Tips for Young IT Researchers in Medical and Healthcare Fields

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Short Biography

- Yoshitoshi Murata received a Dr. Engineering degree from Shizuoka University, Japan. From 1979 to 2006, he worked for NTT and NTT DoCoMo. From 2006 to 2020, he was a professor of at Iwate Prefectural University. He retired in March, 2020, and is now a Professor Emeritus of Iwate Prefectural University.
- Prof. Murata is a Fellow of the International Academy, Research and Industry Association.
- His research interests include the Internet of things in the medical and healthcare fields and industry.

Introduction

- Researching and writing journal papers is an important duty of laboratory researchers.
- However, this is not so easy for most young IT researchers in the medical and healthcare fields because of their lack of professional contacts, facilities, and know-how.
- My research experience has taught me that there are three keys to researching and writing journal papers.
  - The most important is finding a research topic for which novel and useful results can be obtained.
  - Second is selecting appropriate sensors and deciding which data to measure.
  - Third is identifying an appropriate academic conference.
- In this tutorial, I present 15 tips based on my experience that will help young IT researchers research and write journal papers .

Basic steps

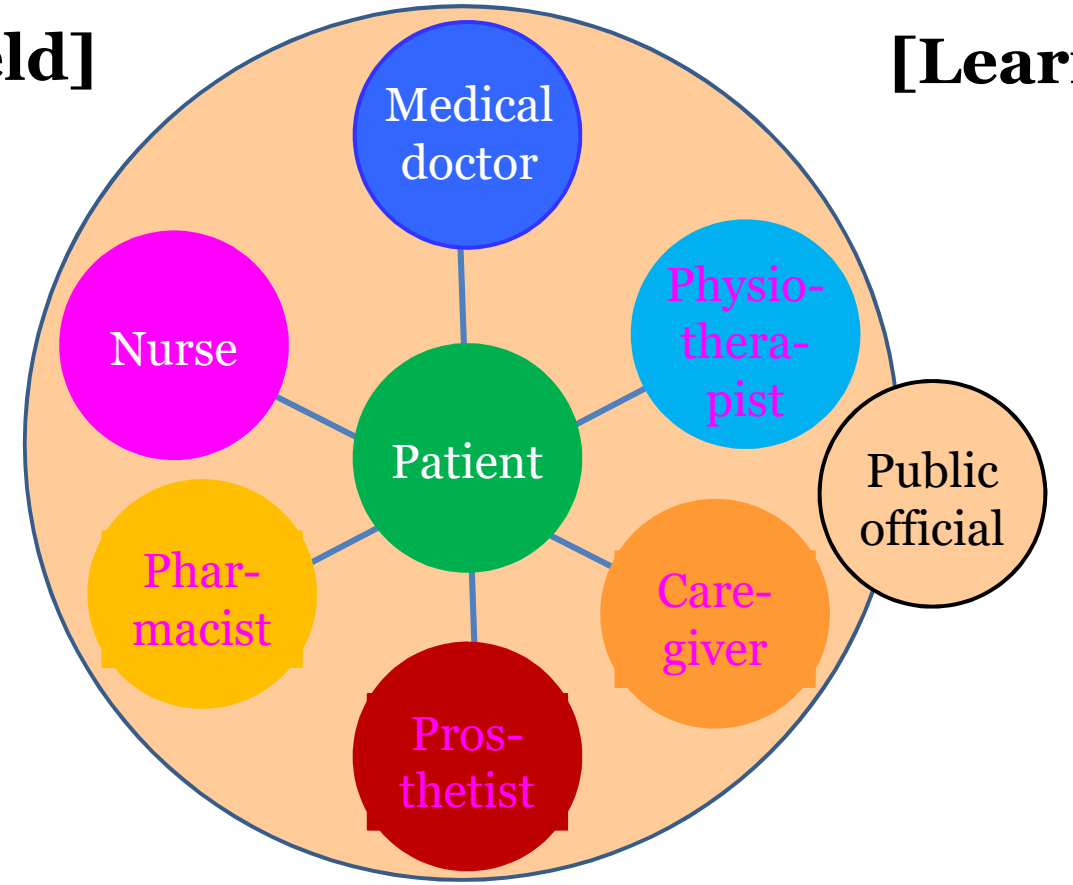
- Make friends with medical personnel.
  - Establish and maintain trusting relationships with them.
- Identify promising research topics.
  - Listen to concerns and problems expressed by medical worker friends.
  - Identify actual problems.
- Research systems, tools, and references related to those problems.
- Observe patients to determine which features characterize the problems, and select sensors to detect them.
- Develop novel systems or tools using selected sensors, and use them to collect data.
- Identify appropriate academic conferences, such as IARIA conferences, and attend them regularly.

Research topics (RTs)

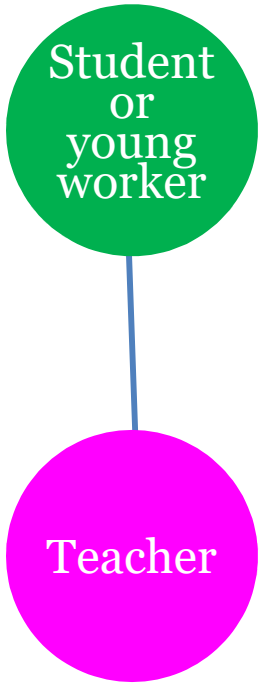
Tip 1: Determine which field: real or learning.

- Research topics can be categorized by field: real or learning.
- Topics include relationships between patients and medical staff.

[Real field]



[Learning field]



Tip 2: Build trusting relationships with medical personnel.

- Job-related complaints could be clues to important research topics.
- Such complaints are rarely shared with an untrusted person.

Example: Preventing tripping-related falls

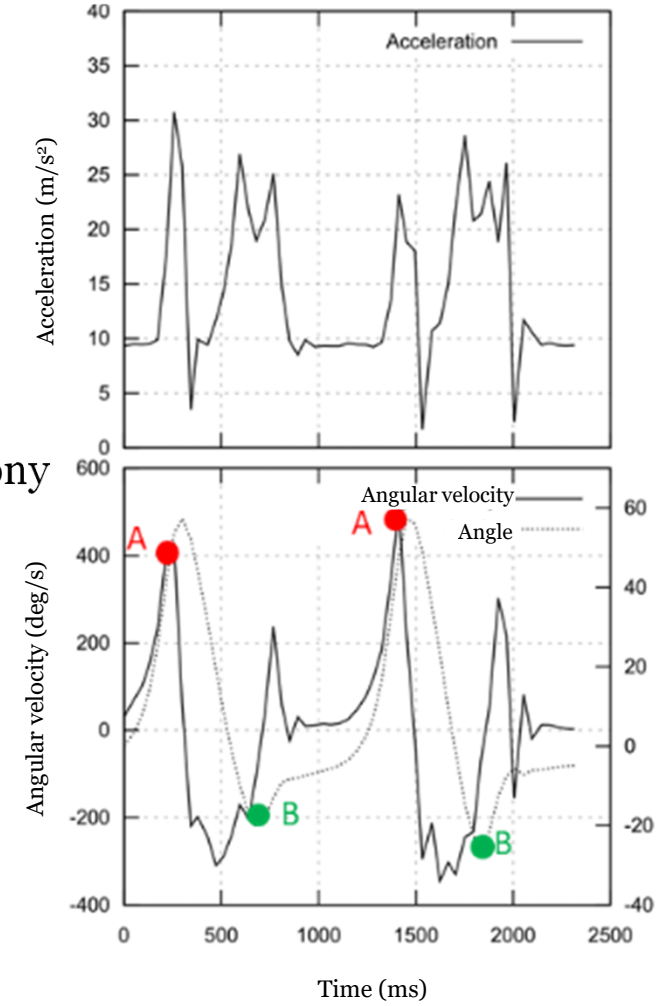
- Complaint from a physiotherapist friend: “Patients with a leg disability sometimes trip even on a flat floor and fall down”.
- Approach to finding a solution:
  - Analyze reasons for tripping on a flat floor.
  - Develop a gait monitoring system that measures gait motion and alerts wearer if gait posture become poor.
  - Develop a gait assist unit.

