

Курс “Практическа роботика
и умни “неща” - 2020

Роботика и Интернет на “нещата” (IoT)

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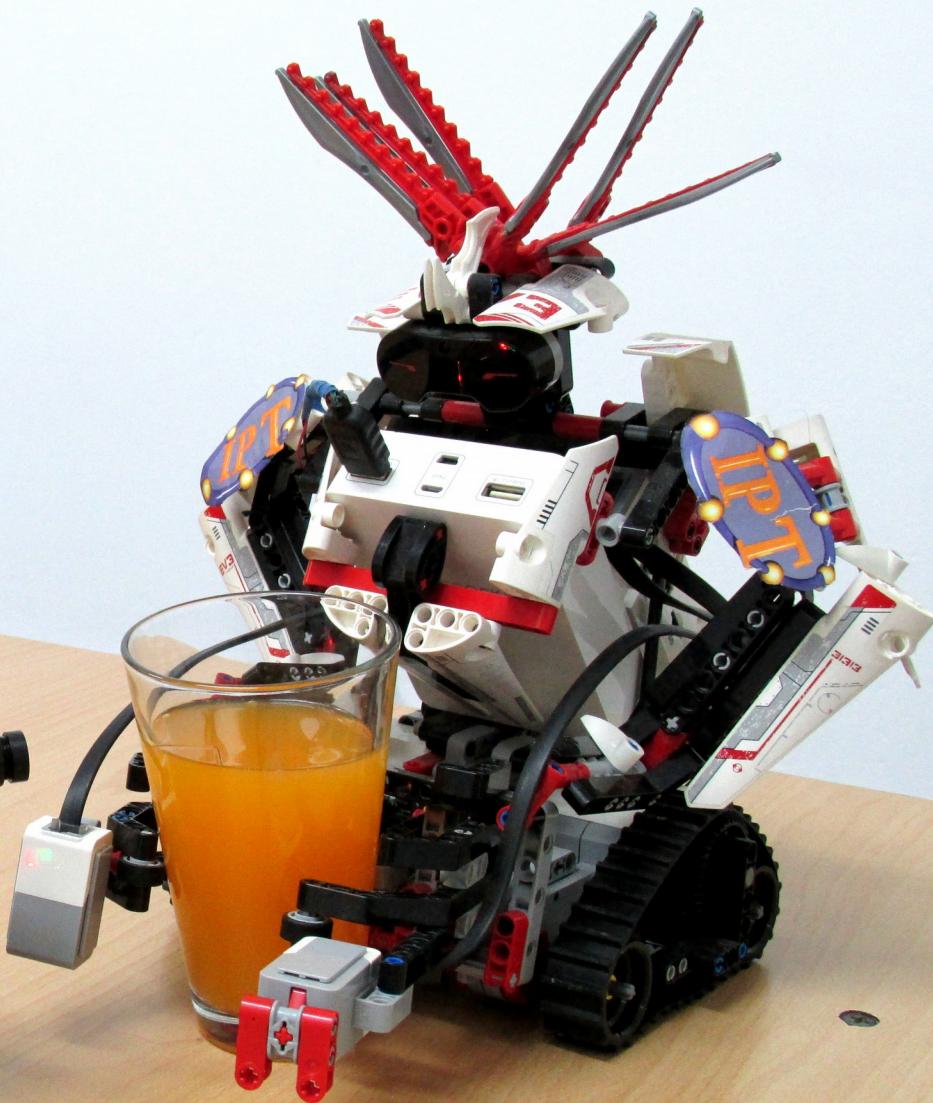
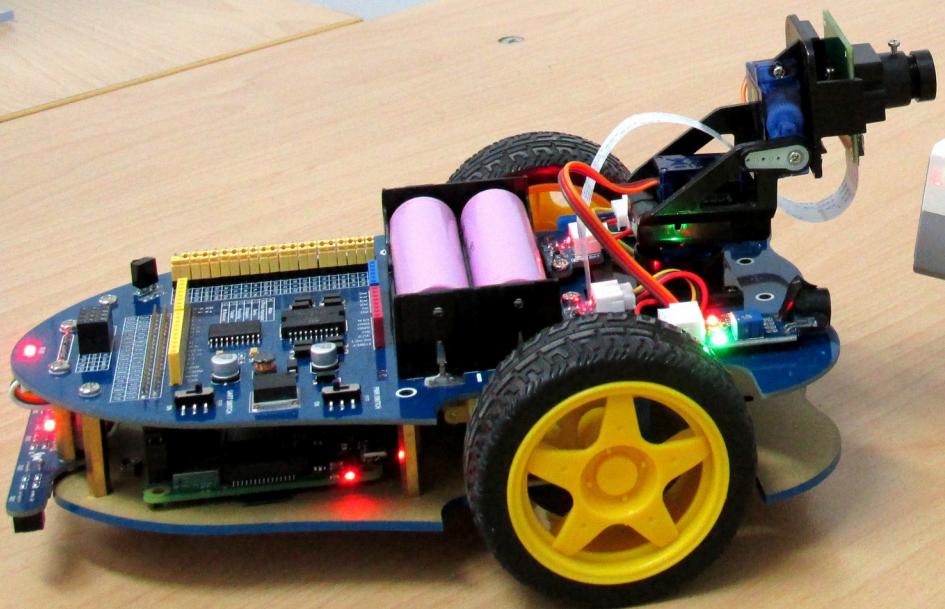
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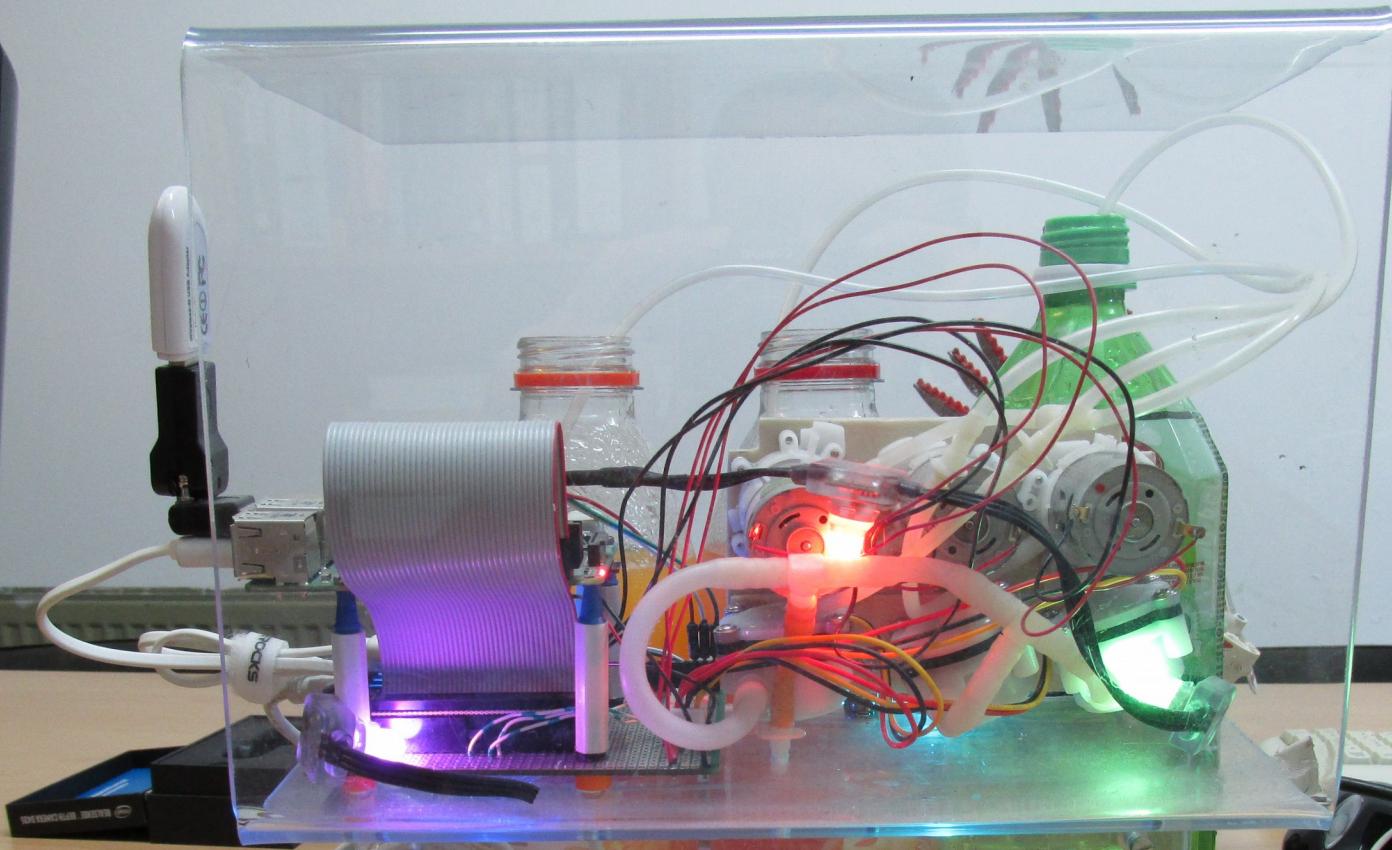
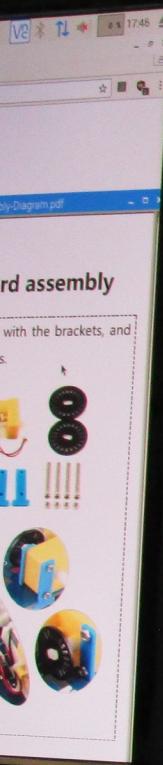
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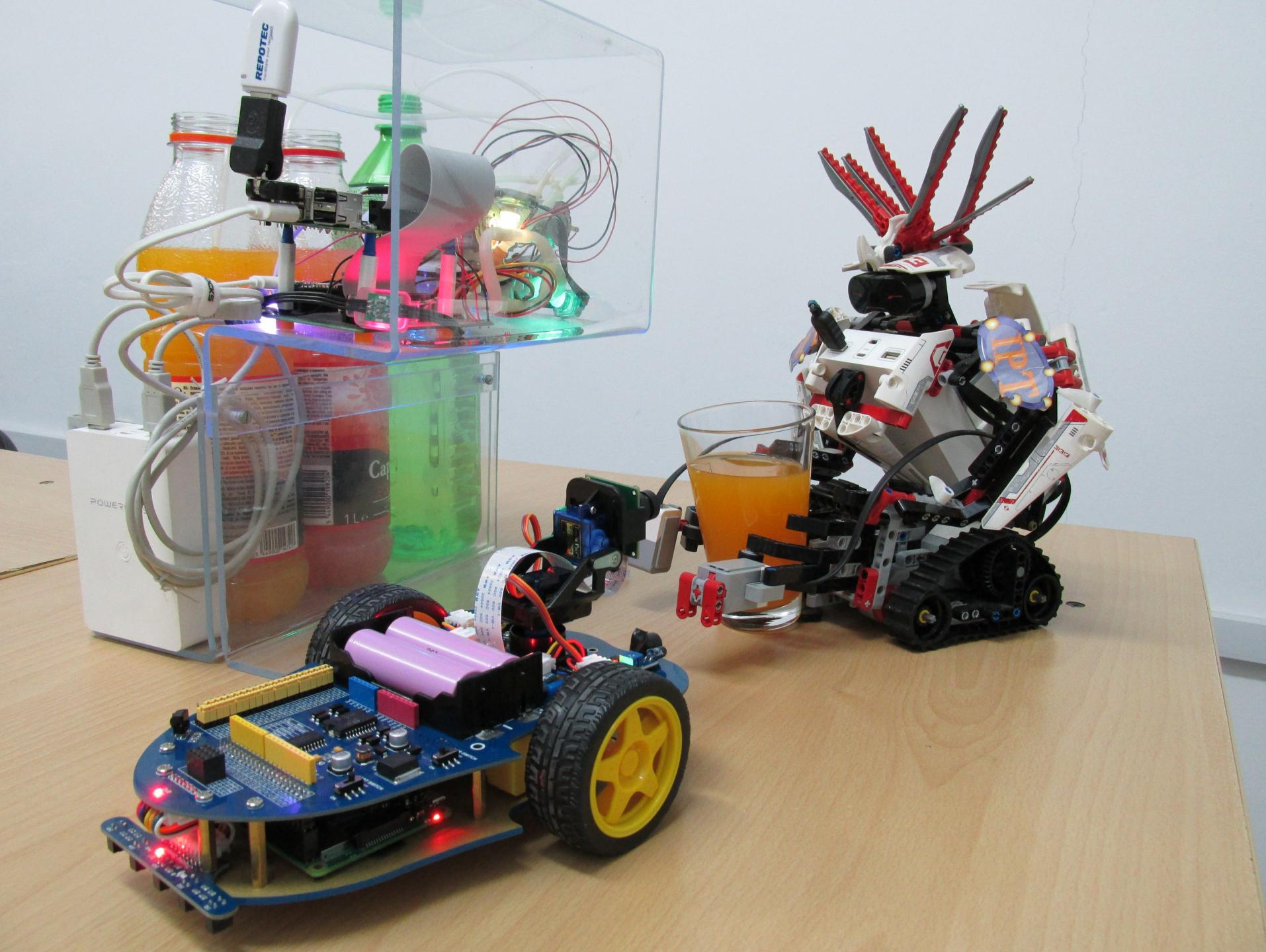
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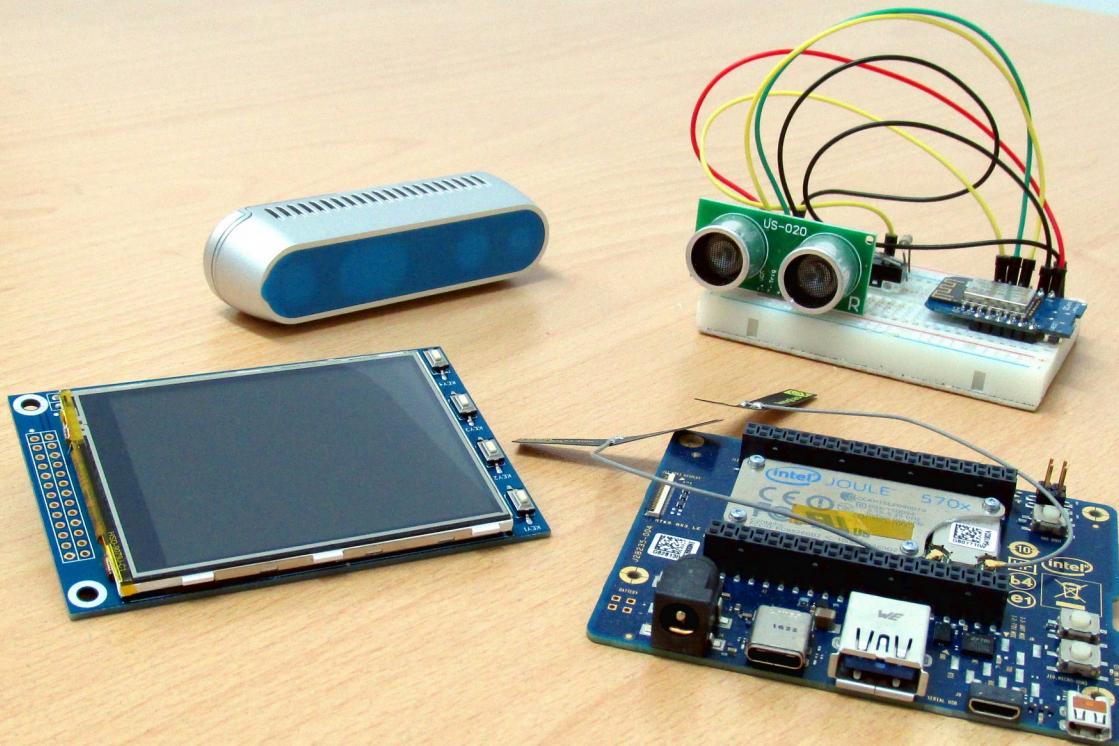
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EEG-SMT

