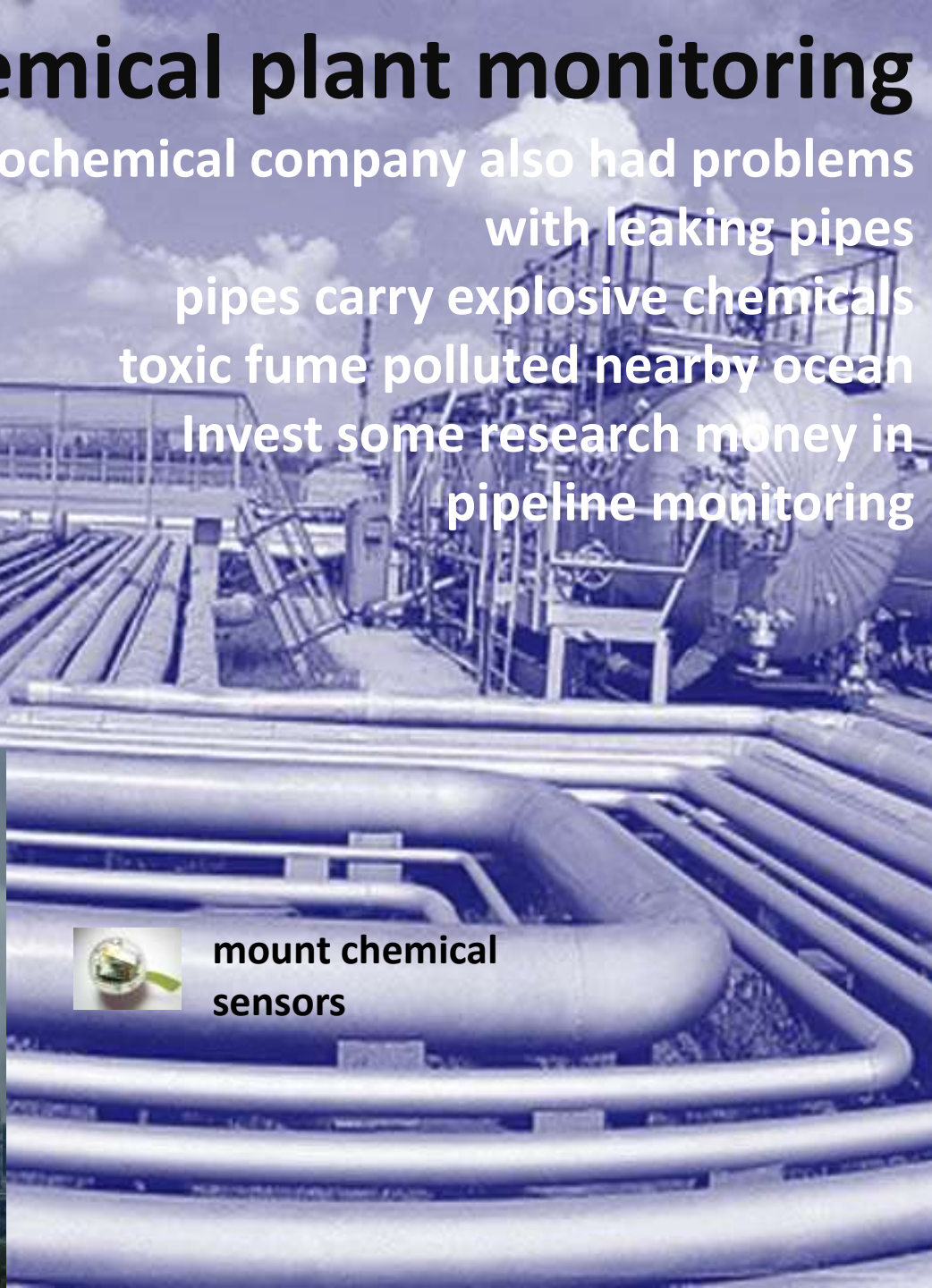
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petrochemical plant monitoring

formosa petrochemical company also had problems with leaking pipes pipes carry explosive chemicals toxic fume polluted nearby ocean Invest some research money in pipeline monitoring



mount chemical sensors

convenience probe (2010)