Measured data

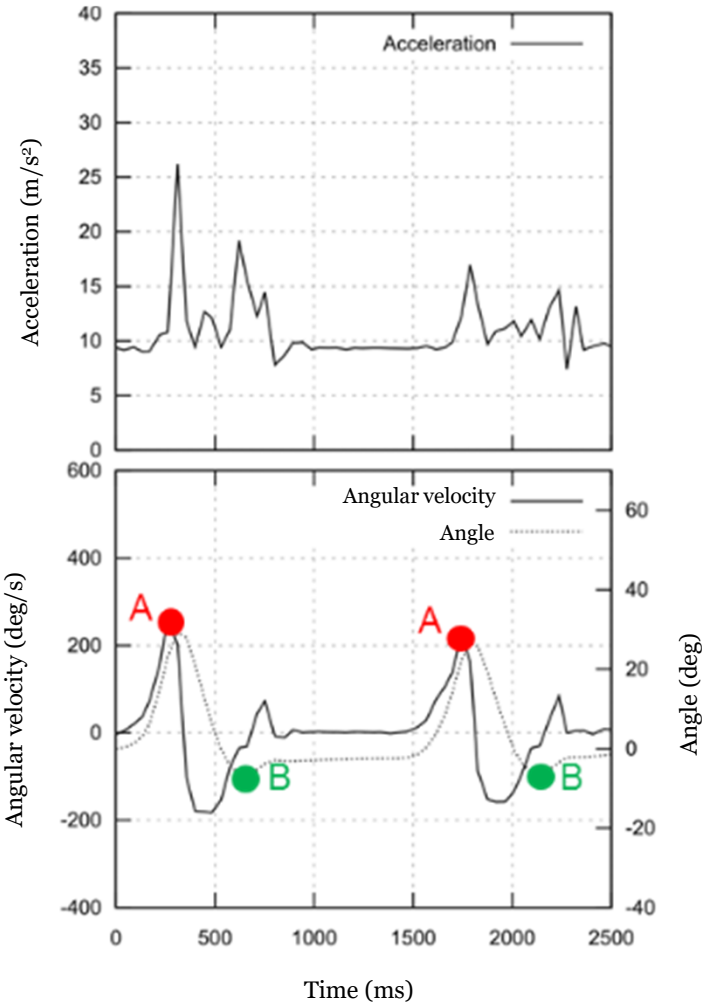
WD: SmartWatch 3, Sony

WD* mounted on foot

*WD: wearable device



Measured data for unimpaired participant



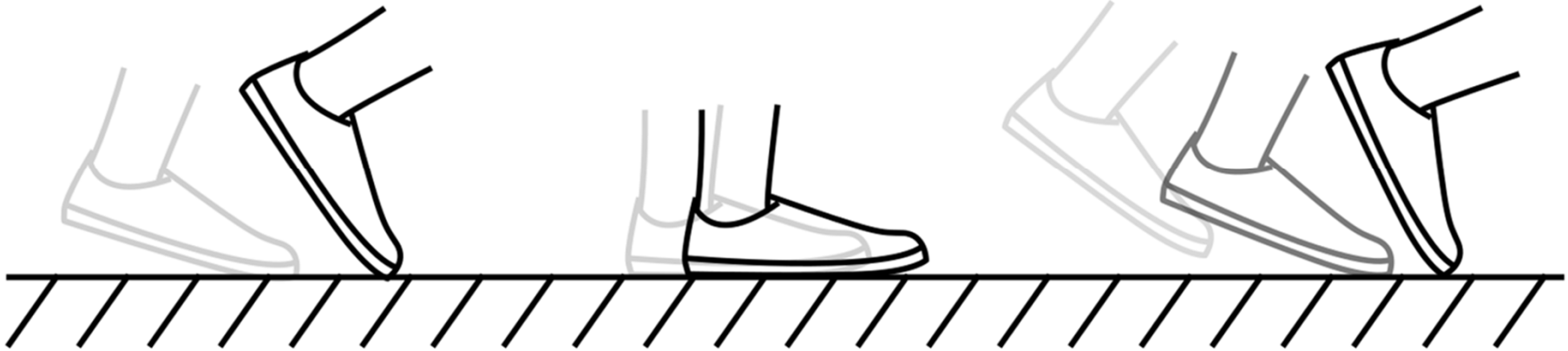
Measured data for participant with walking disability

Possible reasons for tripping on a flat floor

Toe on floor
at initial contact

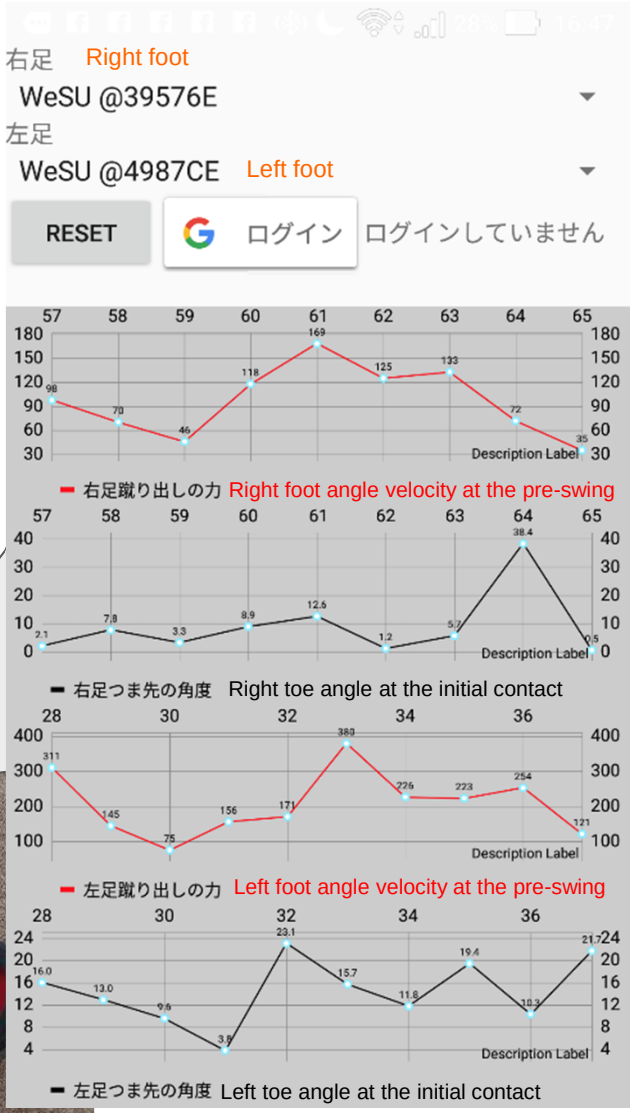
Shuffle instead
of swing

Toe collision with
floor during swing



Gait monitoring system

Bluetooth



Gait assist unit

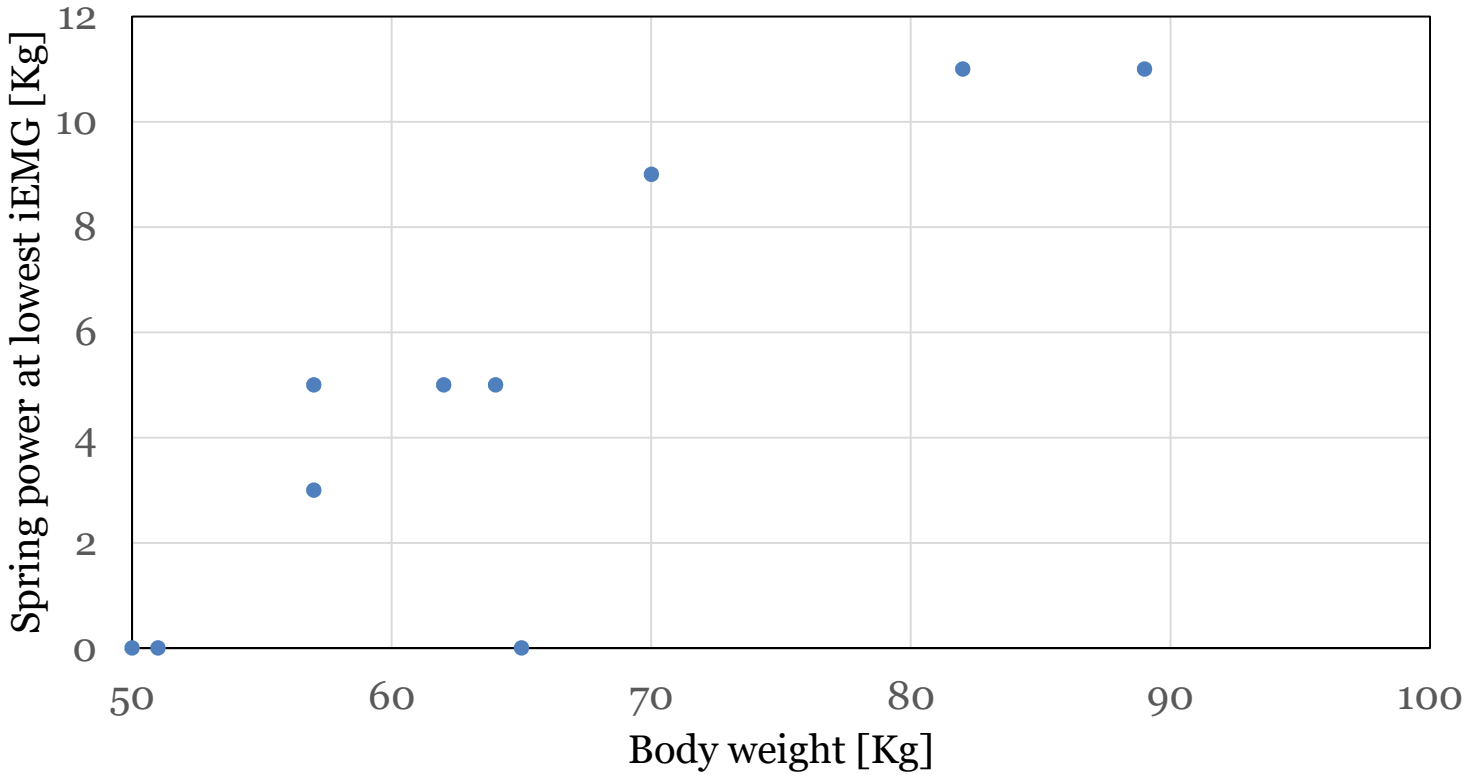
- Developed assist unit comprises a conical coil spring and a V-shaped attachment cover.
- Spring is compressed when stepping.
- Spring power is 3, 5, 9, or 11 kg.

Spring assist unit (heel-up spring)

Pair of shoes with built-in spring assist units

A1

Spring power at lowest iEMG increases linearly with body weight.



Lowest iEMG vs. participant body weight

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A1 Original title is confusing and not needed.
Author, 5/26/2021

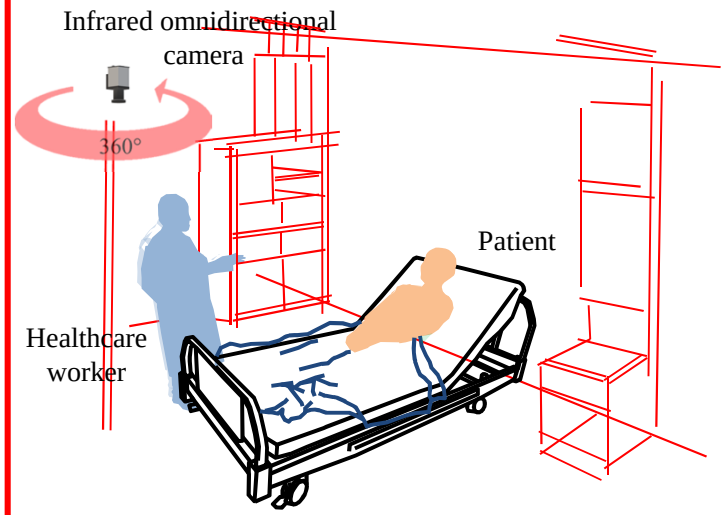
Example: Very noisy in nursing staff room

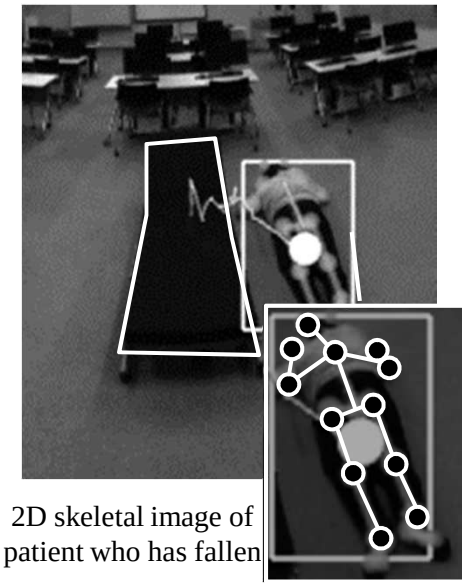
- Complaint from a nurse friend: “The nursing staff room is very noisy due to the many paging alerts”.
- Analysis showed that 90% of alerts were generated by mat sensors placed next to beds of dementia patients.
- Solution
  - Developed a patient monitoring system that uses an infrared omnidirectional camera to detect out-of-bed movements by dementia patients.