<http://openEEG.sourceforge.net>

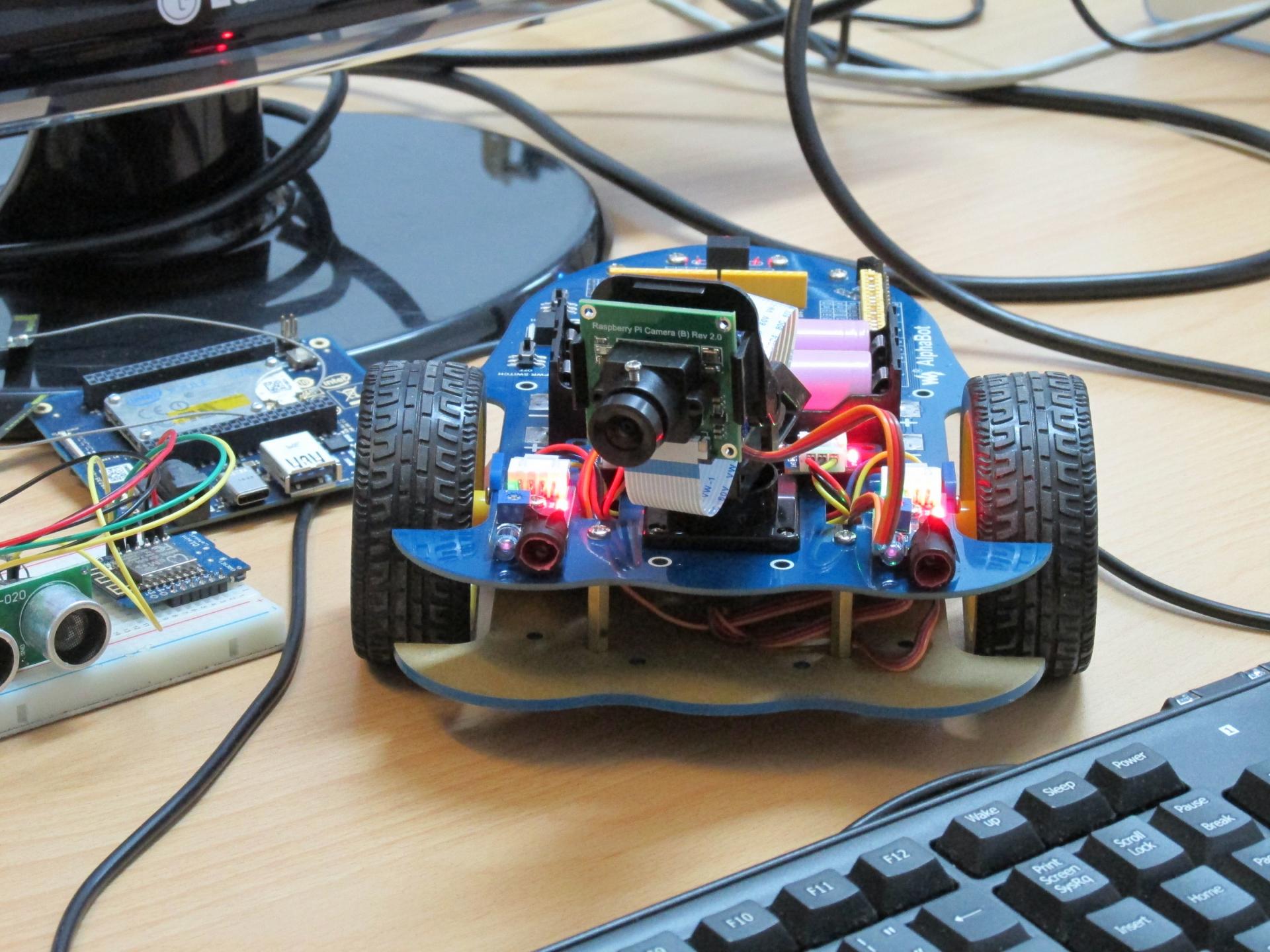
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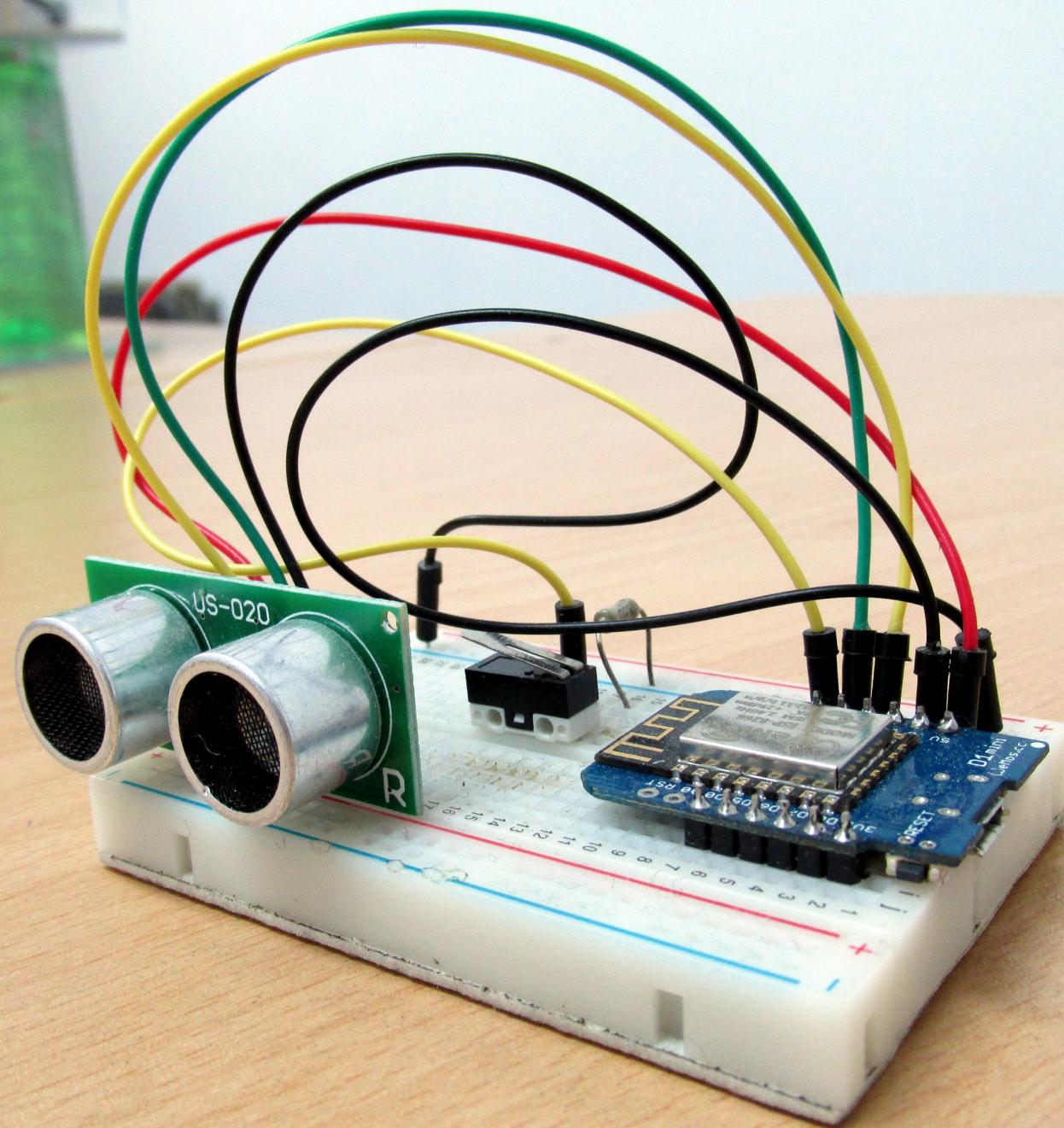
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WÄHRINGEN
IE BROKEN

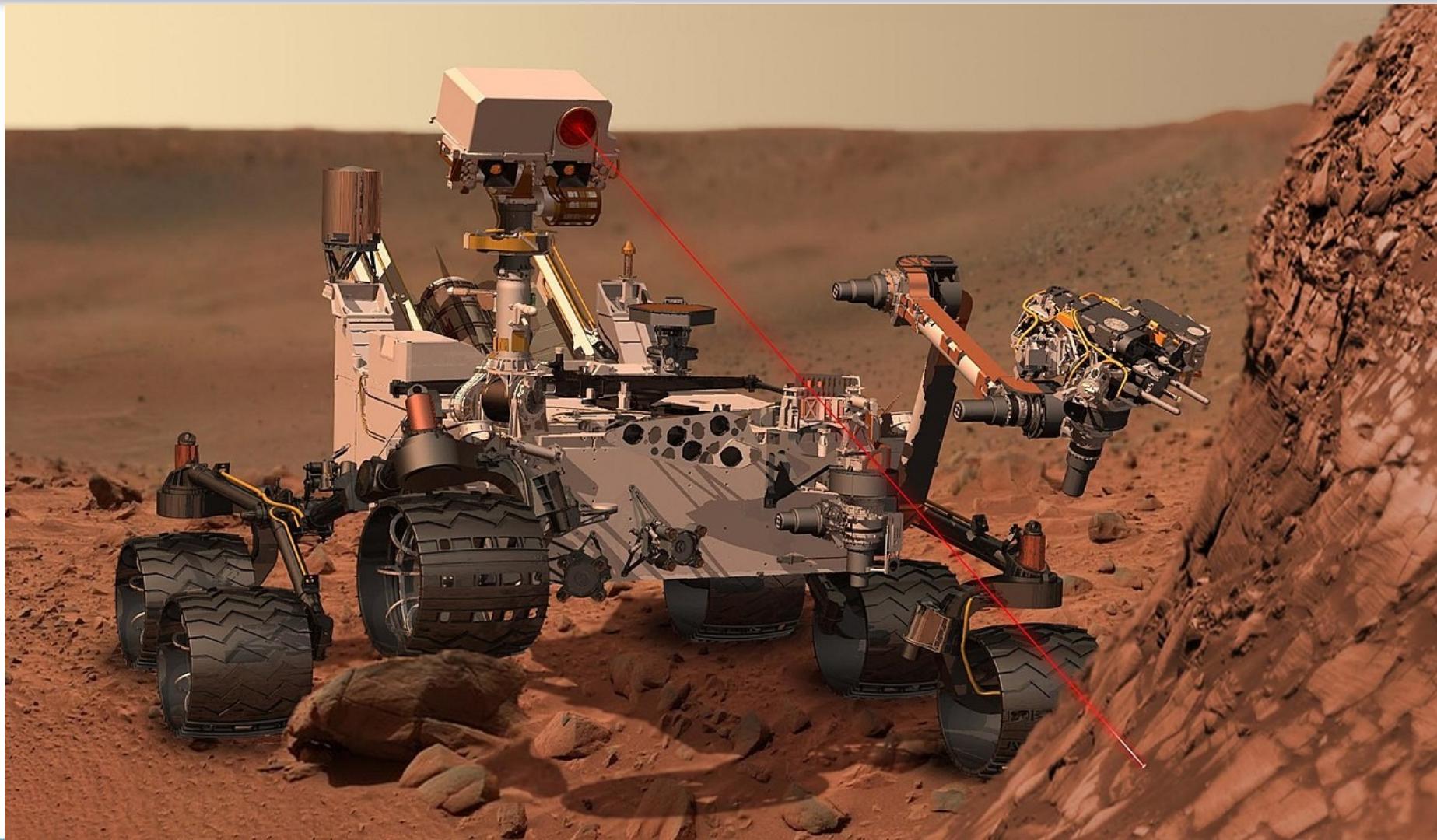
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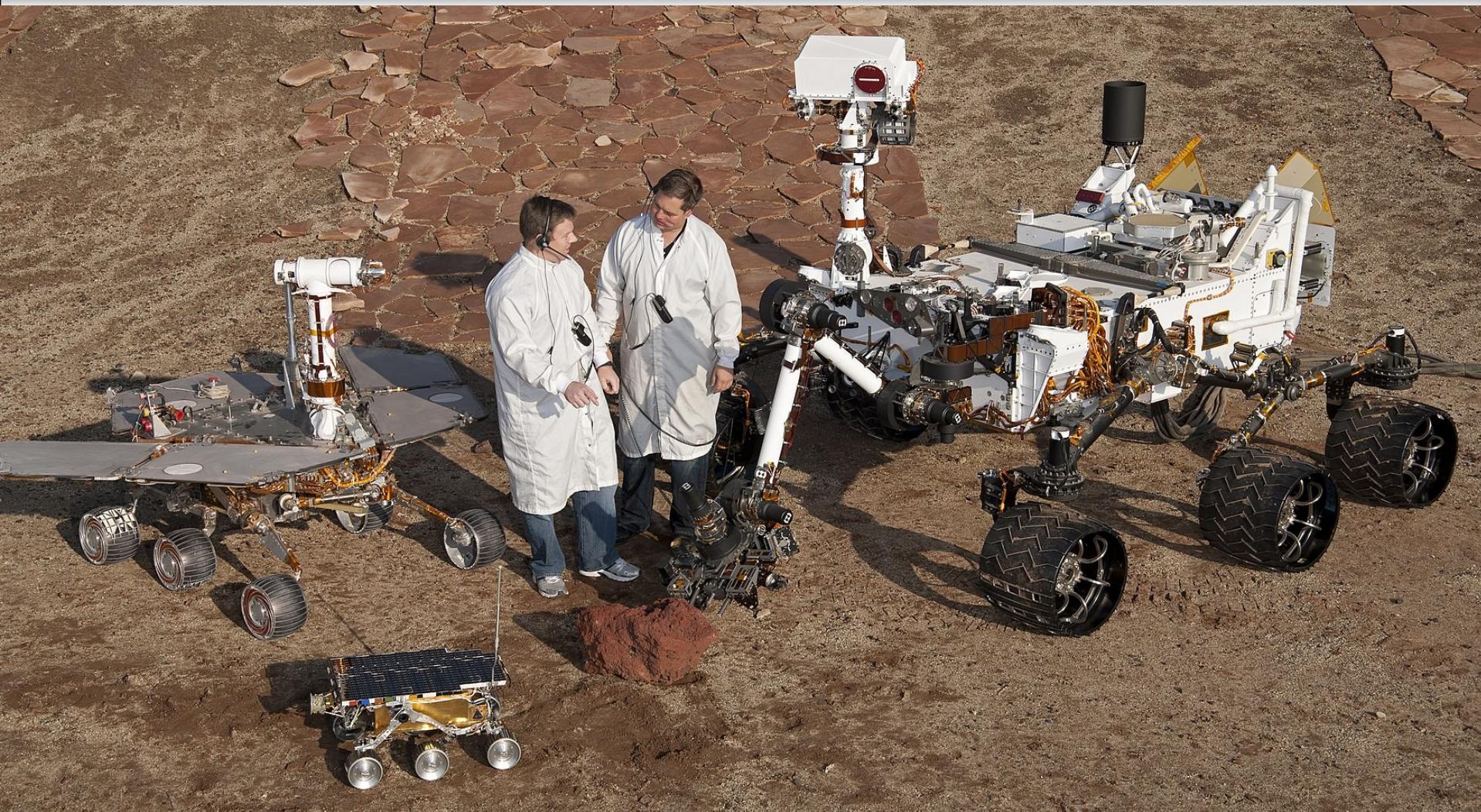




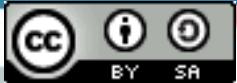
Where no man has been before...