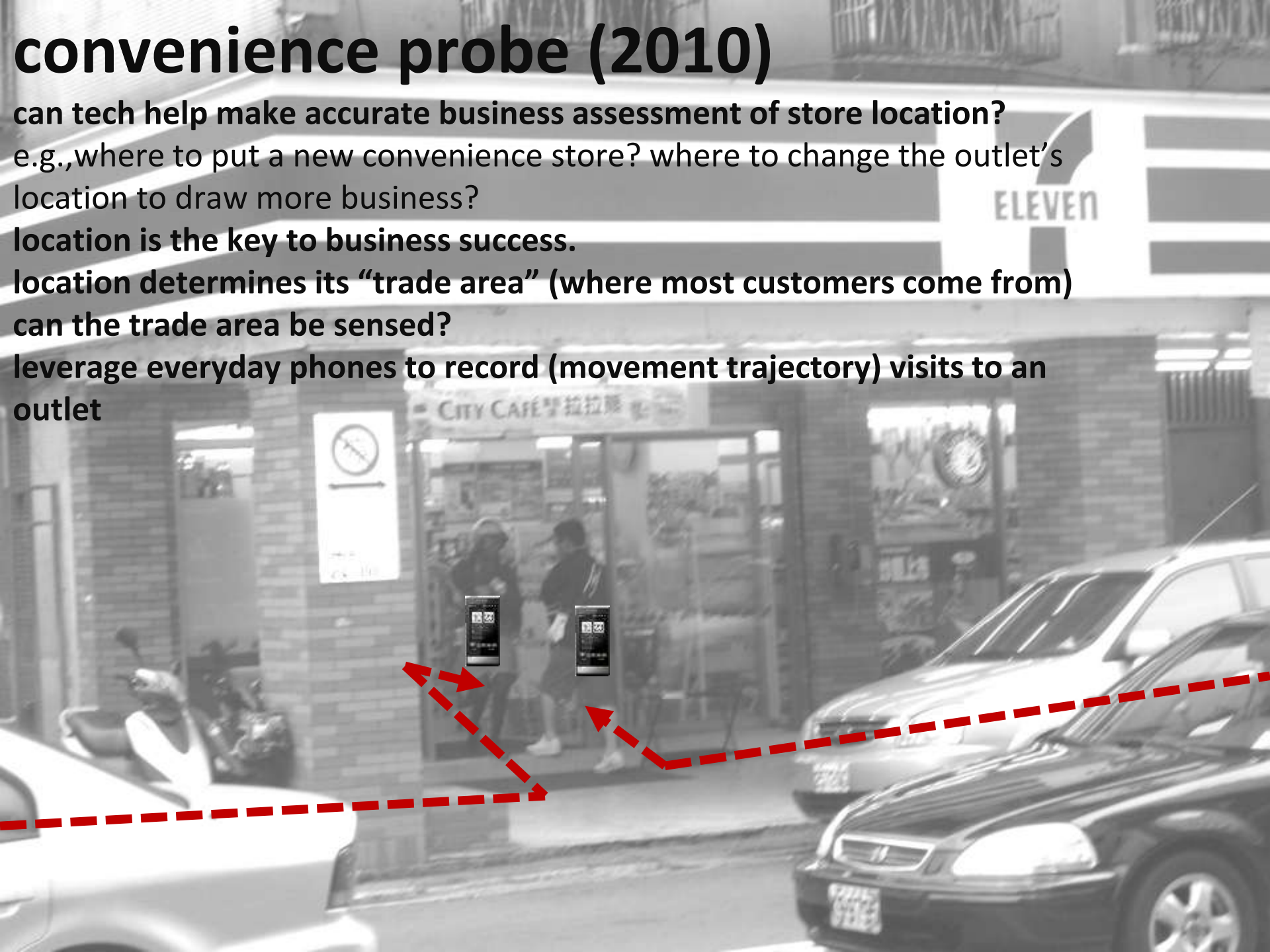
can tech help make accurate business assessment of store location?
e.g., where to put a new convenience store? where to change the outlet's location to draw more business?

location is the key to business success.

location determines its "trade area" (where most customers come from)

can the trade area be sensed?

leverage everyday phones to record (movement trajectory) visits to an outlet





trade area analysis

movement trajectories
of customers

construct trade area

Conclusion

phone makes a good mobile sensing platform

built-in sensors, off-phone sensors
processing power
display

phone is good for sensing human behaviors

phones are carried by users all the time

many phones working together have good potential for large-scale mobile sensing

phone-based WSN (Feng Zhao, "Building a Sensor Network of Mobile Phones")

Thanks

more info about projects

<http://mll.csie.ntu.edu.tw>

ACM UbiComp 2011 will be in Beijing

Date: Sep. 17-21, 2011