Patient monitoring system replacing mat sensor

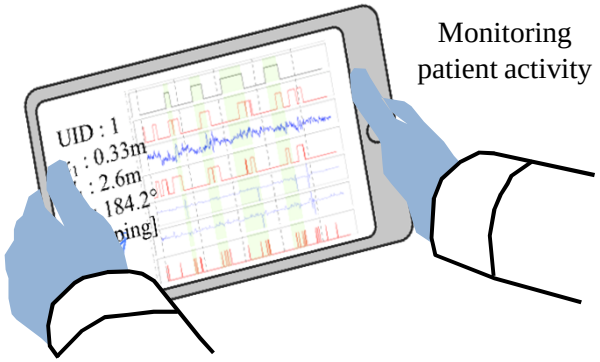
A2

In this paper





2D skeletal image of patient who has fallen



Monitoring patient activity

Monitor multiple patients both day and night using infrared omnidirectional camera.

Detect multiple actions in accordance with predefined rules.

Notify hospital staff of abnormal patient actions.

- Panoramic expansion from camera images.
- Detection and tracking of patients using 2D skeletal images obtained using OpenPose library.
- Joint angle calculation and action classification.

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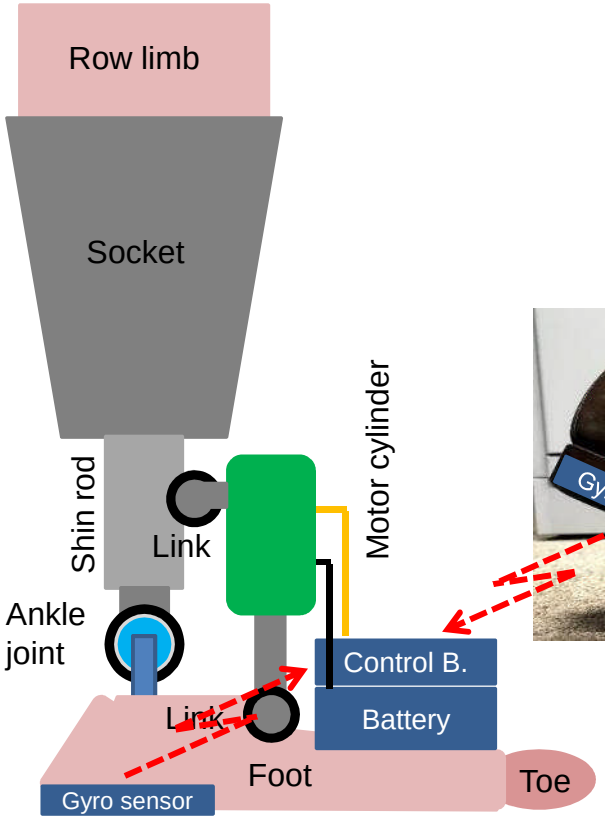
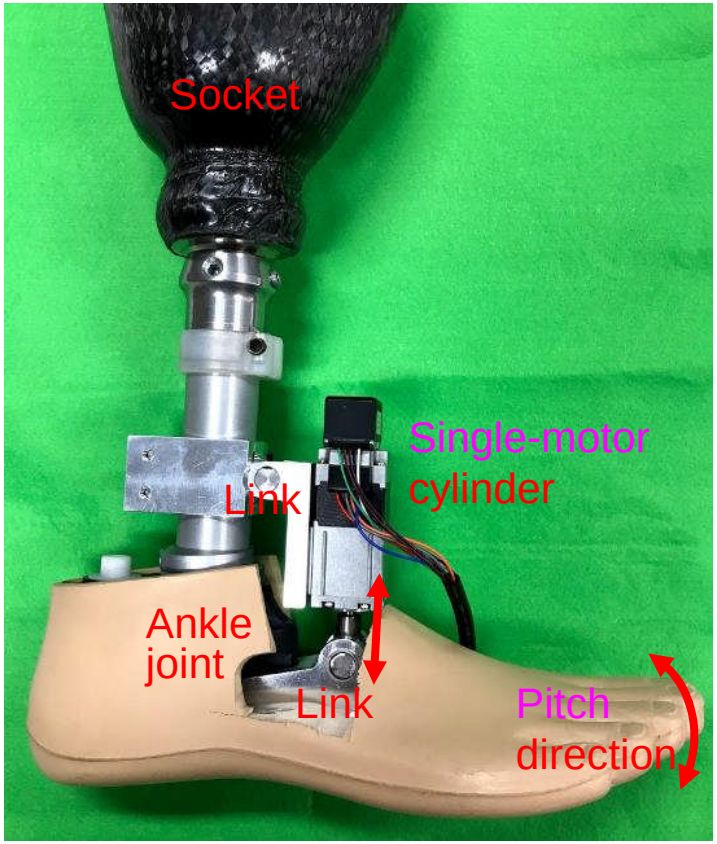
A2 I would cut "In this paper".
Author, 5/26/2021

Example: Reasonably priced powered foot prosthesis

- Complaint from a prosthetist friend about a problem the disabled have when driving an automobile: “A powered prosthesis is very useful for a person who has lost a foot. But they are too expensive for an ordinary person. And the government doesn’t provide support for buying one. Why can’t they produce a reasonably priced one?”
- Solution
  - Use an industrial cylinder motor to reduce production cost and introduce a method for controlling the foot part that synchronously moves with the other foot.

Basic principle and prototype





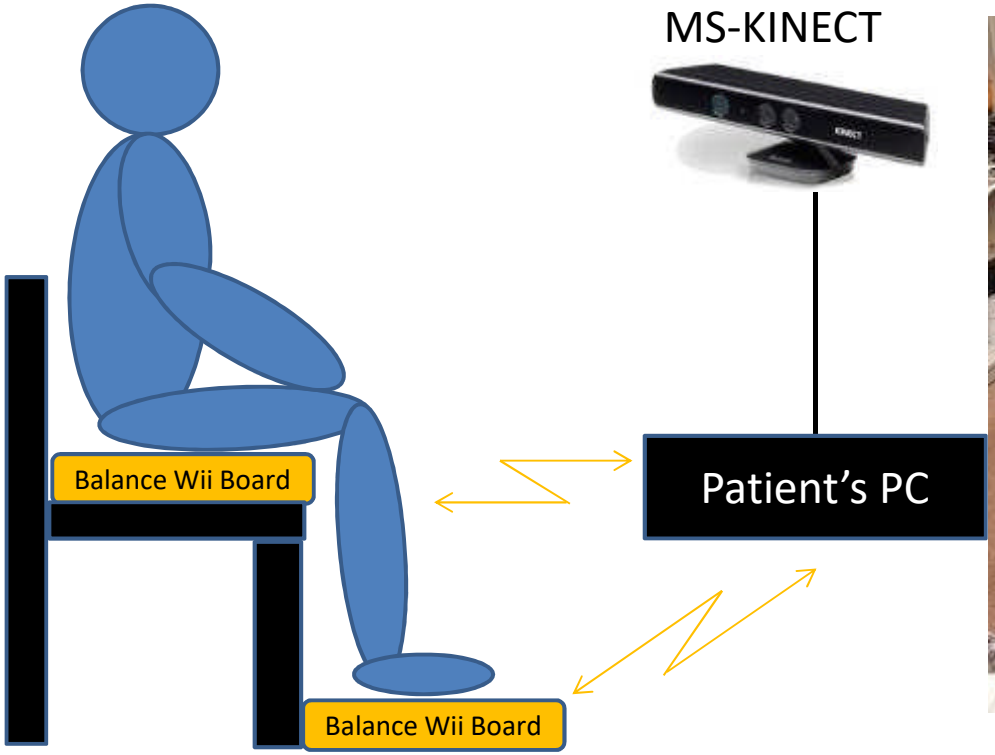
Tip 3: Don’t simply ask your medical friends what problems they would like solved. Spend time with them and observe them on the job.

- Problems are the mother of research topics.
- Problems that suddenly arise are usually solved in one way or another at that time. Since medical workers are typically very busy, such problems are quickly forgotten.
- So spend time observing them on the job and make notes on the problems they deal with.

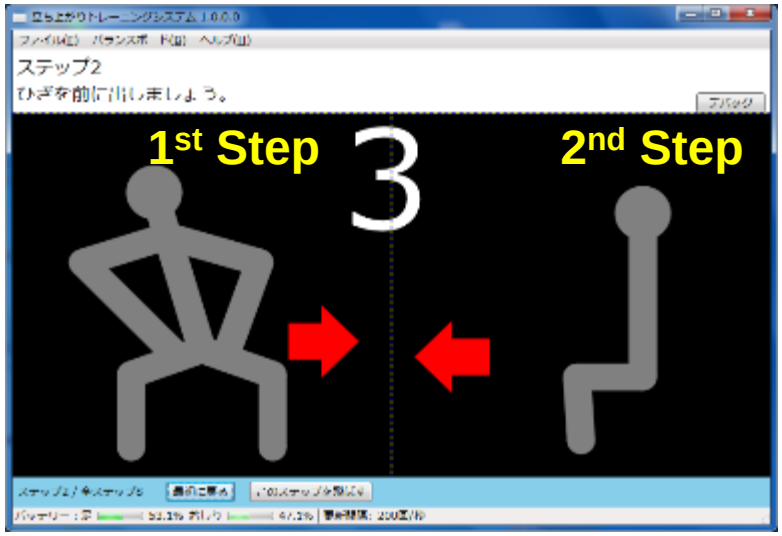
Tip 4: Replace existing analog evaluation methods with digital ones.