With Mission to Explore...



Lonely Riders ...



By Arroww at the English language Wikipedia, CC BY-SA 3.0,
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Удобно облекло :)



By DARPA - This file was derived from: DARPA Strategic Plan (2007).pdf, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=20798337>

Работите са вече у дома ...



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... и как бихме пропуснали



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Source: Korea Institute of Industrial Technology, <http://news.naver.com/main/read.nhn?mode=LSD&mid=sec&sid1=102&oid=020&aid=0000371339>

Във всякакви размери ...



Интернет на нещата (IoT, IoE)

Today computers—and, therefore, the Internet—are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes (a petabyte is 1,024 terabytes) of data available on the Internet were first **captured and created by human beings**—by typing, pressing a record button, taking a digital picture, or scanning a bar code. ... The problem is, people have limited time, attention and accuracy—all of which means they are not very good at capturing data about **things in the real world**. ... We're physical, and so is our environment ... If we had computers that knew everything there was to know about things ... we would be able to track and count everything, and **greatly reduce waste, loss and cost**. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best. **The Internet of Things has the potential to change the world, just as the Internet did. Maybe even more so.**

— Kevin Ashton, 'That 'Internet of Things' Thing', RFID Journal,
July 22, 2009



Интернет на нещата (IoT, IoE)

Интернет на нещата има потенциала да промени света, така както го направи Интернет. Дори повече.

— Kevin Ashton, 'That 'Internet of Things' Thing', RFID Journal, 2009

- ❖ 50 петабайта данни се създават и въвеждат от хора
- ❖ Хората имат ограничено време, внимание и точност
- ❖ Данни за нещата от реалния свят в реално време
- ❖ Проследяване и управление на всичко, намаляване на проблемите, загубите и цената
- ❖ Ще знаем кога нещата се нуждаят от замяна, ремонт или извеждане от експлоатация

Интернет на нещата в цифри

- According to Gartner, there will be nearly **26 billion** devices on the Internet of Things by 2020.
[Gartner, 2013-12-12,
<http://www.gartner.com/newsroom/id/2636073>]
- According to ABI Research, more than **30 billion** devices will be wirelessly connected to the Internet of Things by 2020 (Internet of Everything)
[ABI Research, <https://www.abiresearch.com/press/more-than-30-billion-devices-will-wirelessly-conne>]
- It's expected to be a **19 Trillion USD** market
[John Chambers, Cisco CEO,
<http://www.bloomberg.com/news/2014-01-08/cisco-ceo-pegs-internet-of-things-as-19-trillion-market.html>]

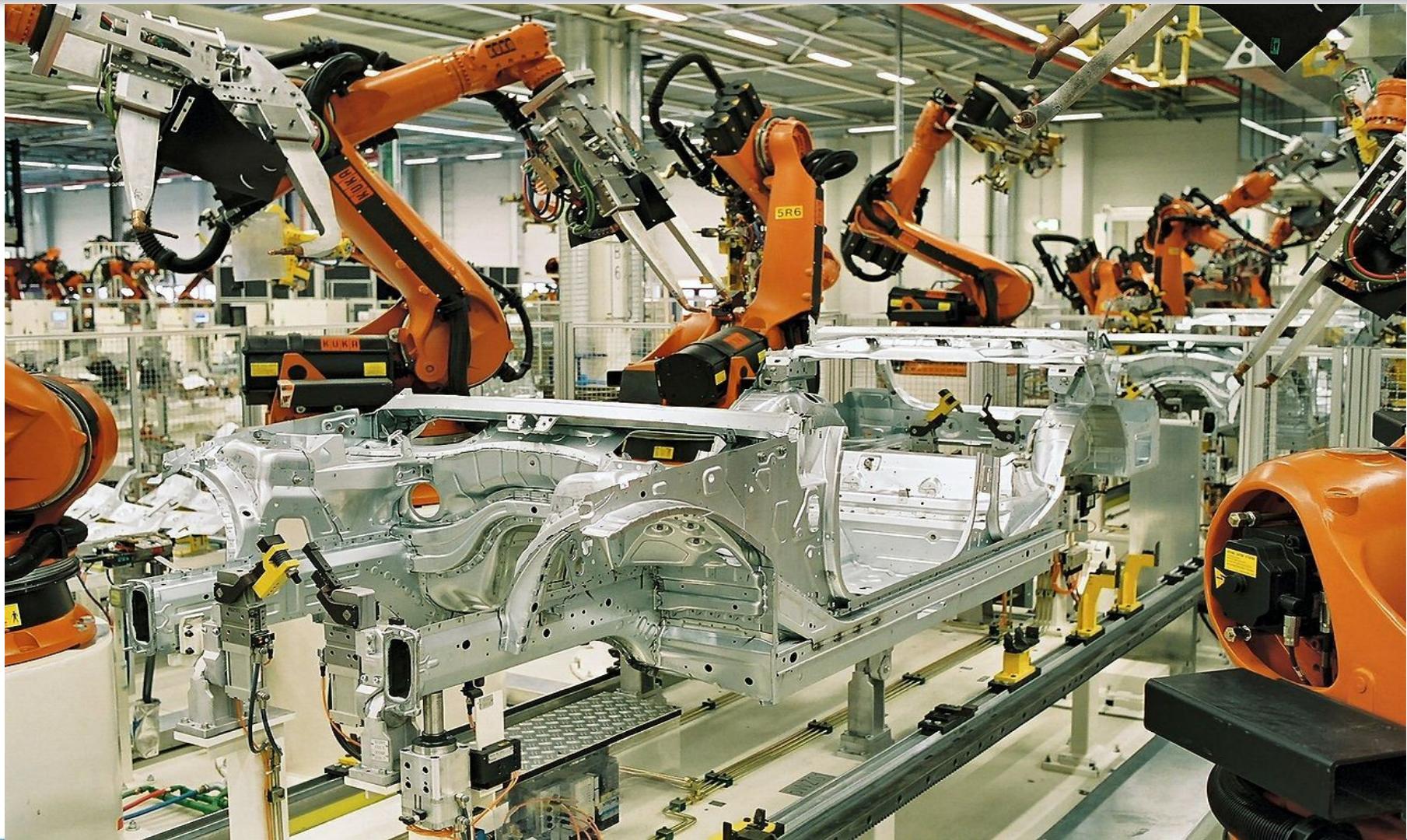
Internet of Things & AI

“Artificial intelligence (AI) is viewed as vital to realising the value of IoT data. Just over a quarter of survey respondents (26%) say that IoT data are pivotal to their current or planned use of AI, with 56% identifying IoT as “one of many important sources” for AI initiatives. Furthermore, 64% agree that “the value of IoT data to my organisation has increased as we have developed our AI capabilities”. Many interviewees view IoT and AI as two components of an advanced analytics capability. Reportedly, algorithms trained on data sources including IoT provide the greatest value and competitive differentiation.”

[The Economist Intelligence Unit Limited 2020:
<https://learn.arm.com/economist-iot-report-typ.html>]



В промышленности ...



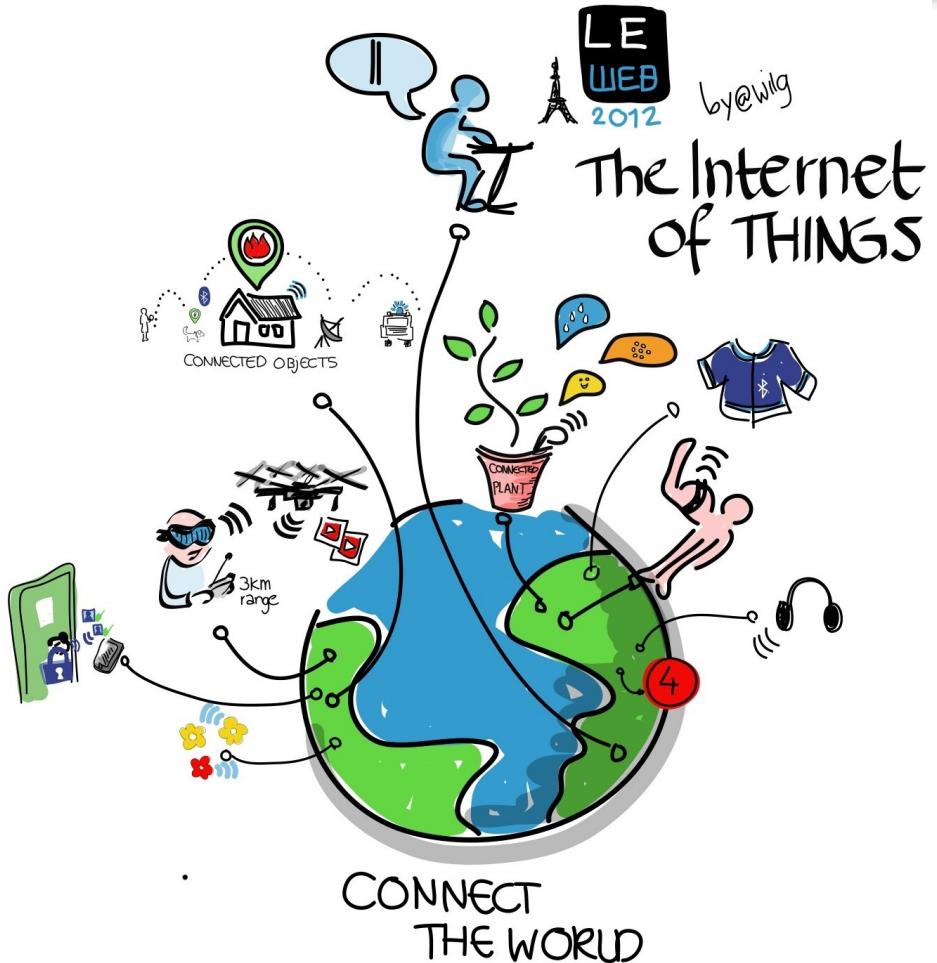
Internet of Things (IoT) – архитектурни изисквания

"Basket of remotes" problem – we'll have hundreds of applications to interface with hundreds of devices that **don't share protocols for speaking with one another**

[Jean-Louis Gassée, Apple initial alumni team, and BeOS co-founder,
<http://www.mondaynote.com/2014/01/12/internet-of-things-the-basket-of-remotes-problem/>]

- IoT устройствата трябва да бъдат лесно достъпни за своите потребители и техните агенти
- IoT архитектурите трябва да бъдат конкурентни разпределени, устойчиви на грешки, високо-производителни, еластични и децентрализирани, **динамично** разширяеми и еволюиращи

Работите са интелигентни “неша”

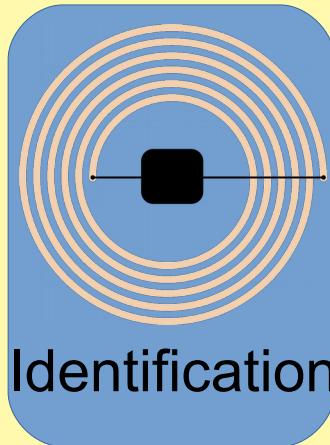


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Radar, GPS, lidar for navigation and obstacle avoidance (2007 DARPA Urban Challenge)

Key Elements of IoT

Internet of Things (IoT)



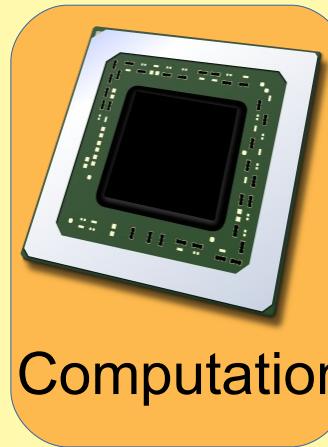
Identification



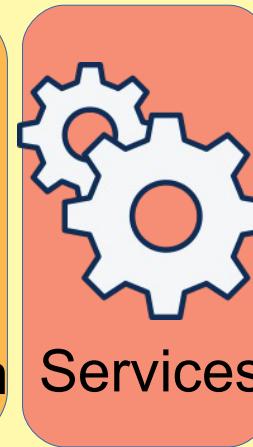
Sensors



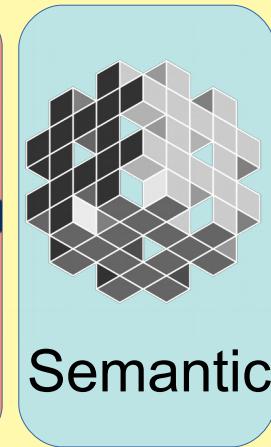
Connectivity



Computation

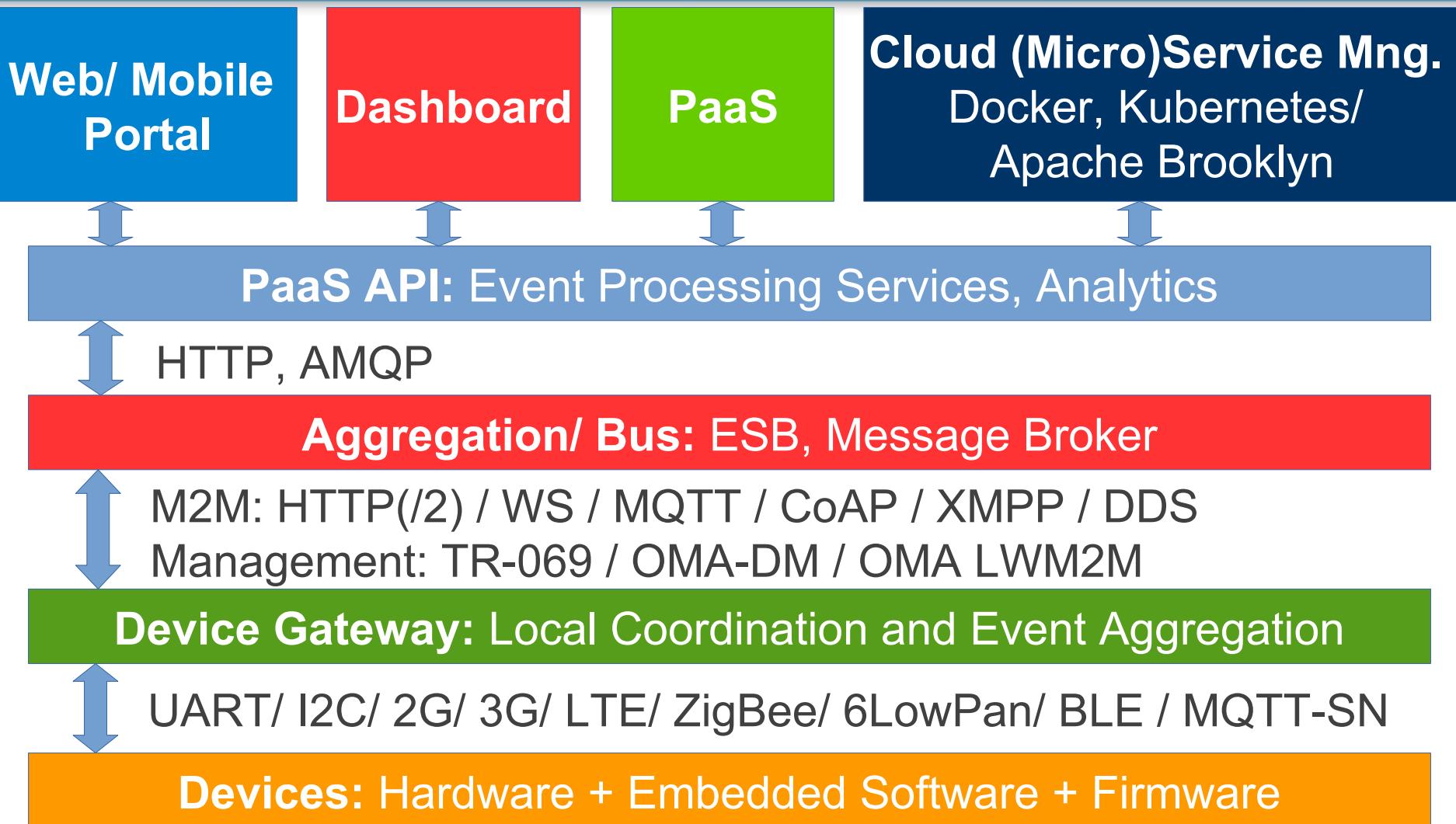


Services



Semantic

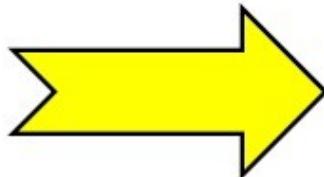
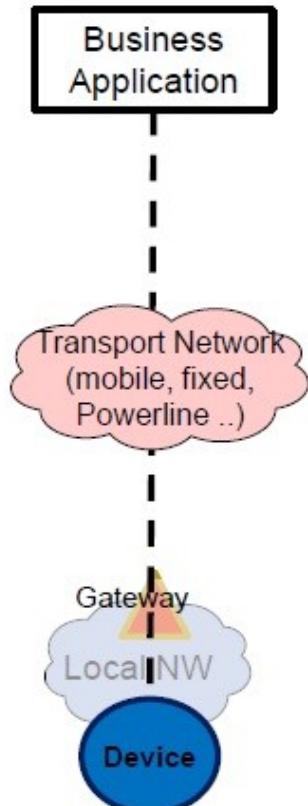
IoT Services Architecture



Vertical vs. Horizontal IoT

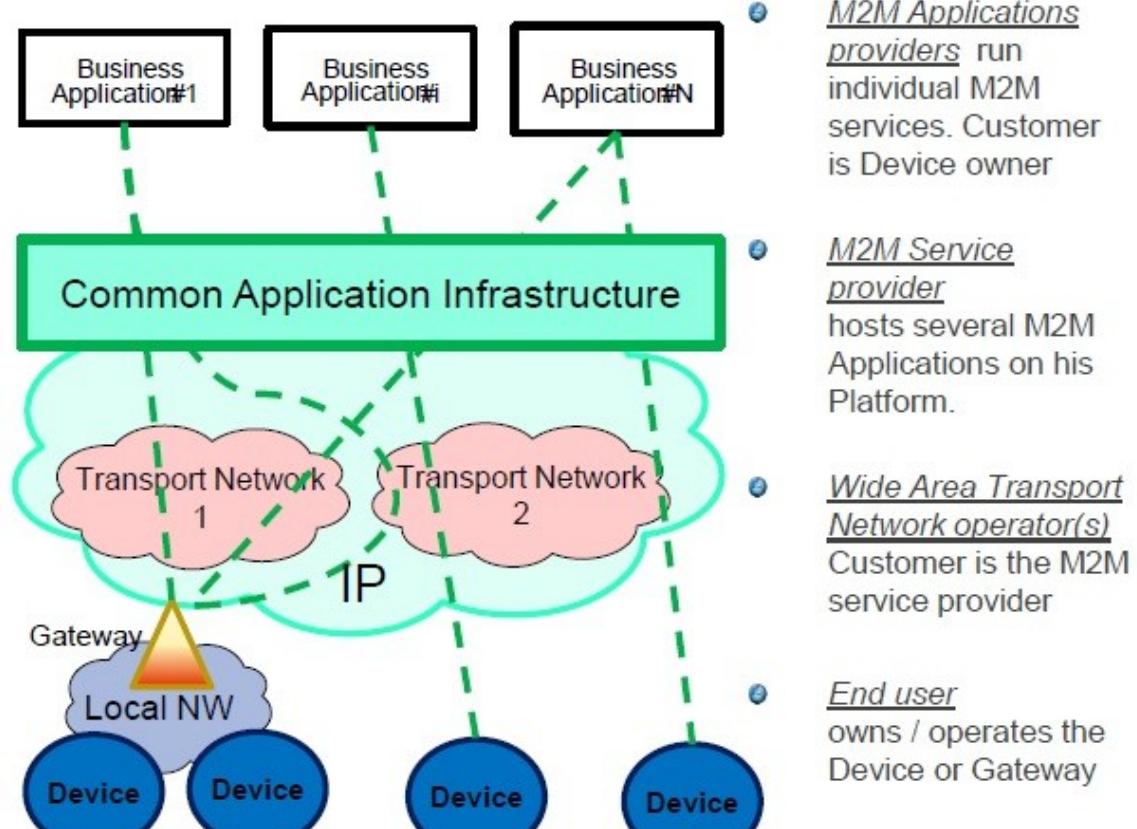
Pipe (vertical):

1 Application, 1 NW,
1 (or few) type of Device



Horizontal (based on common Layer)

Applications share common infrastructure, environments
and network elements



- M2M Applications providers run individual M2M services. Customer is Device owner

- M2M Service provider hosts several M2M Applications on his Platform.

- Wide Area Transport Network operator(s) Customer is the M2M service provider

- End user owns / operates the Device or Gateway

Cloud, Fog and Mist Computing

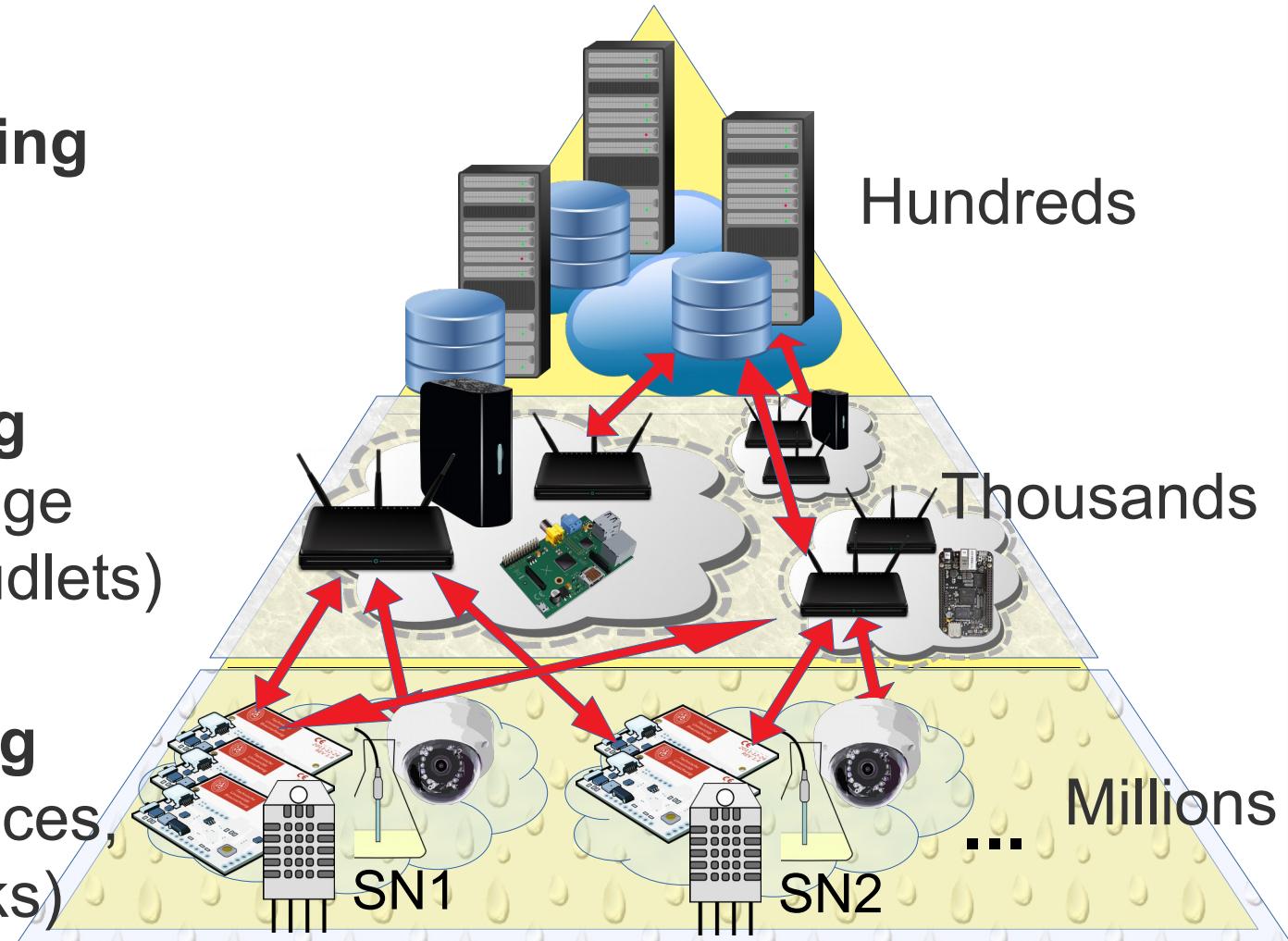
Cloud Computing
(Data-centers)



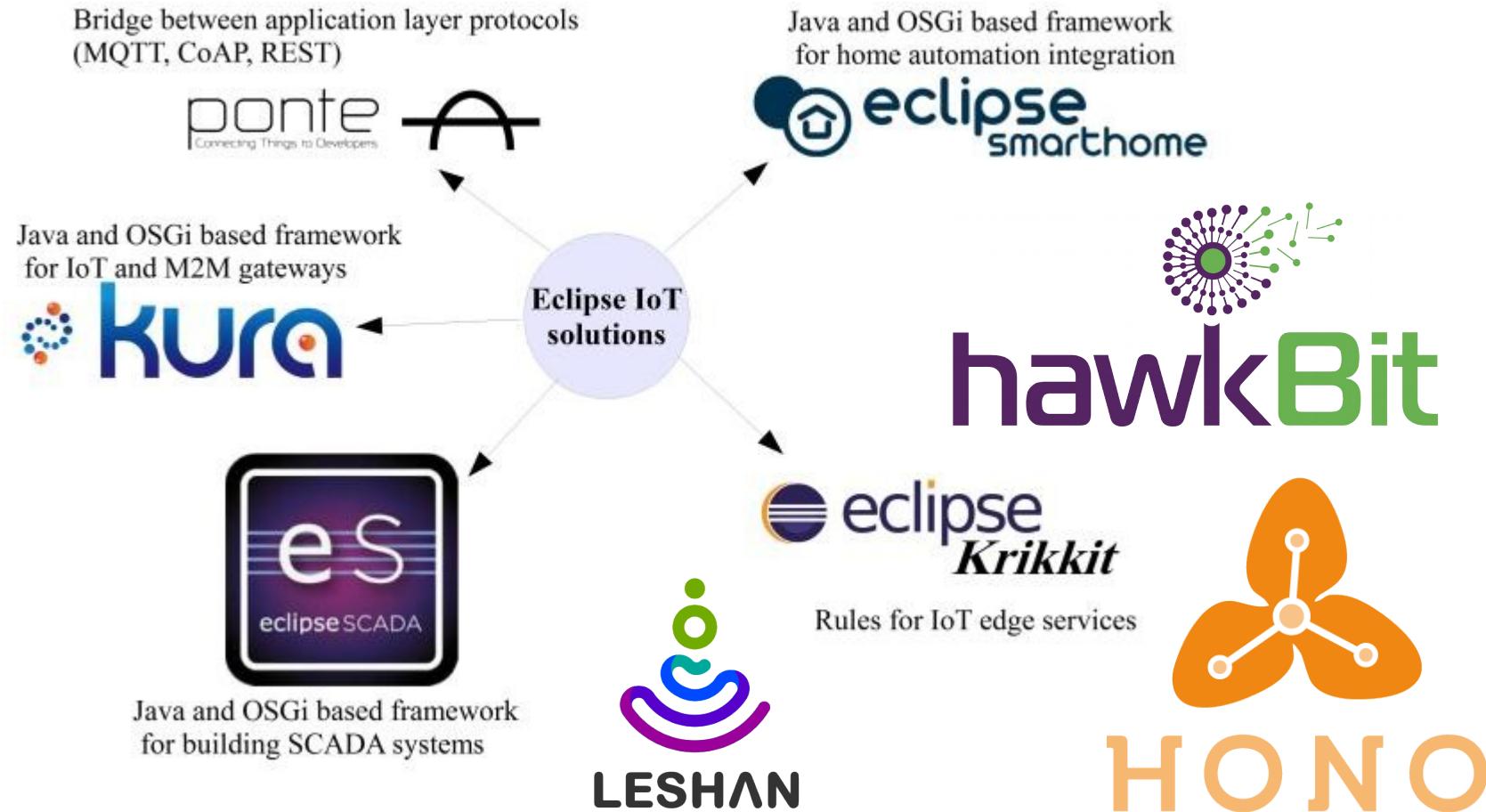
Fog Computing
(Fog Nodes, Edge Gateways, Cloudlets)



Mist Computing
(Smart IoT Devices,
Sensor Networks)



Eclipse IoT Platform



Based on: https://www.researchgate.net/publication/279177017_Internet_of_Things_A_Survey_on_Enabling_Technologies_Proocols_and_Applications, By Ala Al-Fuqaha et al. - Internet of Things: A Survey on Enabling Technologies, Protocols and Applications

Интер-дисциплинарно обучение



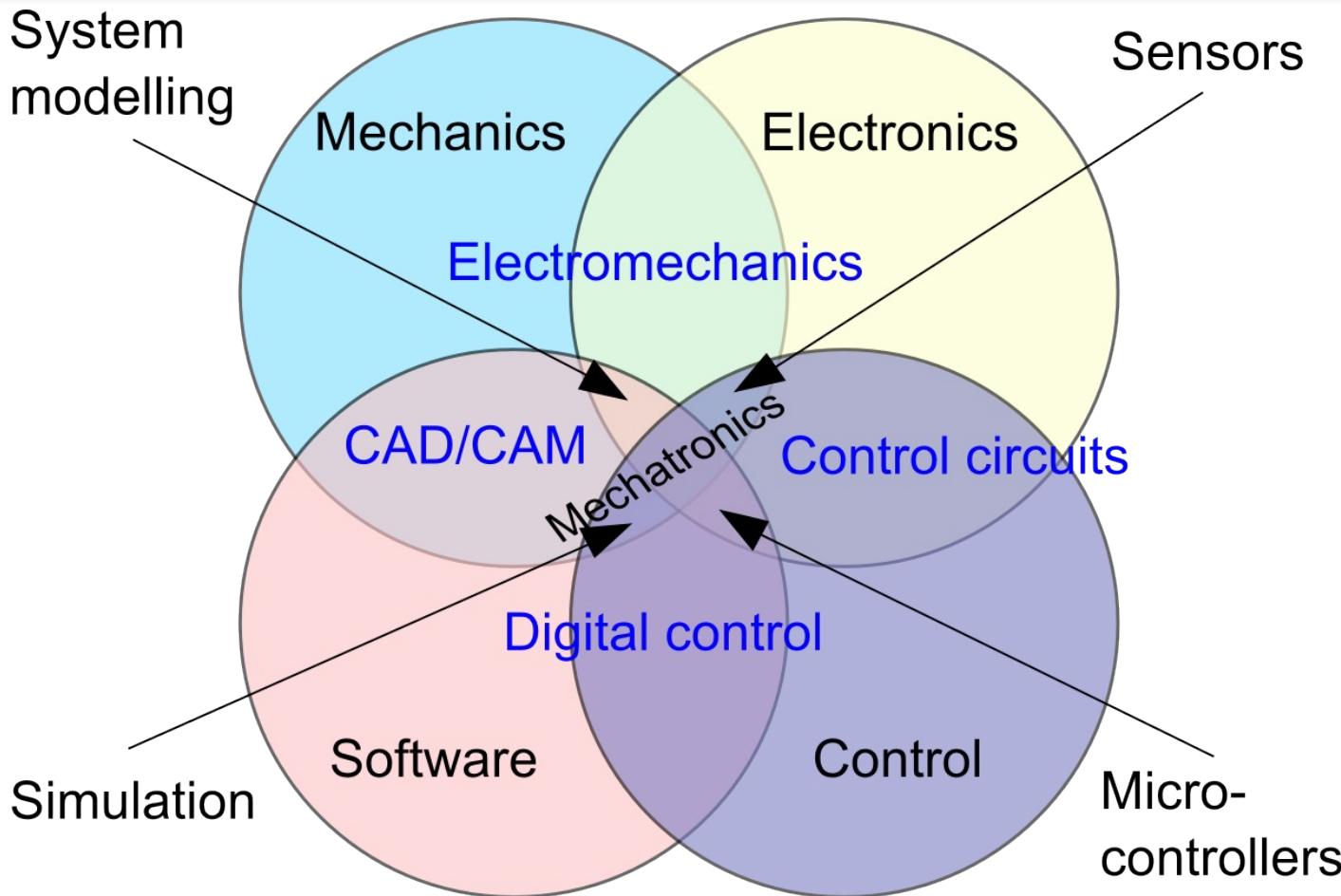
Роботиката е пресечна точка на
много дисциплини:

- ❖ Механика
- ❖ Електроника и компютърни науки
- ❖ Софтуерно инженерство
- ❖ Изкуствен интелект (AI)
- ❖ Човеко-машинни интерфейси
- ❖ Социология и психология
- ❖ Дизайн

Picture by Hugo Elias of the Shadow Robot Company -
<http://www.shadowrobot.com/media/pictures.shtml>, CC BY-SA 3.0

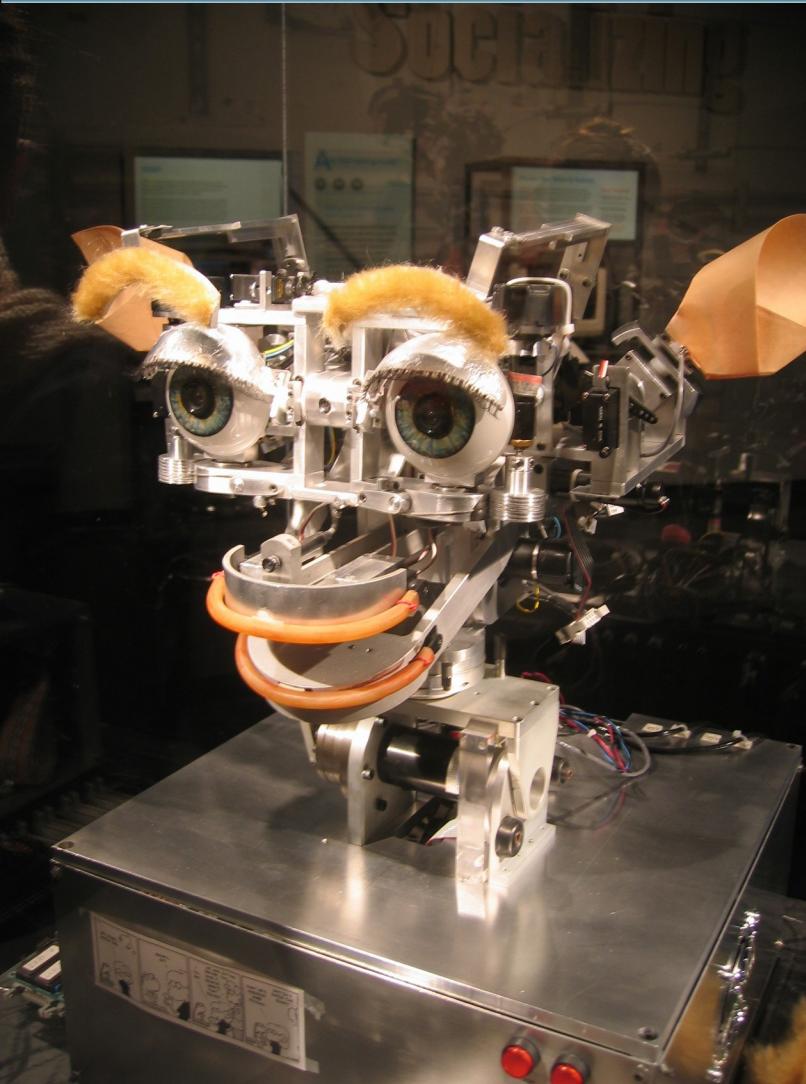


Инженерство, наука и искусство



Source: <https://commons.wikimedia.org/w/index.php?curid=551256>, CC BY-SA 3.0

Роботите могат да бъдат социални :)



Обучение чрез програмиране на малки роботи





Documentation FAQ Download Mailing List Code Commercial Support

Build powerful concurrent & distributed applications more easily.

Akka is a toolkit and runtime for building highly concurrent, distributed, and resilient message-driven applications on the JVM.

Simple Concurrency & Distribution

Asynchronous and Distributed by design. High-level abstractions like Actors, Futures and STM.

Resilient by Design

Write systems that self-heal. Remote and/or local supervisor hierarchies.



High Performance

50 million msg/sec on a single machine. Small memory footprint; ~2.5 million actors per GB of heap.

Elastic & Decentralized

Adaptive load balancing, routing, partitioning and configuration-driven remoting.

Extensible

Use Akka Extensions to adapt Akka to fit your needs.

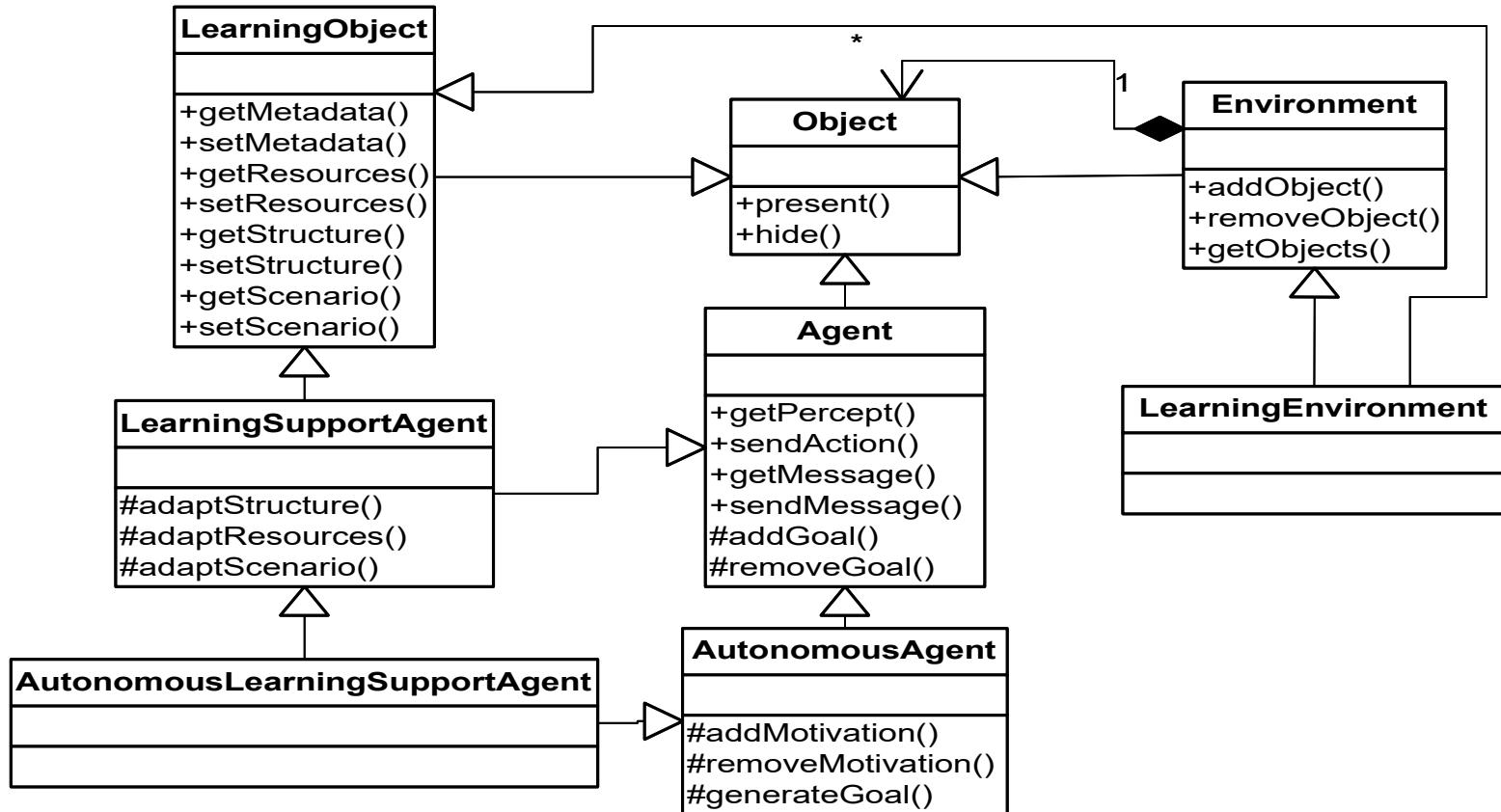
Подход на интелигентните агенти при моделиране на знания и системи

- Интелигентните агенти (ИА) са софтуерни/хардуерни системи, които притежават свойствата:
 - Автономност
 - Способност за реагиране (реактивност)
 - Проактивност
 - Социална способност (комуникация, ACL)
 - Рационалност
 - Адаптивност (Самообучение)
 - Мобилност
- ИА възприемат средата с помощта на сензори и ѝ въздействат с помощта на ефектори

Дефиниции за интелигентни агенти

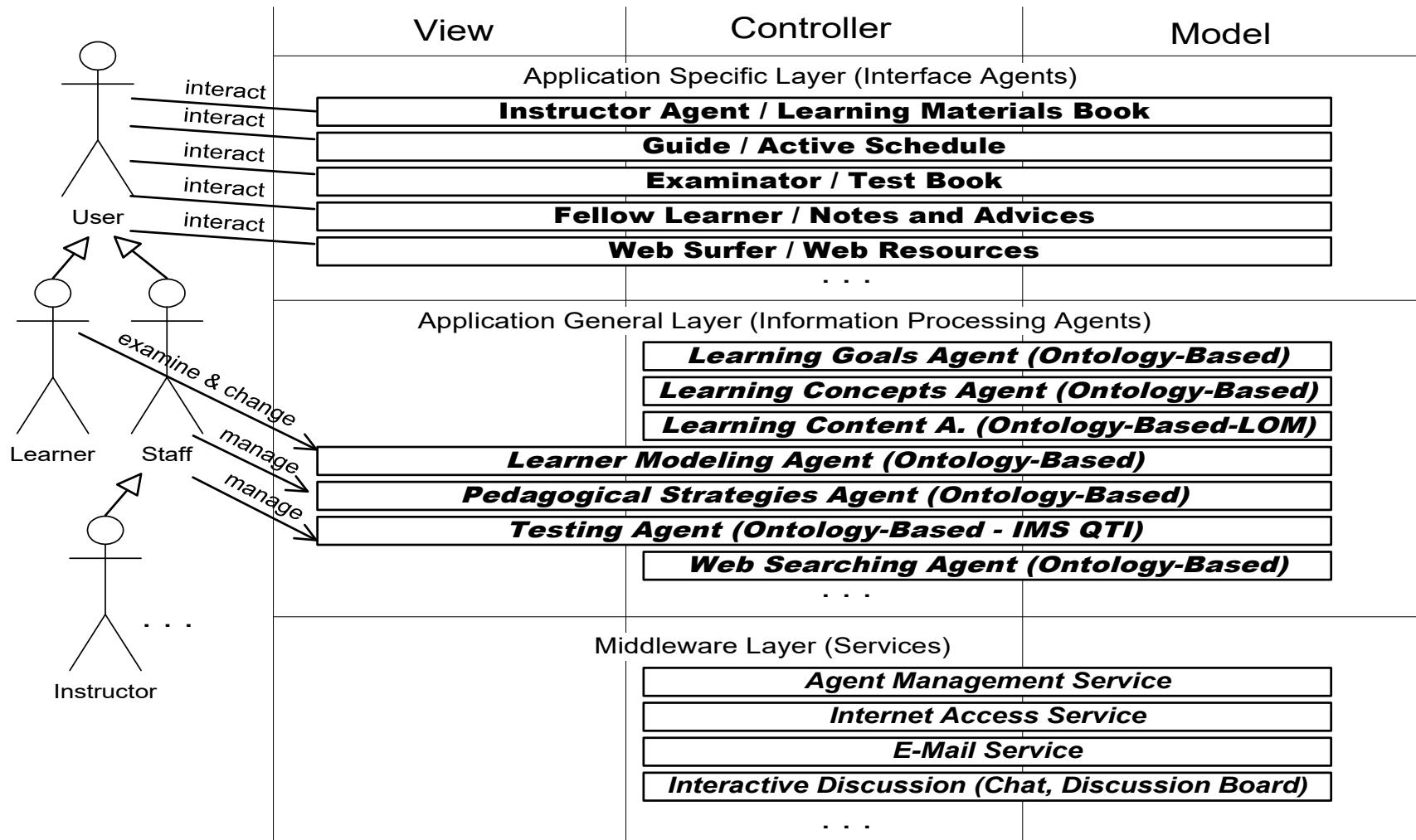
- Интелигентните технологии в нашия живот – визия за бъдещето
- Дефиниции:
 - Intelligent Agent = Agent + Intelligence
 - AIMA agent (Russel & Norvig, 1995)
 - Maes agent (Maes, 1995)
 - Hayes-Roth agent (Hayes-Roth, 1995)
 - SodaBot агенти
 - Foner агенти
 - Wooldridge и Jennings агенти
 - Franklin и Graesser агенти
- Формализация на Luck и d'Inverno на понятията свързани с агентите

Пример: Learning Support Agents [Iliev, ICL2003]



E-ACADEMIA Agent Architecture

[Iliev, ICL2003]



Характеристики на интелигентните агенти

- Автономност
- Способност за реагиране (реактивност)
- Проактивност
- Социална способност (комуникация, ACL)
- Рационалност
- Доброжелателност и честност
- Времева продължителност
- Адаптивност (Самообучение)
- Личност и антропо-морфизъм
- Мобилност

Автономност на интелигентните агенти

- “Автономността е трудно за прецизно дефиниране понятие и ние го разглеждаме в смисъл, че системата трябва да може да действа без директна интервенция от страна на хора (или други агенти) и че тя трябва да притежава контрол върху своите собствени действия и вътрешно състояние“

[Jennings, Sycara и Wooldridge]

- “Една система е автономна в степента, в която нейното поведение се определя от нейния собствен опит“

[Russell и Norvig, AIMA]