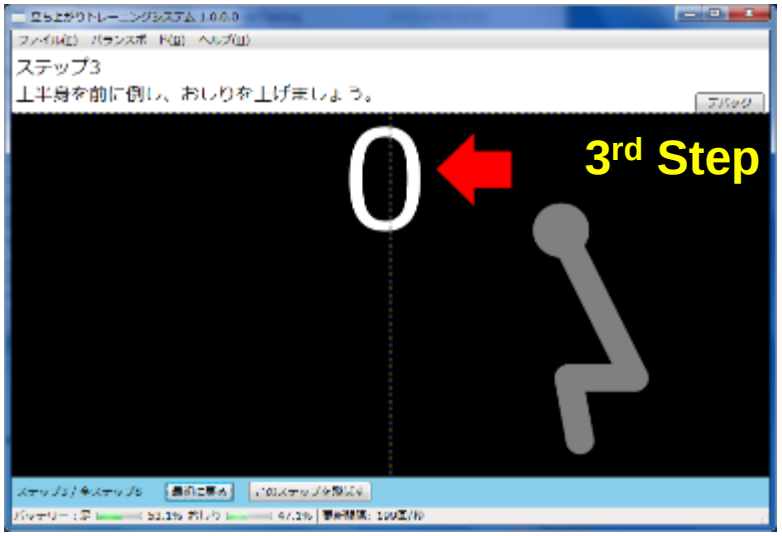
- Most of their jobs have not yet incorporated digital technologies.
- Although PCs and tablets are being used more and more by nurses in progressive hospitals, their usage is insufficient.
- Sensor technologies are useful for rehabilitation therapy in many cases.

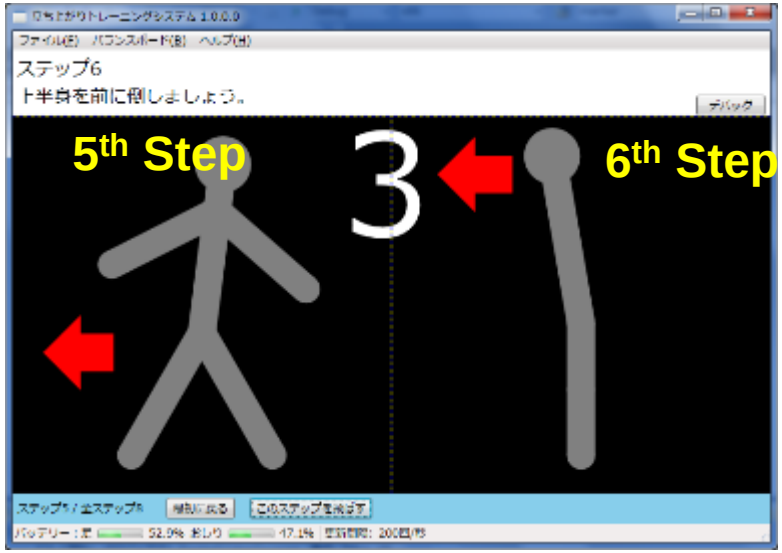
Example: Standing up training system for disabled people, such as a hemiplegia patient

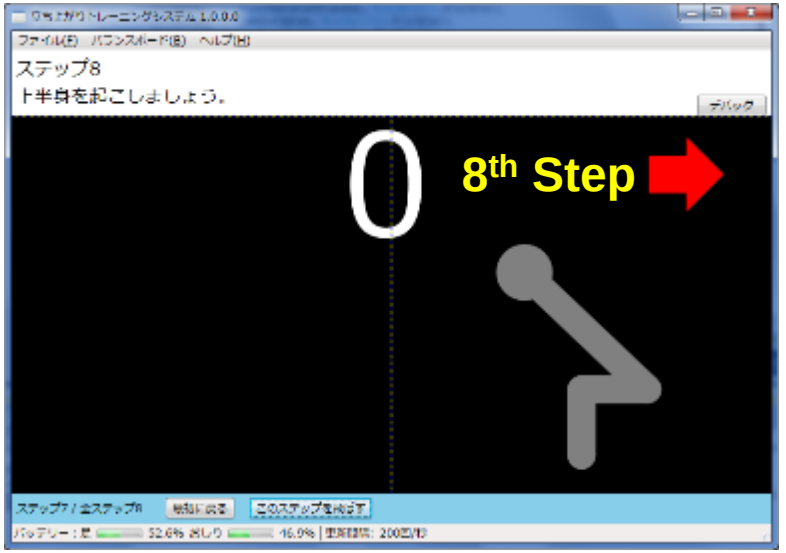


Training steps









Tip 5: Gaze jobs of public officials for medical services

- Government health department provides many kinds of services to not only the disabled but also hospitals, medical clinics, rehabilitation facilities, and so on.
- Measurement methods are needed to evaluate various criteria, such as degree of disability to provide such services. Most criteria are evaluated using analogue methods, such as questionaries and visual observation.

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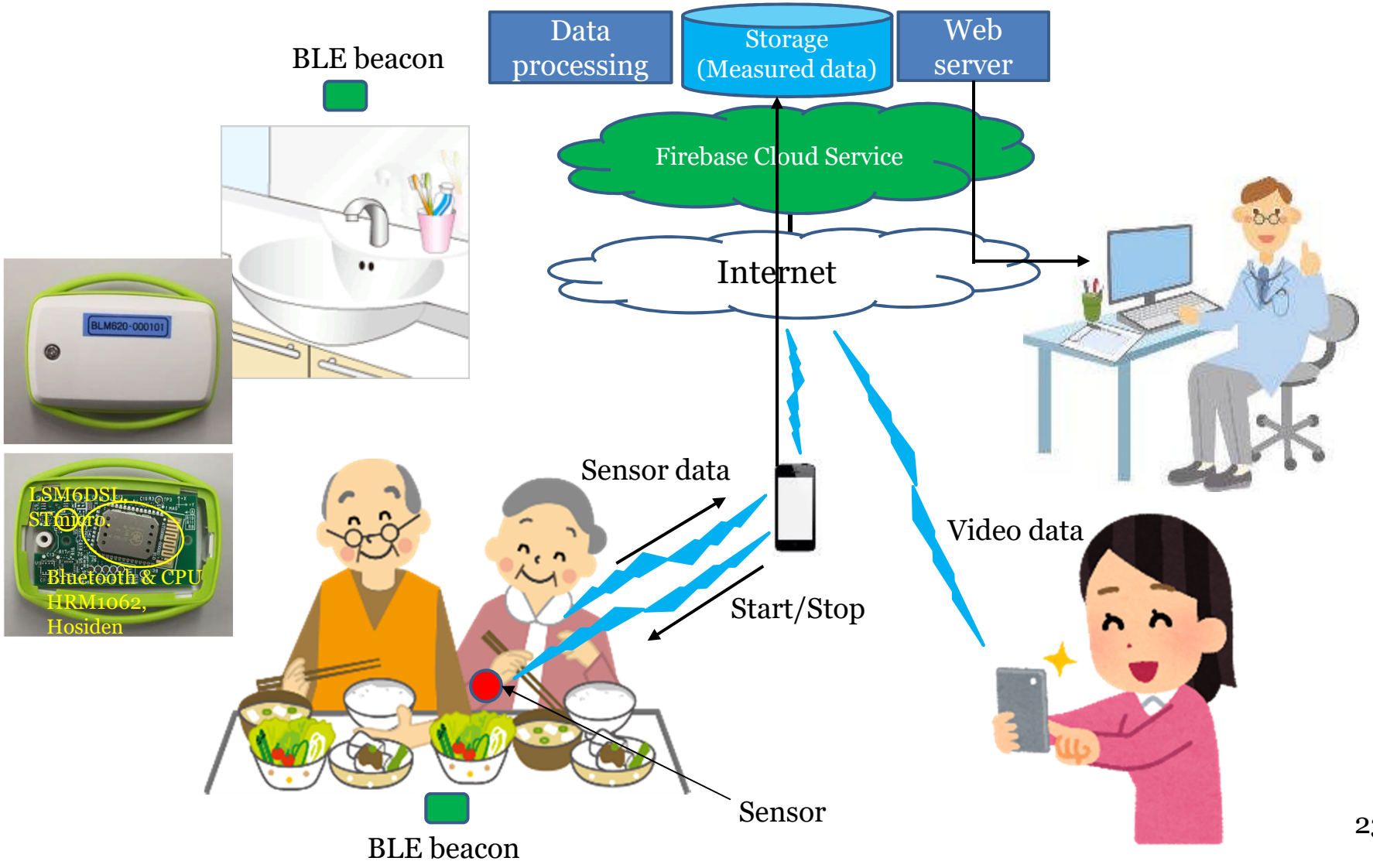
A3 This makes no sense.
Author, 5/26/2021

Example: System for collecting data on seniors' movements during the day

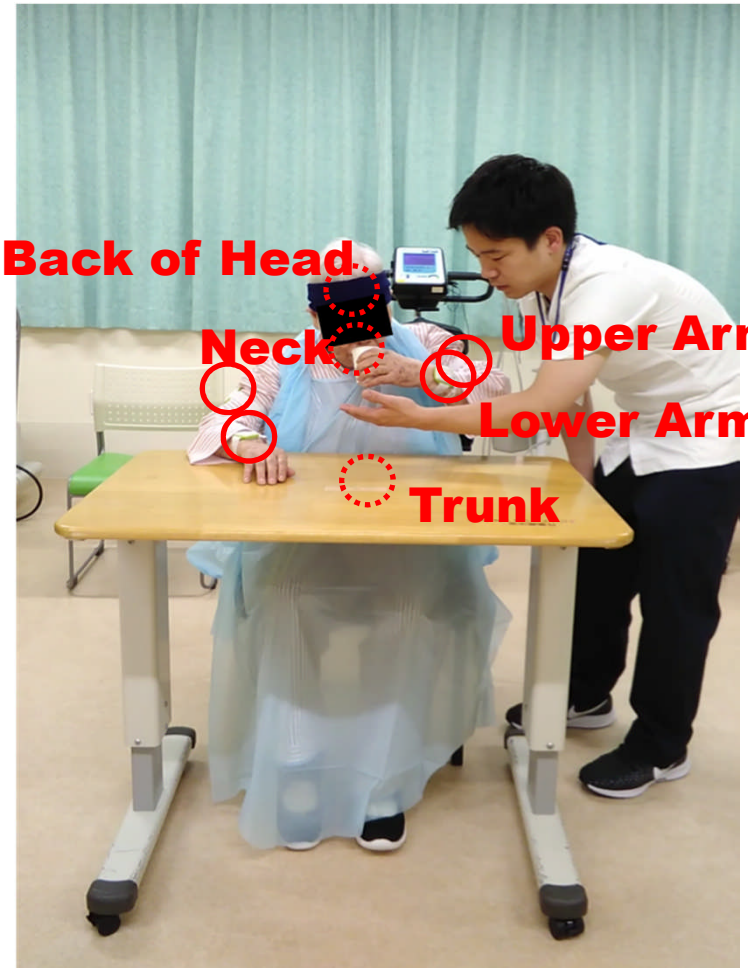
- Revision of rehabilitation service fee from time to improvement in daily living -



Tip 6: Measure data for real patients as such data is invaluable.

- Papers without any measurement data for real patients are nevertheless worthwhile.
- Establishing a trusting relationship with medical personnel is important as well for measuring data for real patients.

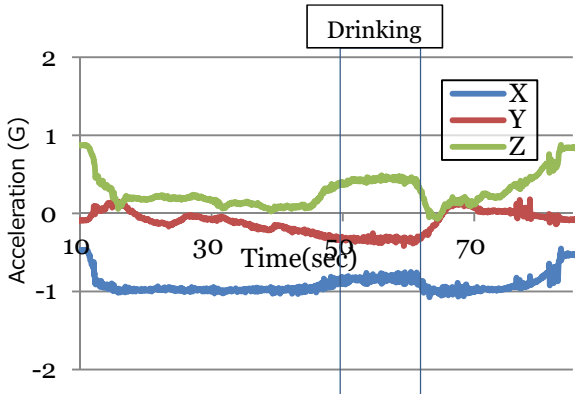
Example: Collecting data on hospitalized patients



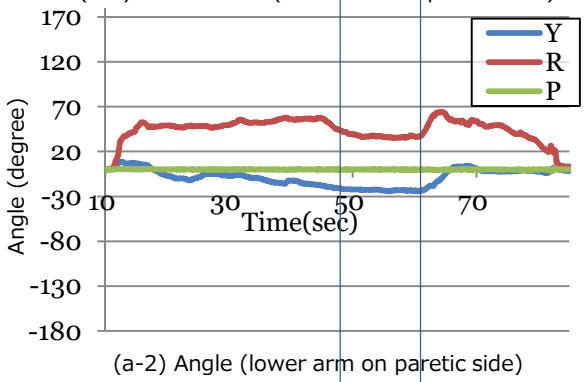
Drinking

Walking

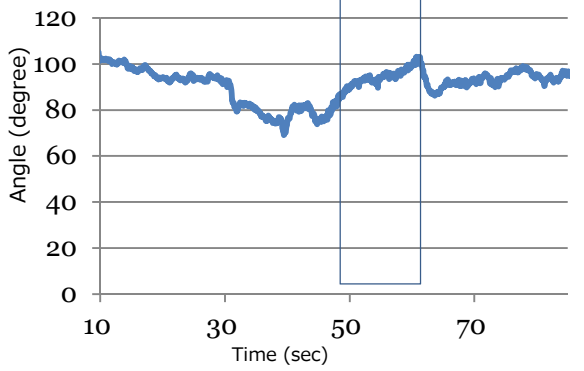
Data collected for two patients while drinking



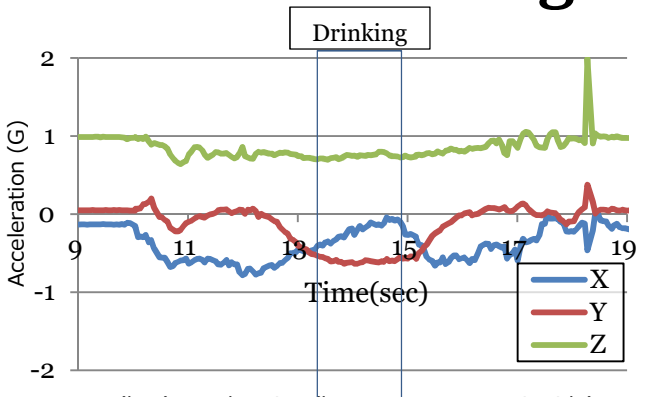
(a-1) Acceleration (lower arm on paretic side)



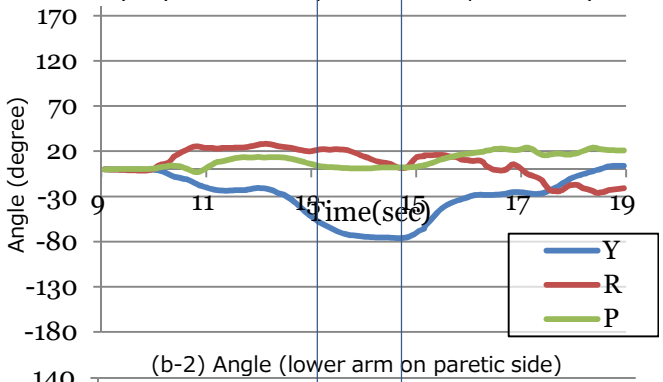
(a-2) Angle (lower arm on paretic side)



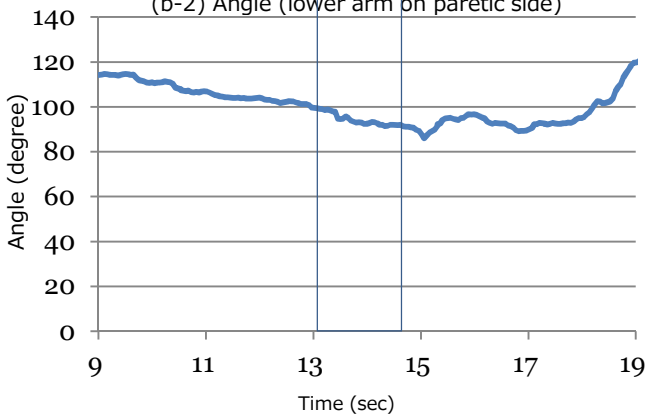
(a-3) Angle (head)



(b-1) Acceleration (lower arm on paretic side)



(b-2) Angle (lower arm on paretic side)

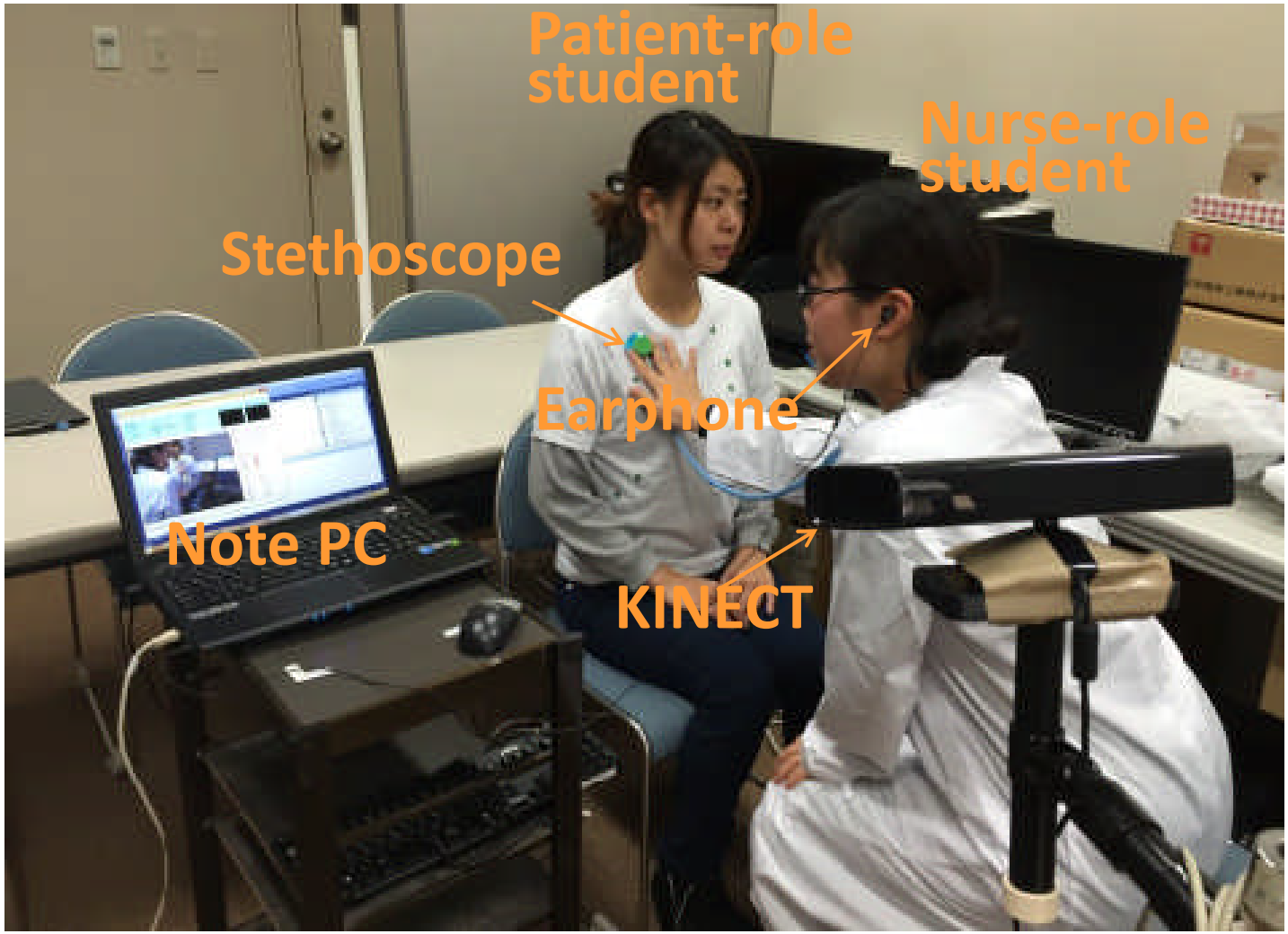


(b-3) Angle (head)