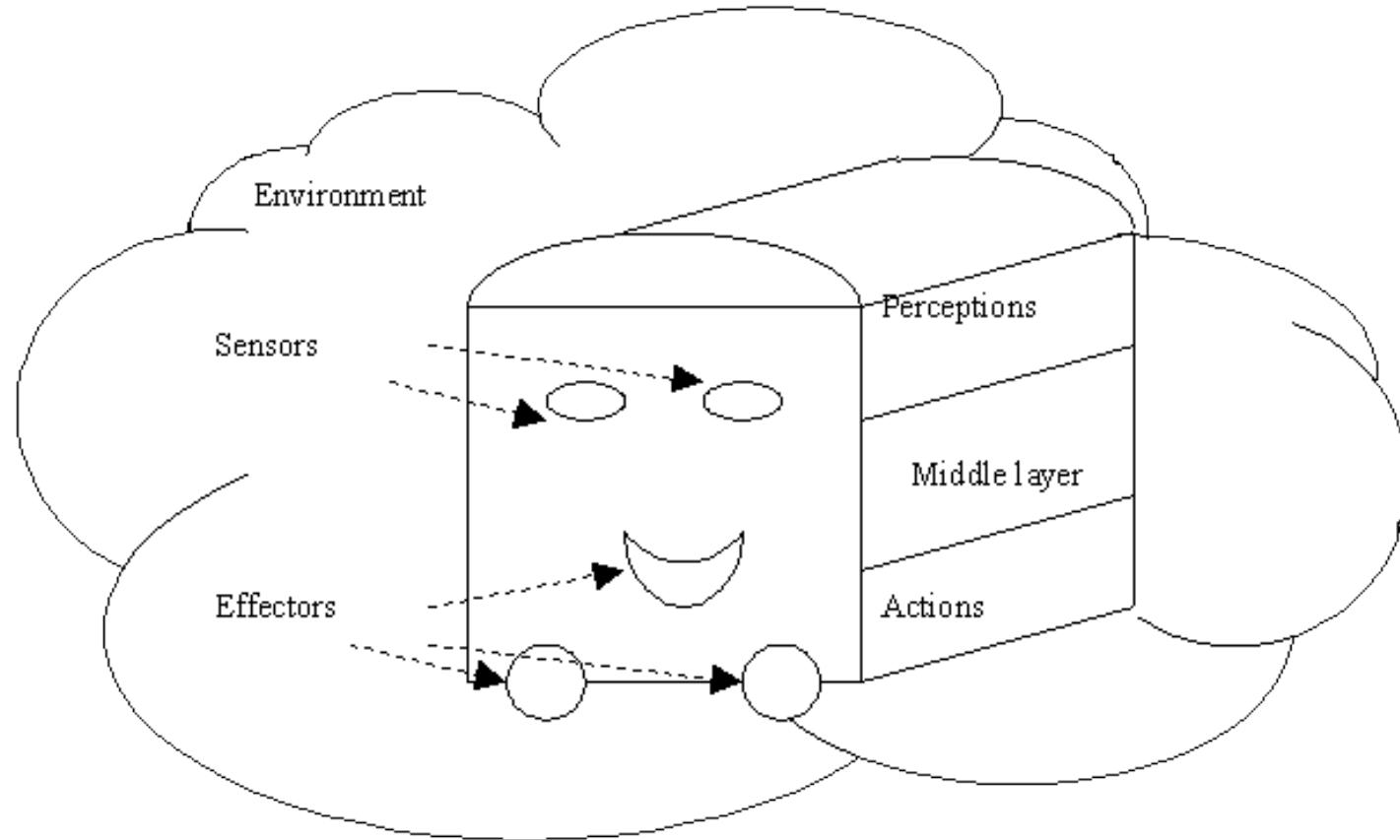
Автономност на интелигентните агенти 2

- Luck и d'Inverno – две възможни гледни точки към автономността:
 - **силна гледна точка към автономността** – “разглеждана като абсолютна без измерения или мярка за степен”;
 - **слаба гледна точка към автономността** – практически ориентирана, “при която автономността се счита за синоним на независимостта, едно явно относително понятие”.

Видове агенти

- Сътрудничещи си (Collaborative)
- Интерфейсни (Interface)
- Информационни (Information)
- Реагиращи (Reactive)
- Мобилни (Mobile)
- Хибридни (Hybrid)
- Хетерогенни (Heterogeneous)
- **Типове приложения**

Базова архитектура на интелигентен агент



Intelligent agent – basic architecture

Основни парадигми при МАС и ИИ роботиката

- **Йерархична парадигма** – планиране, символно представяне на знанията и глобален модел на света. Три слоя: Sensing, Planning, Acting [Murphy].
- **Реактивна парадигма** – “intelligent behavior emerges from the interaction of various simpler behaviors” [Wooldridge]: Subsumption Architecture [Brooks].
- **Хибридна Deliberative/Reactive** парадигма – синтез на предишните два подхода: INTERRAP [Muler].

Стандарти при управлението на знания. Онтологии.

- Семантична мрежа - W3C Resources Description Framework (RDF)
- Онтологии – W3C Web Ontology Language (OWL):
 - Концептуализация
 - Речник
 - Аксиоматизация

Основни парадигми в ИИ роботиката

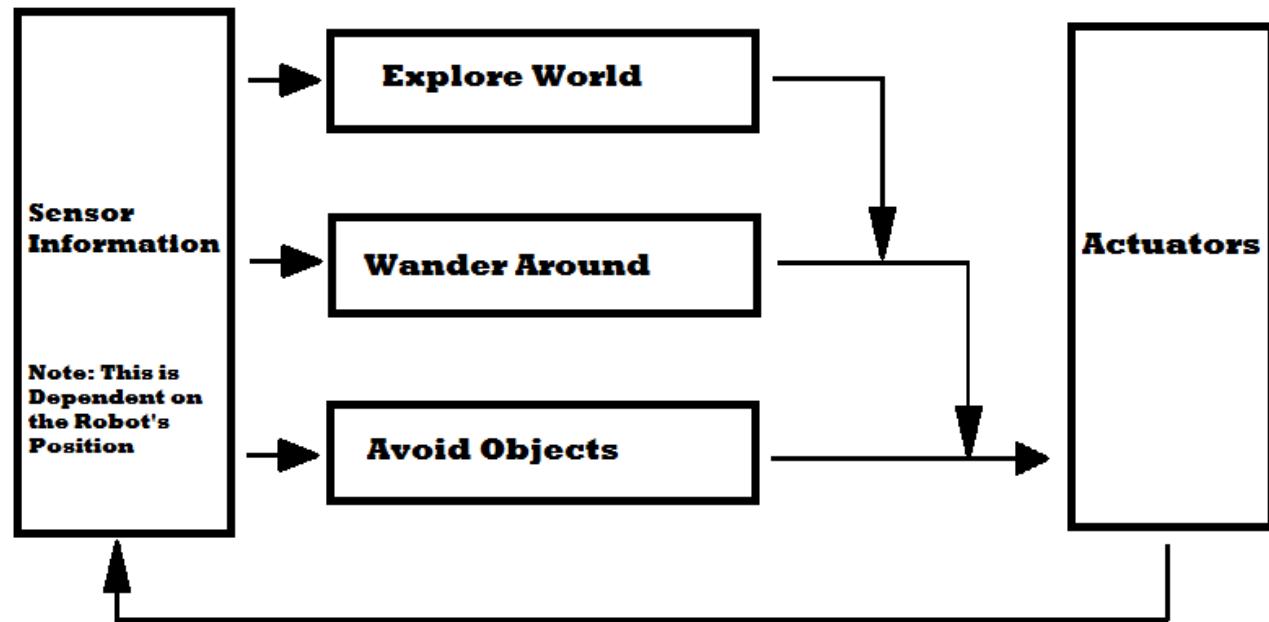
- Йерархична парадигма – подход на планиране [STRIPS, <http://en.wikipedia.org/wiki/STRIPS>]
- Реактивна парадигма [Brooks, Subsumption Architecture]
- Хибридна парадигма [INTERRAP]:
 - Реагиране
 - Планиране
 - Социална комуникация и взаимодействие

Subsumption Architecture [Brooks, 1986 & 1991]

- Rodney A. Brooks, MIT AI Lab — статия "Elephants Don't Play Chess", 1986
- Бихевиористки подход към реализацията на изкуствен интелект – **Behavior-Based Robotics (BBR)**.
- BBR роботите действат на база множество независими, прости поведения, които могат да се надграждат йерархично. Поведенията имат тригер (сензорна перцепция) и действие (включващо ефектор). Когато две поведения са в конфликт, той се решава от Арбитратор.
- Интелигентното поведение не е просто сума на отделните прости поведения, а е **възникващо (emergent)**.

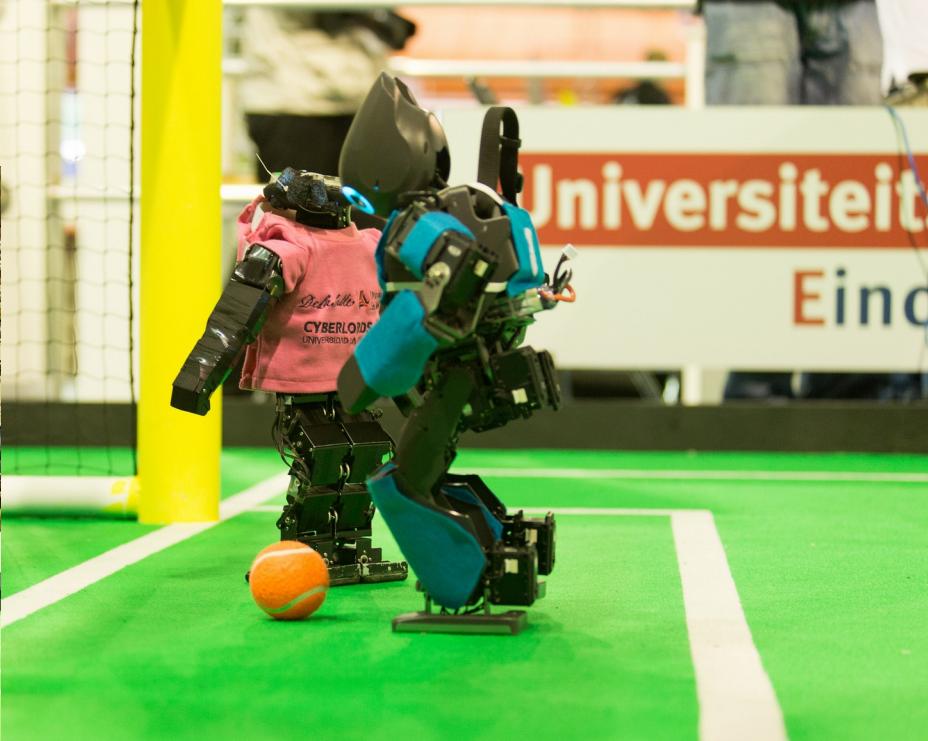
Subsumption Architecture [Brooks, 1986 &1991]

- Situatedness
- Embodiment
- Intelligence
- Emergence

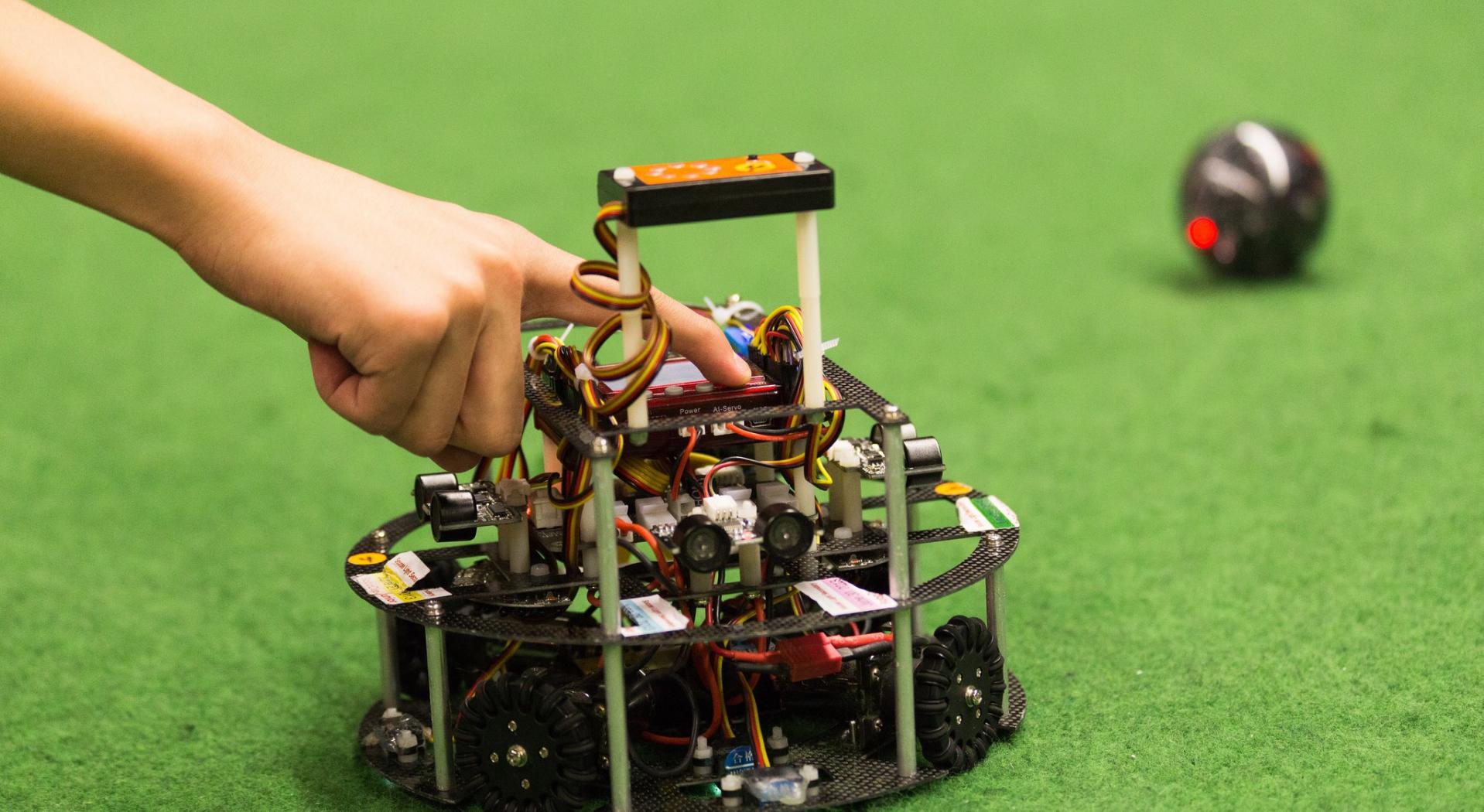


Много-агентни системи (MAS)

- Отделните агенти вземат решения и действат автономно, на базата на **собствен модел на света**
- Резултатът от взаимодействието се определя от съвместните действия на всички агенти => възникващо поведение на системата (*emergent behavior*)
- Необходимо е да се дефинира **механизъм**, по който става взаимодействието между агентите
- Различните агенти могат да имат **различни функции на полезност**, които им позволяват да вземат различни решения



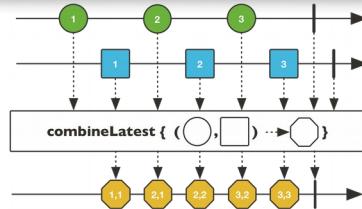
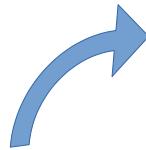
AvB - RoboCup 2013 - Eindhoven



RoboCup 2013
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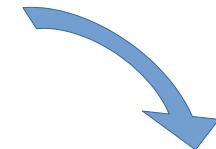
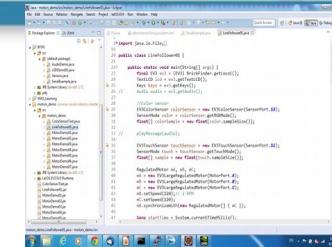
Стилове на учене с роботи



Асимилатор
индукция, теории

Рефлексивно
наблюдение

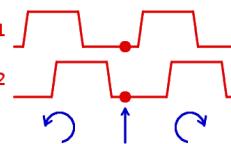
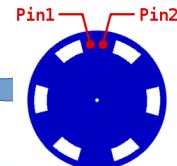
Абстрактна
концептуализация



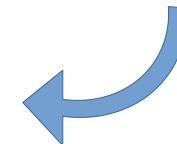
Конвърджър
от общото към частното
прилагане на теориите

Активно
експериментиране

Дивърджър
от частното към общото,
конкретни наблюдения



Конкретен опит



Обучение чрез проекти

Проектно-базираното обучение (PBL) е форма на активно обучение, при която обучаваните получават знания и умения чрез работа и изследване за продължителен период от време върху автентичен, ангажиращ, и сравнително сложен въпрос, проблем или предизвикателство.

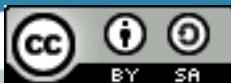
-- What is Project Based Learning (PBL)?
https://www.bie.org/about/what_pbl



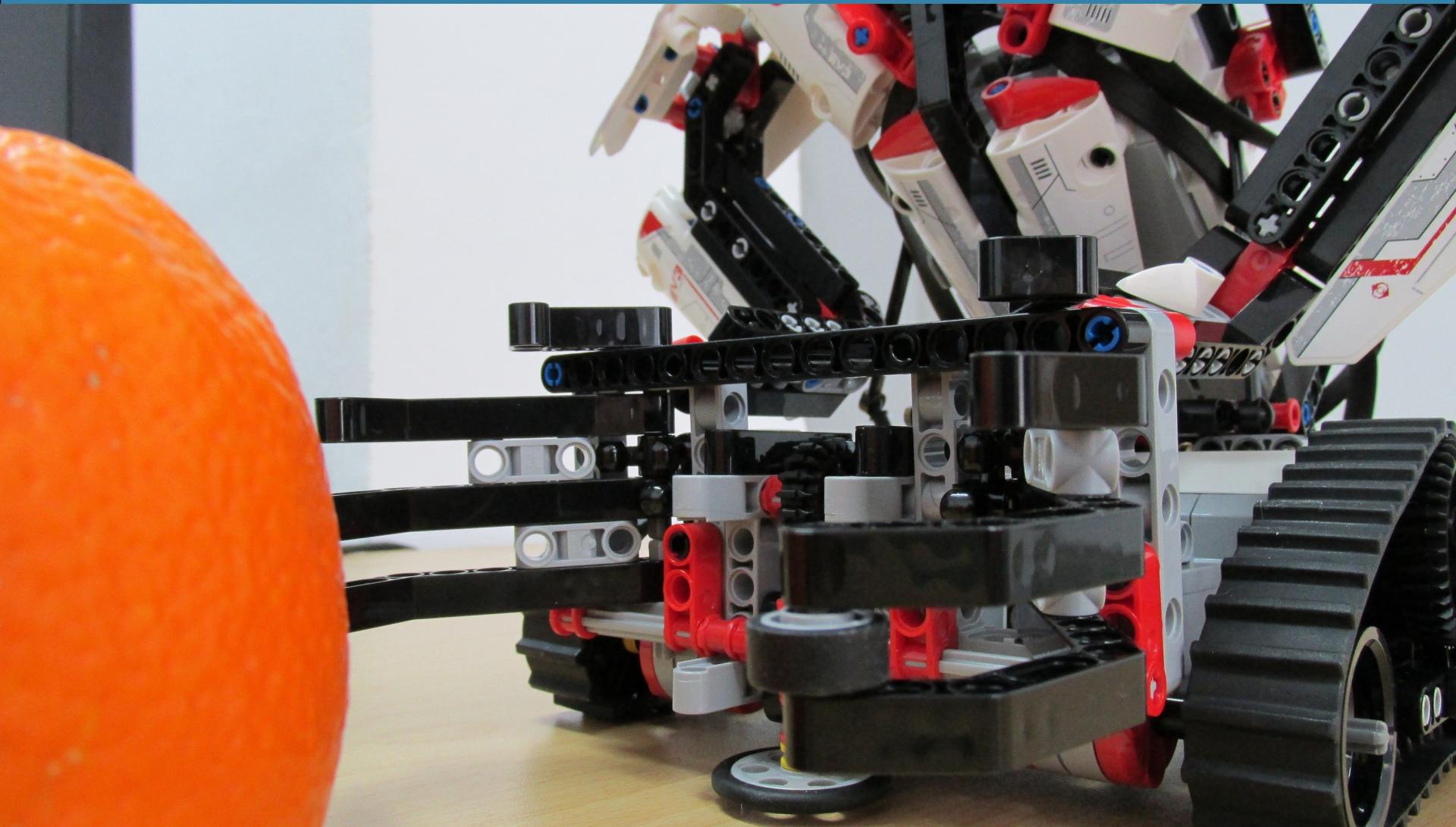
Защо PBL?

[https://www.bie.org/about/what_pbl]

- ❖ Ключови знания, разбиране, критично мислене/решаване на проблеми, комуникация, колаборация, себе-управление и планиране на ресурсите.
- ❖ Предизвикателство с реална ценност – необходимост от адаптиране на сложността на решаваните проблеми.
- ❖ Непрекъснато изследване – продължителен процес на търсене на отговори на въпроси и информационни ресурси, прилагане на информацията на практика
- ❖ Автентичност и релевантност – контекст, задачи, стандарти за качество от реалния свят в съответствие с персоналните интереси на обучаваните
- ❖ Личен избор и креативност – всеки екип сам избира какво ще създаде.
- ❖ Рефлексия – обучаваните и преподавателя обсъждат наученото/ процеса, заедно решават проблемите: решенията не са предварително известни!
- ❖ Обратна връзка – обучаваните дават и получават обратна връзка и непрекъснато усъвършенстват както продукта, така и процеса на работа.
- ❖ Публичен продукт – резултатът се демонстрира публично – пред колеги и в по-широва общност извън класната стая.



Запознайте се с LeJaRo

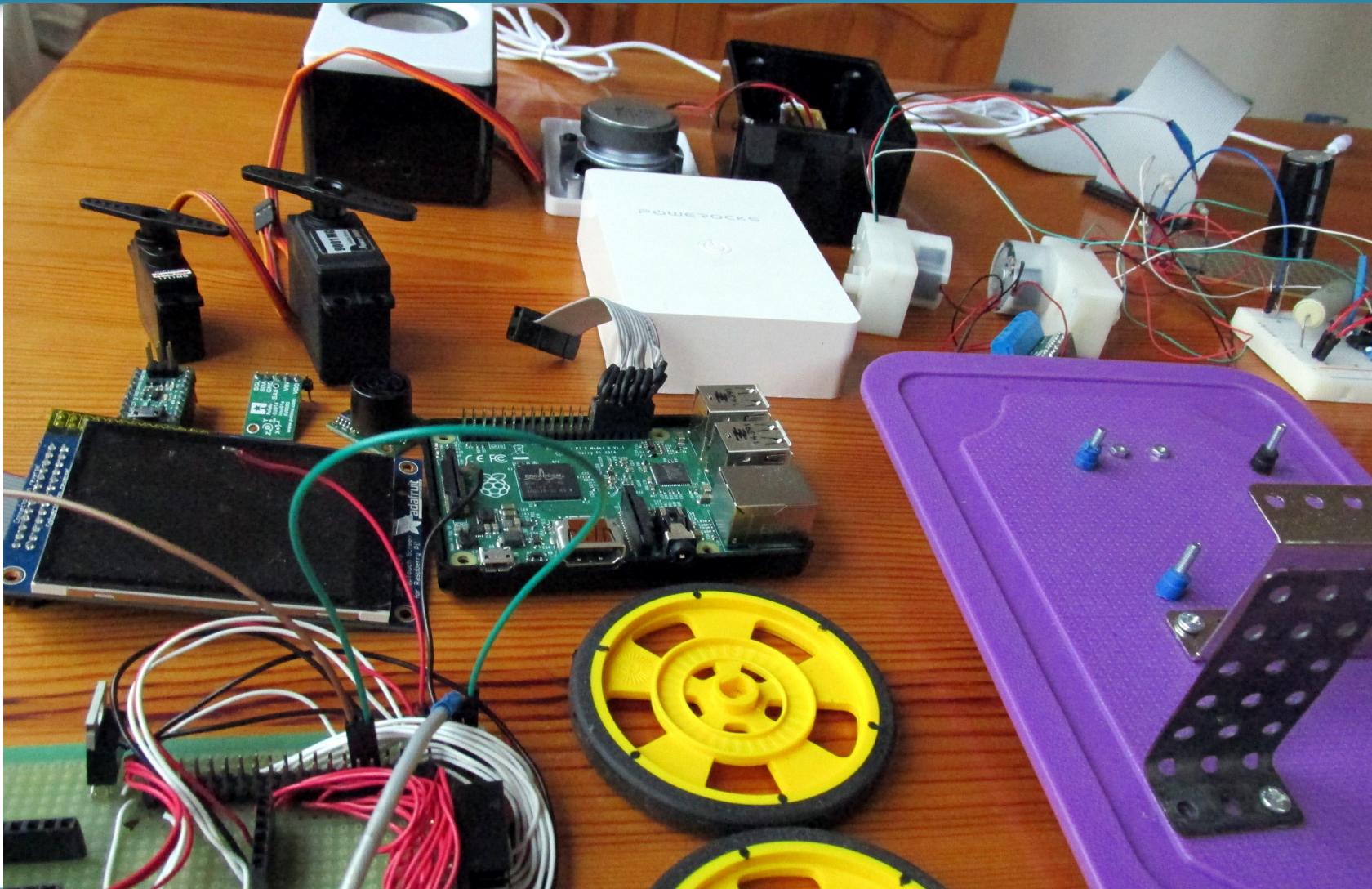


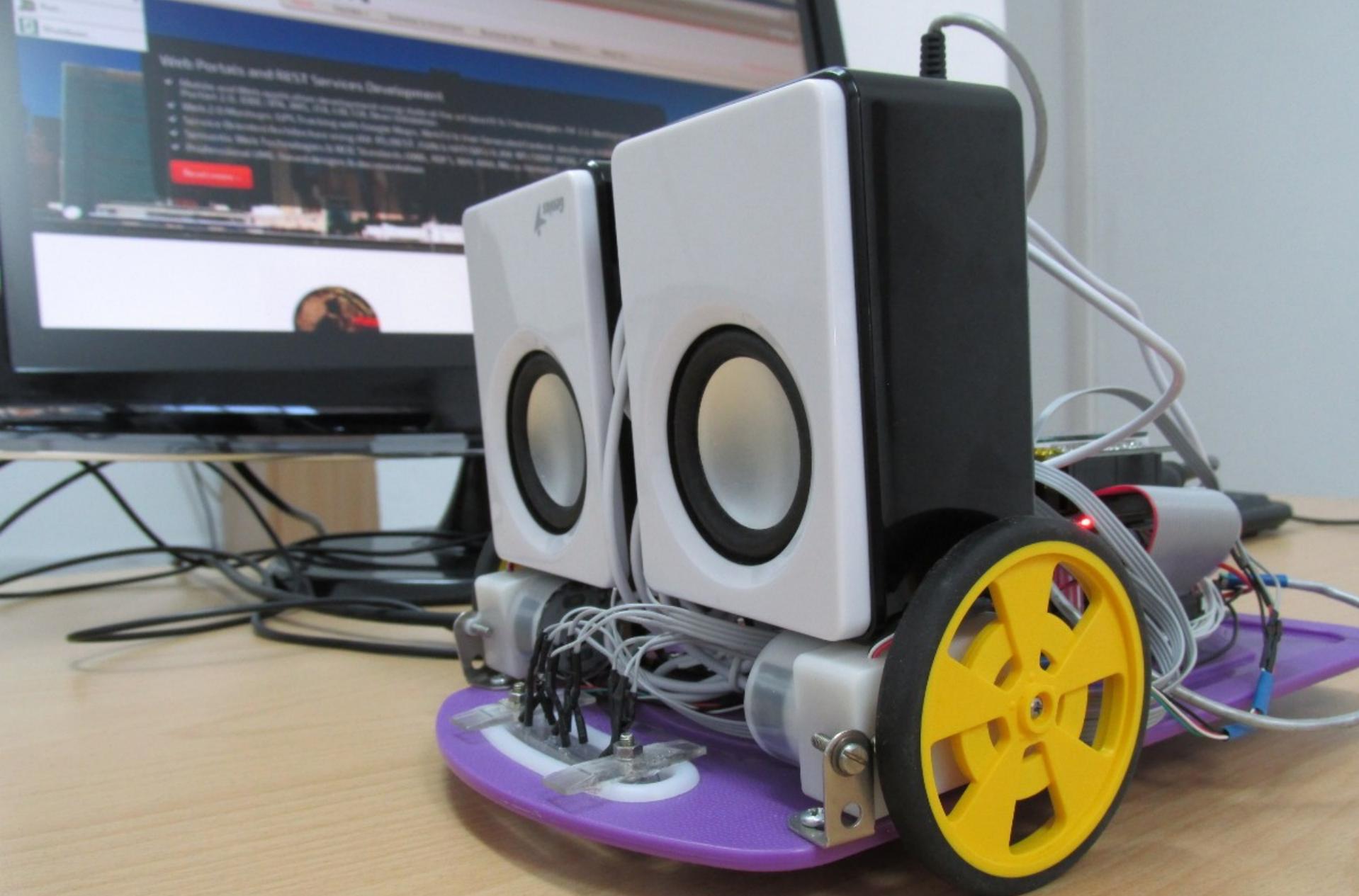
LeJaRo: Lego® Java Robot

- ❖ Modular – 3 *motors (with encoders)* – one driving each track, and third for robot clamp.
- ❖ Three sensors: *touch sensor* (obstacle avoidance), *light color sensor* (follow line), *IR sensor* (remote).
- ❖ LeJaRo is programmed in Java using **LeJOS** library.
- ❖ More information about LeJaRo:
<http://robolearn.org/lejaro/>
- ❖ Programming examples available @GitHub:
https://github.com/iproduct/course-social-robotics/tree/master/motors_demo



Meet IPTPI :)