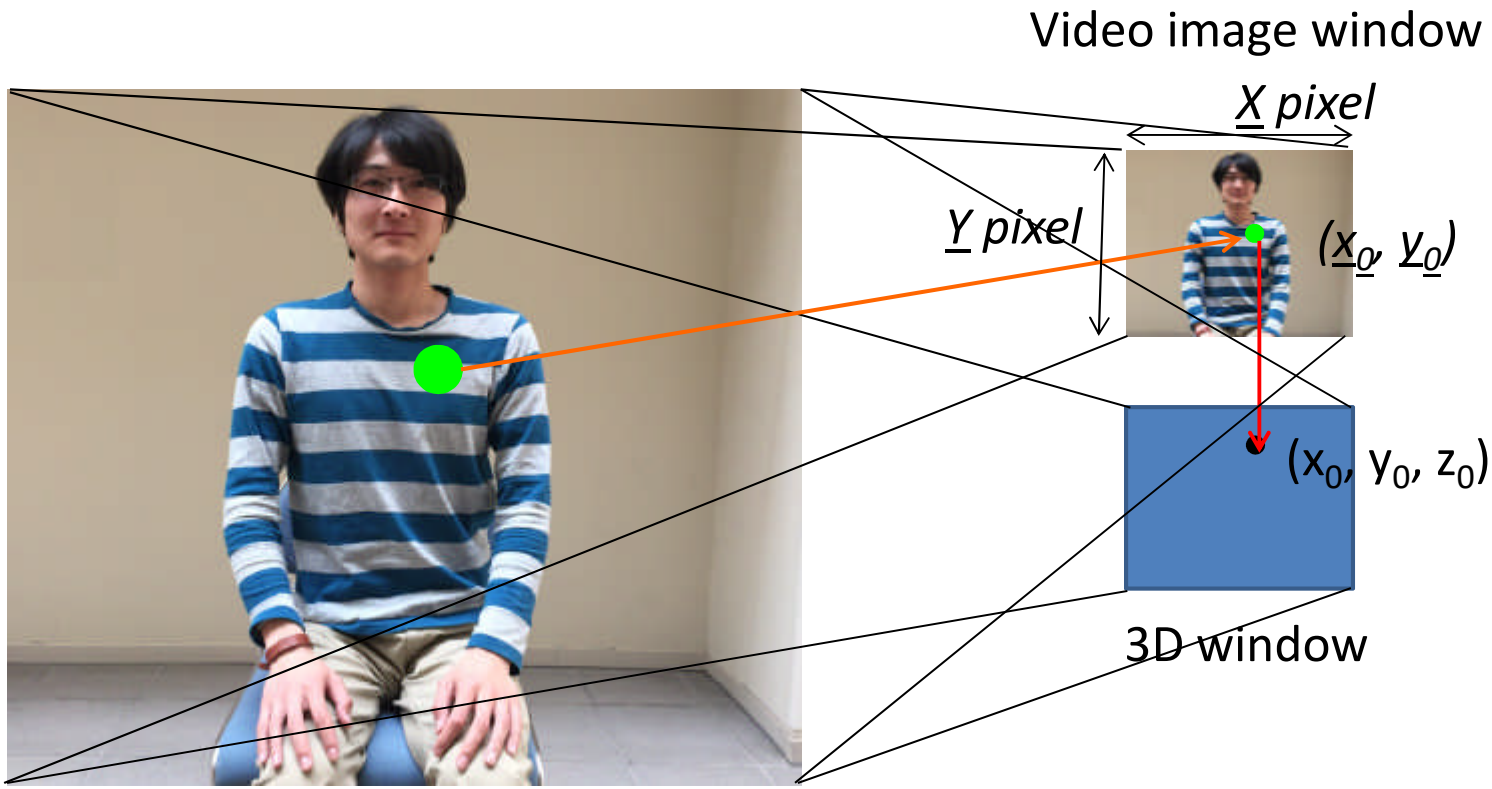
Tip 7: Gaze on RTs during objective structured clinical examination (OSCE).

- Passing the OSCE is necessary for medical students in most countries.
- There are insufficient practice tools for studying for the OSCE.
  - Because of COVID-19, most classes including exercises are held on-line.
  - It is particularly difficult to practice each evaluation OSCE problem on-line.
  - Practice tools for the on-line exercises are greatly required.
  - In particular, simulated patients are required.

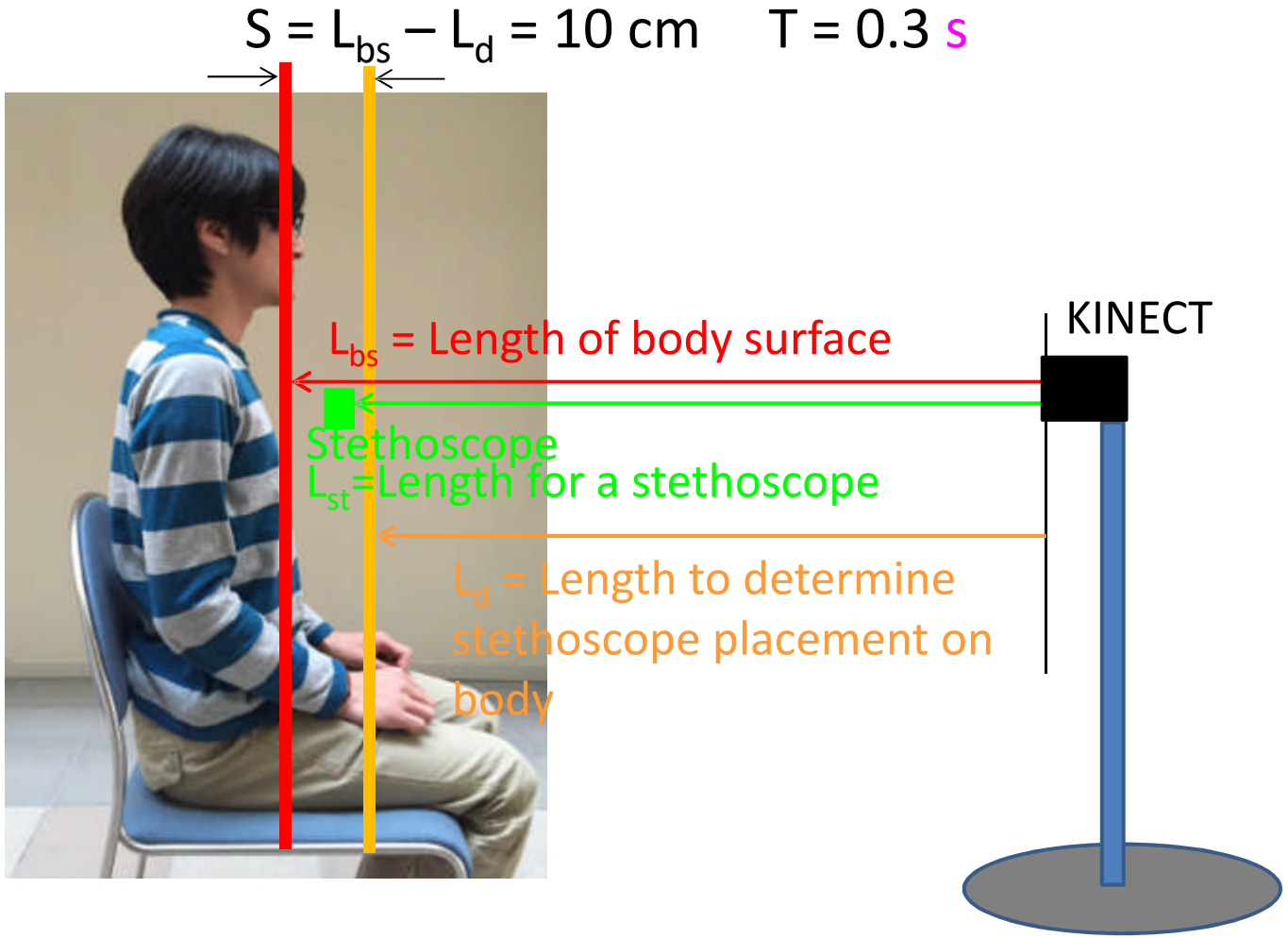
KINECT-based auscultation practice system



Tracing a stethoscope and detecting its location: Determining location



Detecting stethoscope on the body: Principle

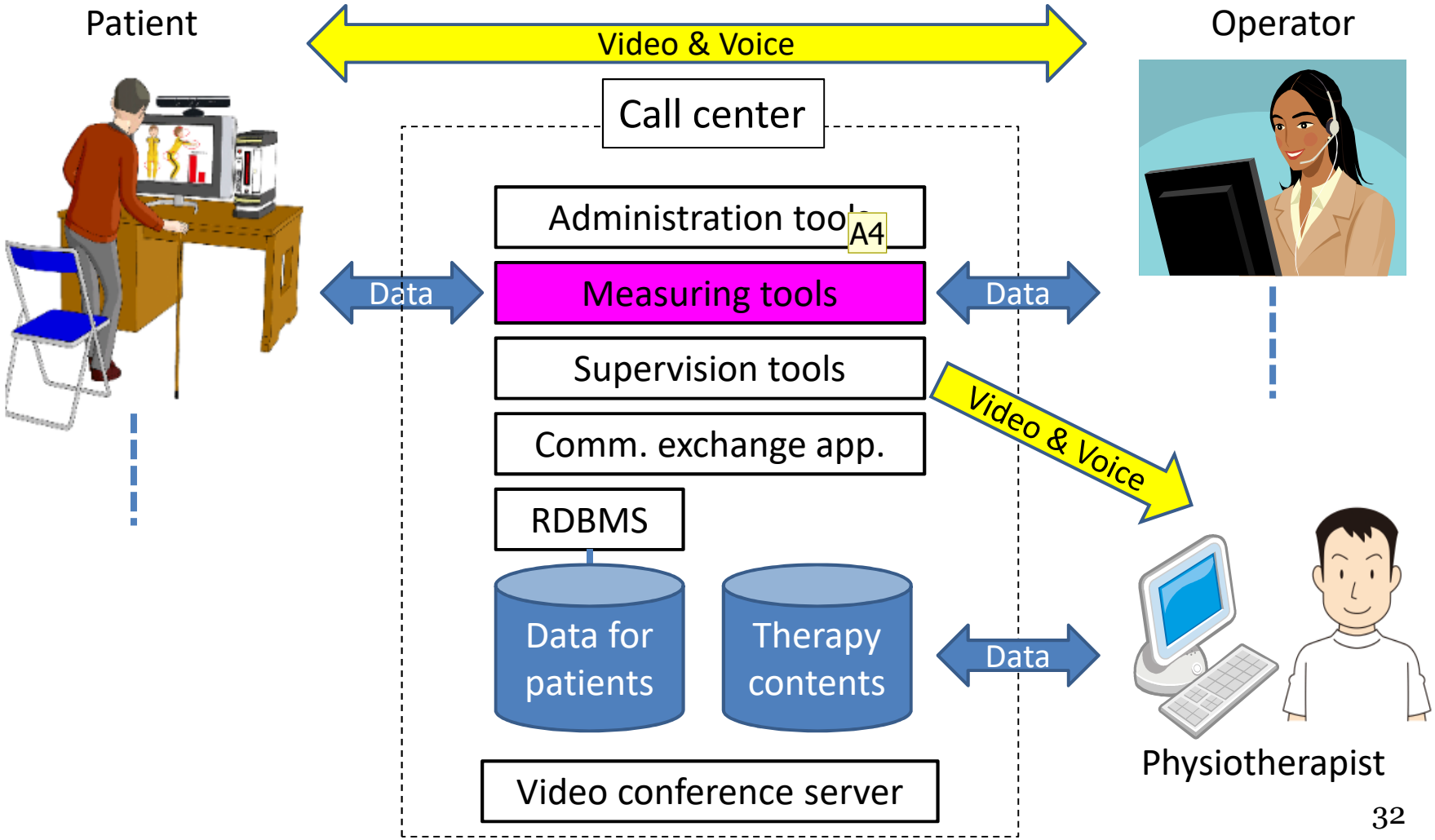


Tip 8: Don't select a topic being addressed by many other researchers.

- It is very difficult for a newcomer to get novel results.
- However, study of an entirely new topic should produce unique results because there are few references.
- Select a topic parallel to one many researchers are working on.

  Example: **Remote rehabilitation, not remote medicine**.

Example: System configuration of remote rehabilitation system



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A4 --> Measurement tools

Author, 5/26/2021

Measurement and sensors

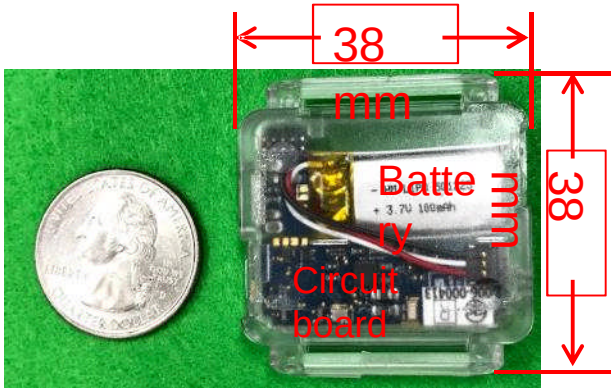
Tip 9: Observe a patient many to identify features of a disease or disability and select appropriate sensors.

- After identifying the features, identify the body parts that present them.
- Select sensors that can detect such features.

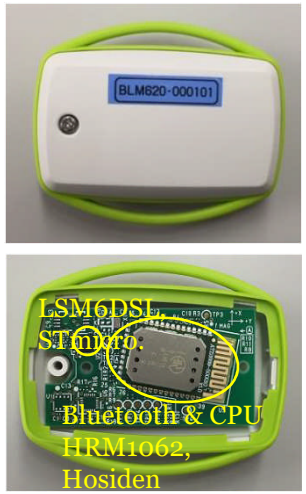
Tip 10: When using sensors in smartphones, wearable watches, and game consoles, be aware of their limited availability.

- Most become obsolete after a few years.
- Obtaining previous versions can be difficult.
- We have had to change an acceleration and gyro sensor twice.

WD: SmartWatch 3
By Sony



STEVAL-WESU1
by STMicroelectronics

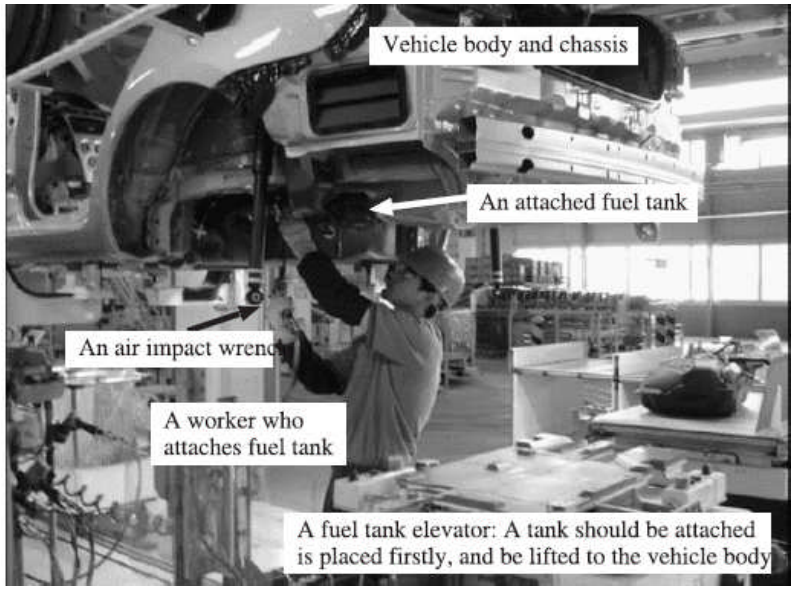


BLM620
by ERi

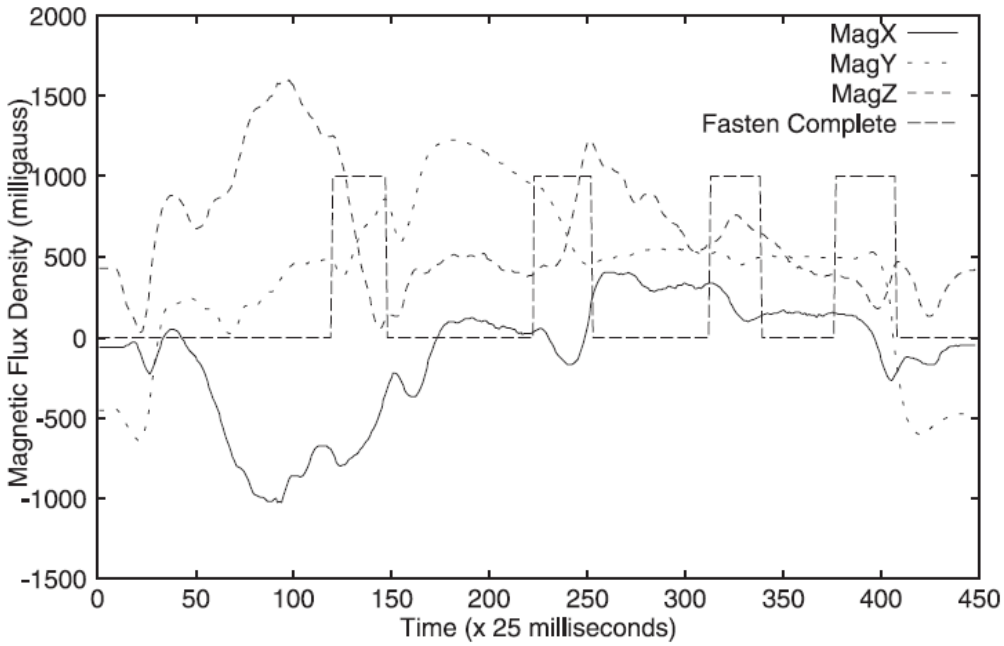
Tip 11: Use terrestrial magnetism sensors to measure motion at the same position daily.

- Terrestrial magnetic sensors measure rotation motion, not linear motion.
- Since the human body consists of combinations of bones and joints, the motions are basically rotation.
- A [magnetic field suffers interference from electronic devices only if they are close?], which is very different from an electric field. We thus use magnetism sensors in automobile assembly factories.
- They are particularly useful for rehabilitation equipment, such as parallel bars, when the equipment is fixed.

Typical waveform of terrestrial magnetism sensor when correcting fastening order in an automobile assembly factory

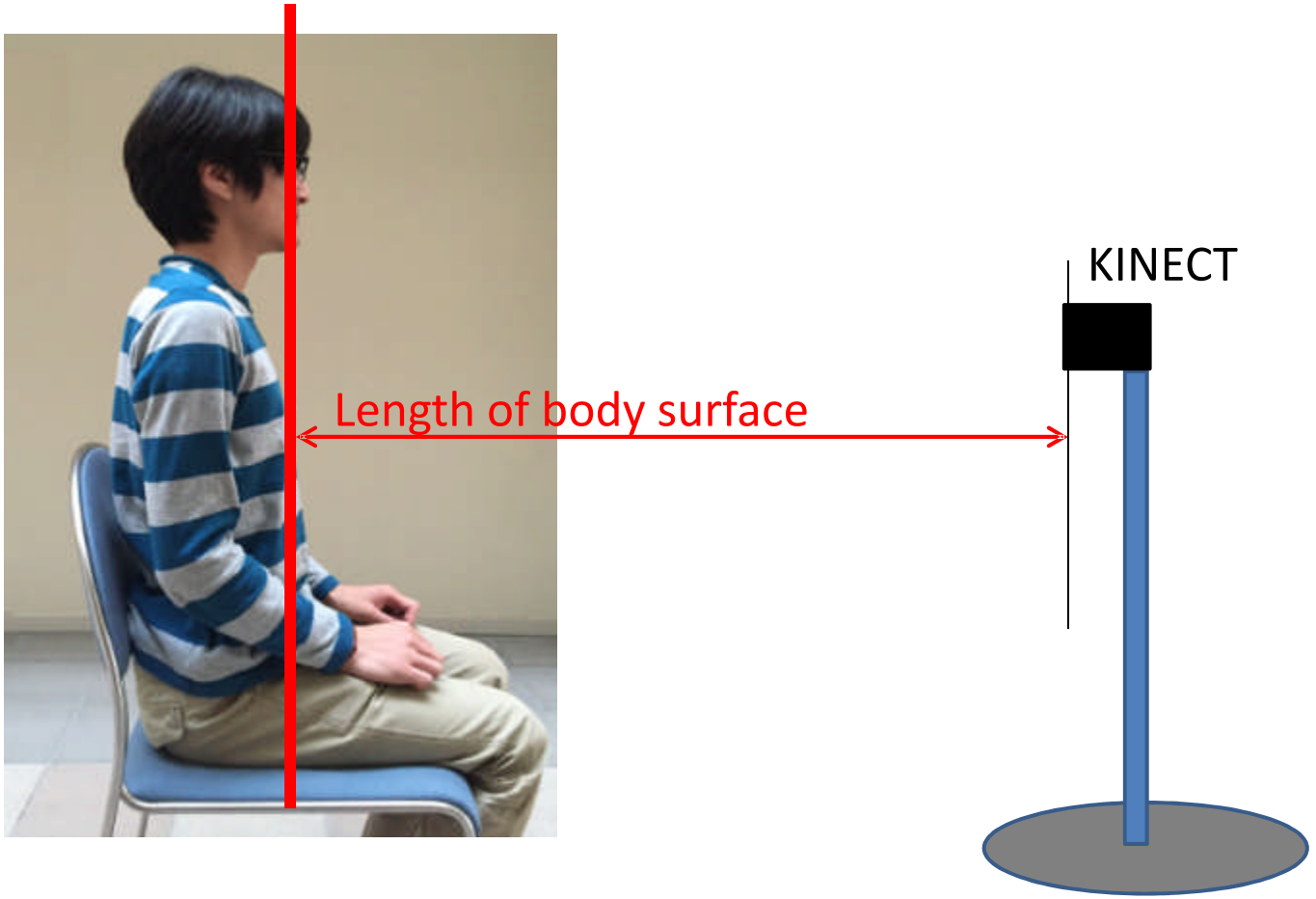


Fastening a fuel tank



Waveform of terrestrial magnetism sensor

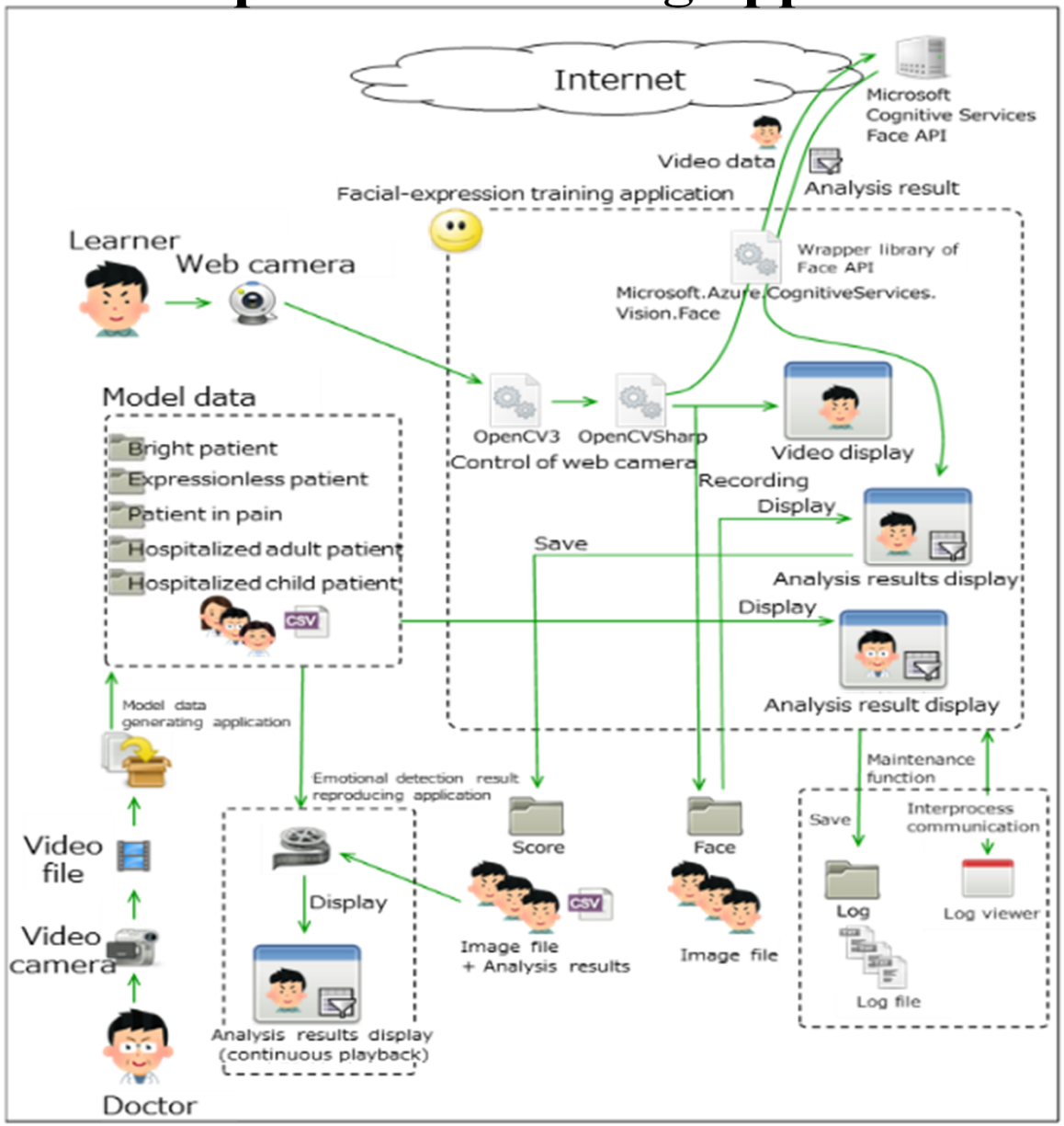
Tip 12: Set up MS-KINECT parallel with subject.



Tip 13: Estimation program of facial expression is also one of sensor.

- There are several programs for estimating facial expressions.
- There are no criteria for measuring the degree of expression.
- Strictly evaluate an estimation program with your sensitivity before using it. And, you believe your sensitivity.

Example: Facial expression training application for doctors



Contents

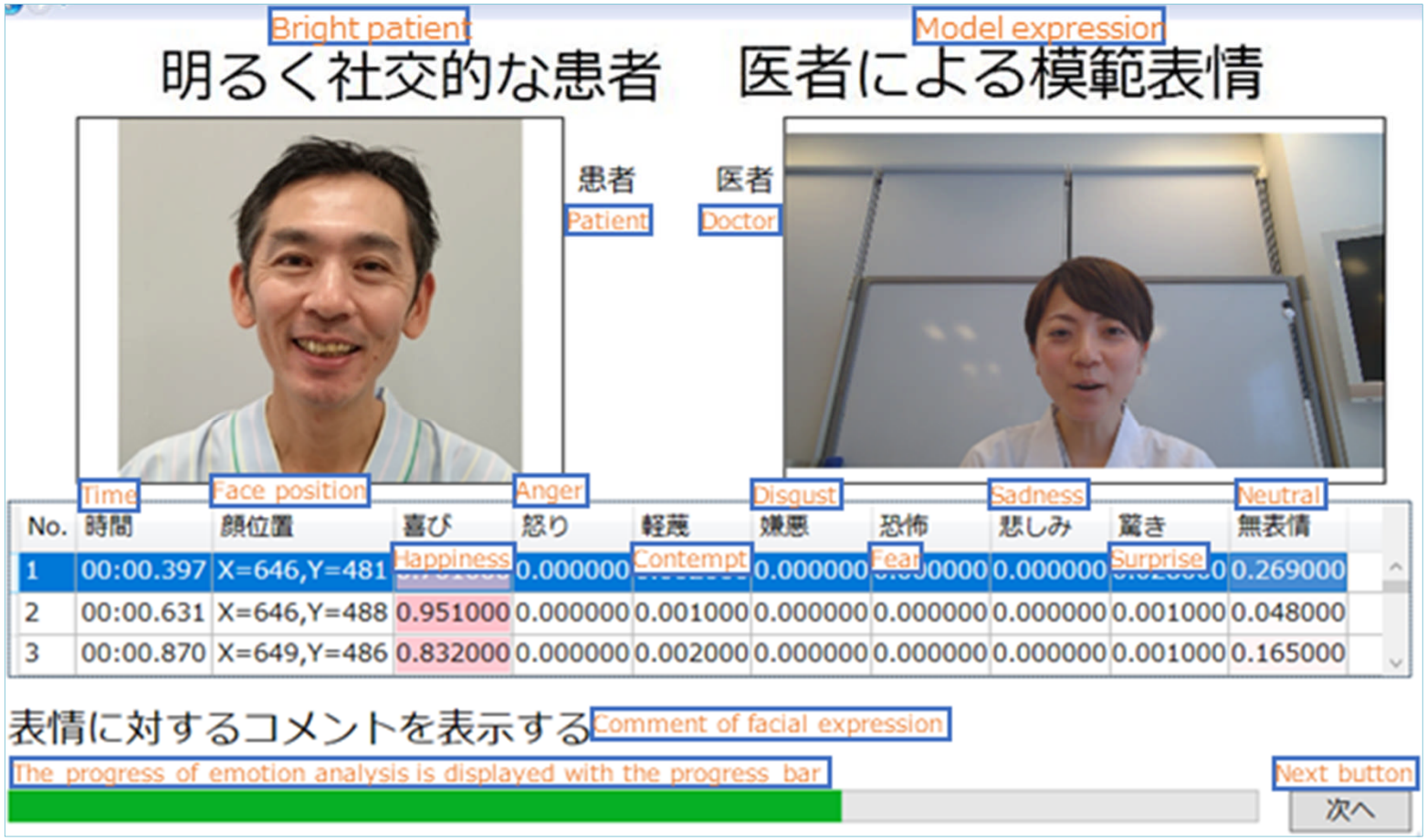
Pictures of patient in 3 conditions

Videos of model doctor's facial expressions

FETA

Learner greets and examines patient while screen is recorded.

Doctor's appropriate facial expression and analysis results



Tip 14: Attend good academic conferences.

- Attend several conferences and identify ones for which the paper selection criteria matches your research style.
- My standards for selection:
  - Has one or more journals and/or recommends conference papers to journals.
  - Provides many pertinent reviews, which provide suggestions and inspirations for my research.
- IARIA conferences are most appropriate for me.
  - Luckily, 11 of my 15 contributions to eTELEMED have been selected as a best paper or have been recommended to IARIA journals.

Final Tip:
Continue to write papers and attend academic conferences.