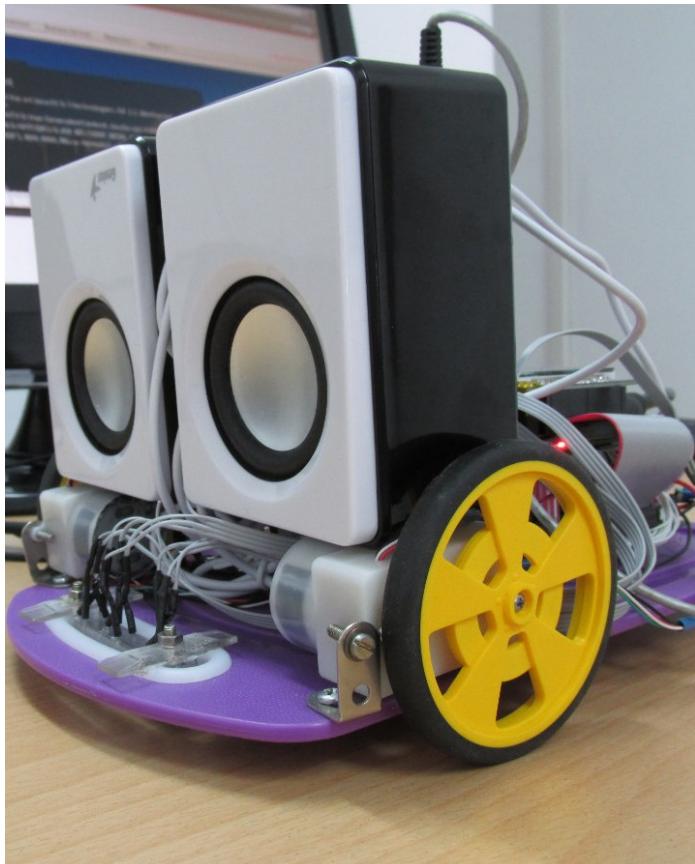


Web Portals and RESTful Services Development

- Mobile and Web mobile client development using Java at the University of Michigan
- SharePoint 2.0, WSS, BCS, MOSS, JS, JSLink, REST, RESTful
- Web 2.0 technologies, SOA, Real-time web, Mobile, Microservices, Cloud Computing
- Services Oriented Architecture using REST, WCF, SOA
- Terminal UI, Web Technologies, C# ASP.NET, Java, Python, Node.js, Angular, React, Vue.js
- Blockchain and IoT

[Read more](#)

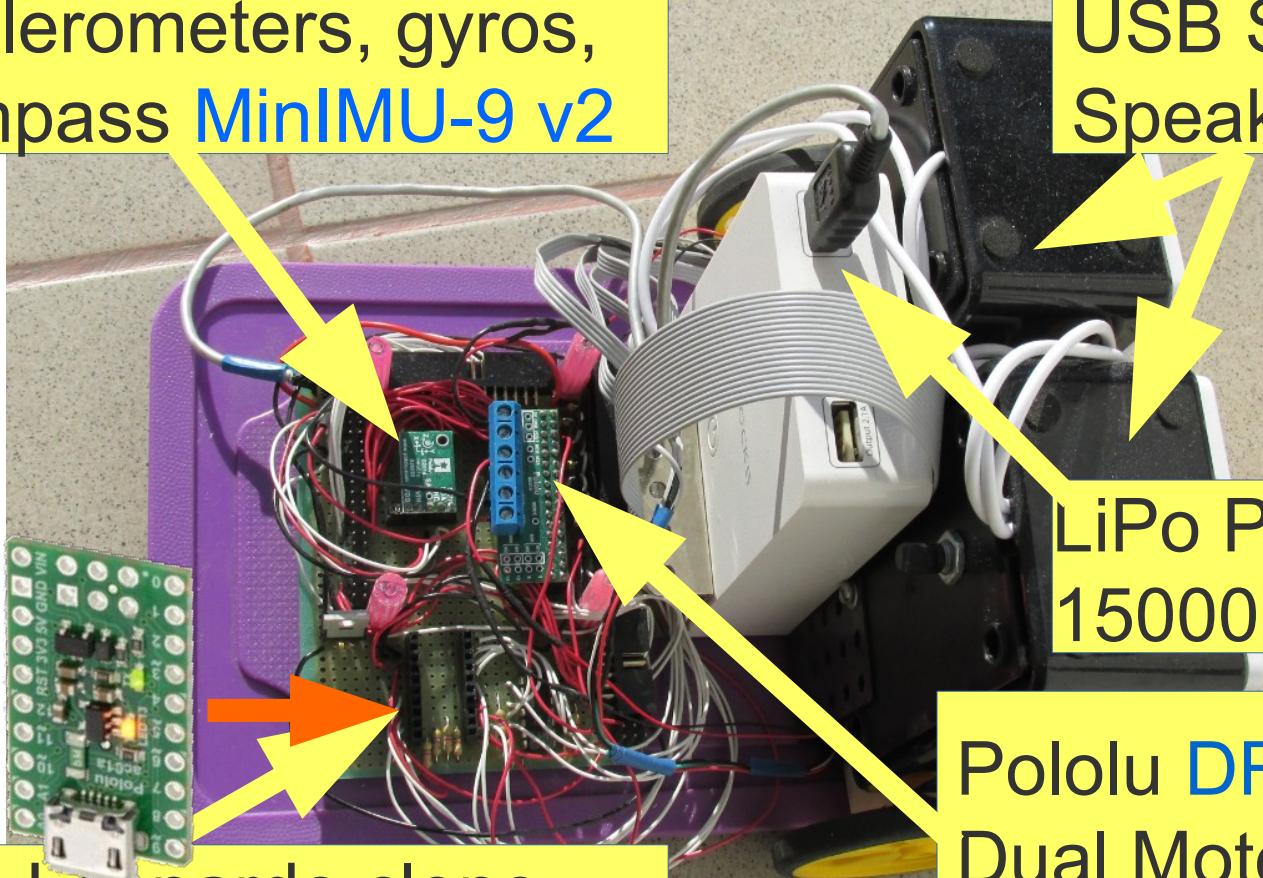
IPTPI: RPi2 + Arduunio Robot



- ❖ Raspberry Pi 2 (quad-core ARMv7 @ 900MHz) + Arduino Leonardo clone **A-Star 32U4 Micro**
- ❖ *Optical encoders* (custom), IR optical array, 3D accelerometers, gyros, and compass **MinIMU-9 v2**
- ❖ **IPTPI** is programmed in Java using **Pi4J**, **Reactor**, **RxJava**, **Akka**
- ❖ More information about IPTPI:
<http://robolearn.org/iptpi-robot/>

IPTPI: RPi2 + Arduinio Robot

3D accelerometers, gyros,
and compass [MinIMU-9 v2](#)



Arduino Leonardo clone
[A-Star 32U4 Micro](#)

USB Stereo
Speakers - 5V

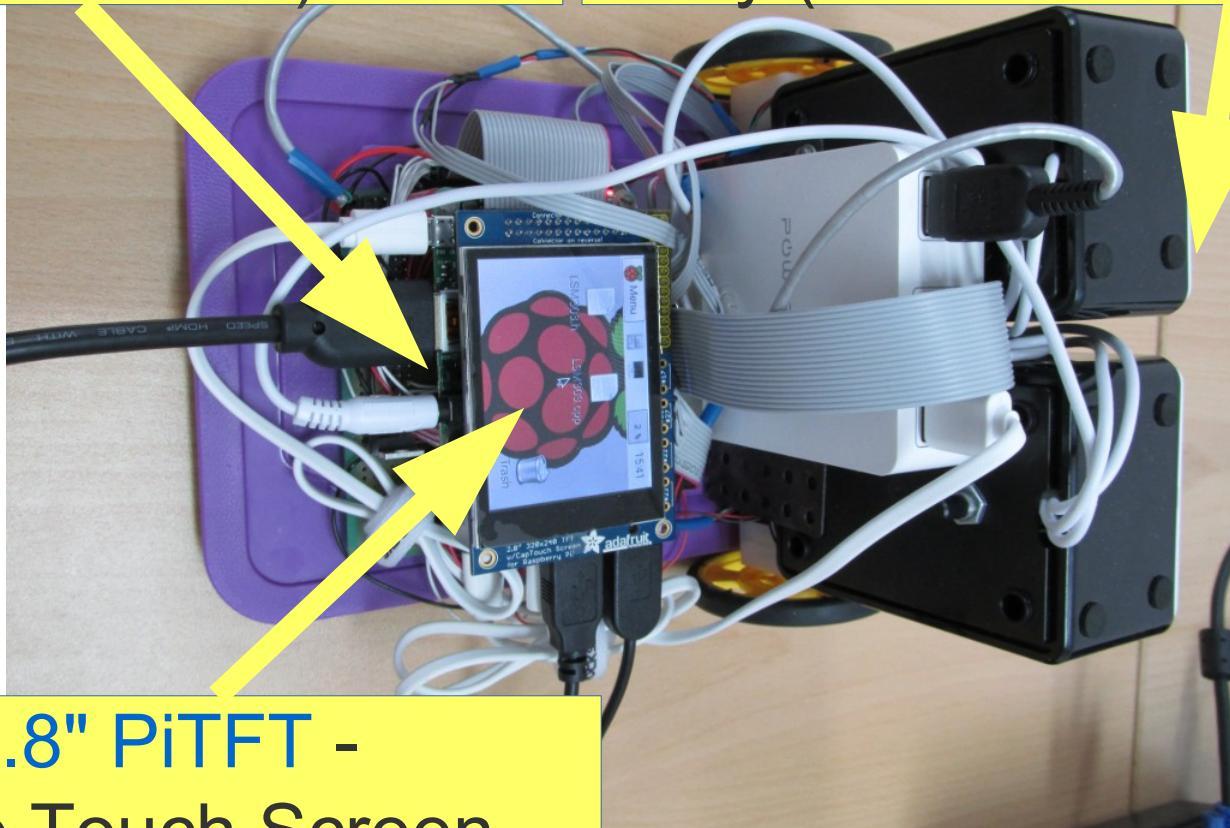
LiPo Powebank
15000 mAh

Pololu [DRV8835](#)
Dual Motor Driver
for Raspberry Pi

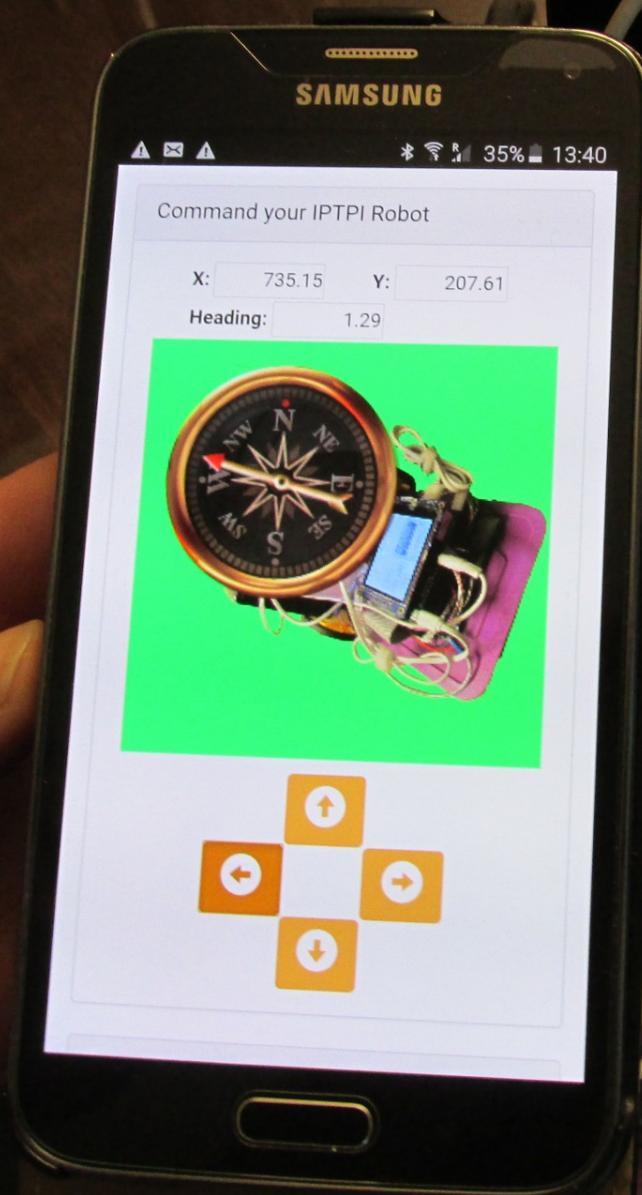
IPTPI: RPi2 + Arduunio Robot

Raspberry Pi 2 (quad-core
ARMv7 @ 900MHz)

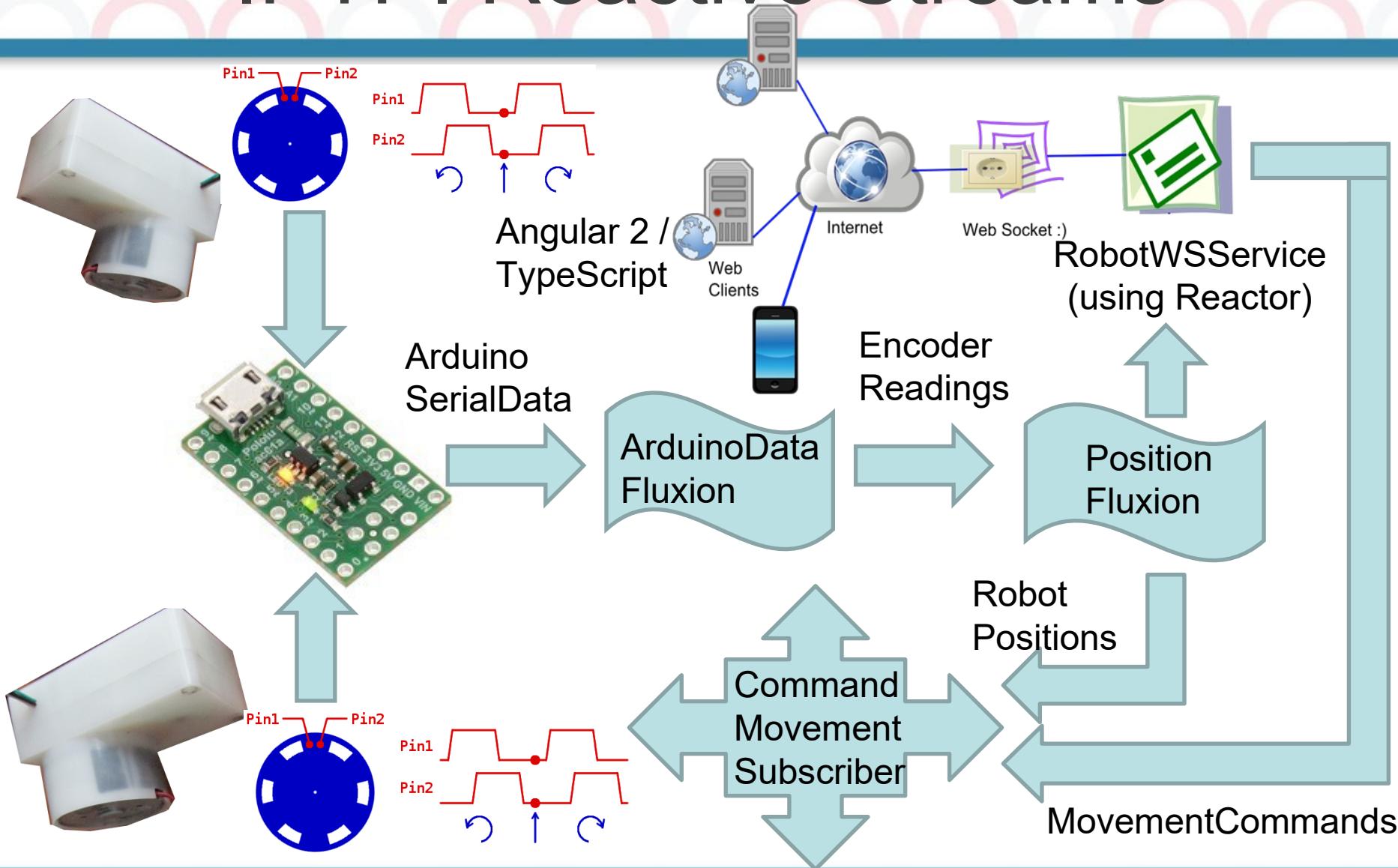
IR Optical Sensor QRD1114
Array (Line Following)



Adafruit 2.8" PiTFT -
Capacitive Touch Screen

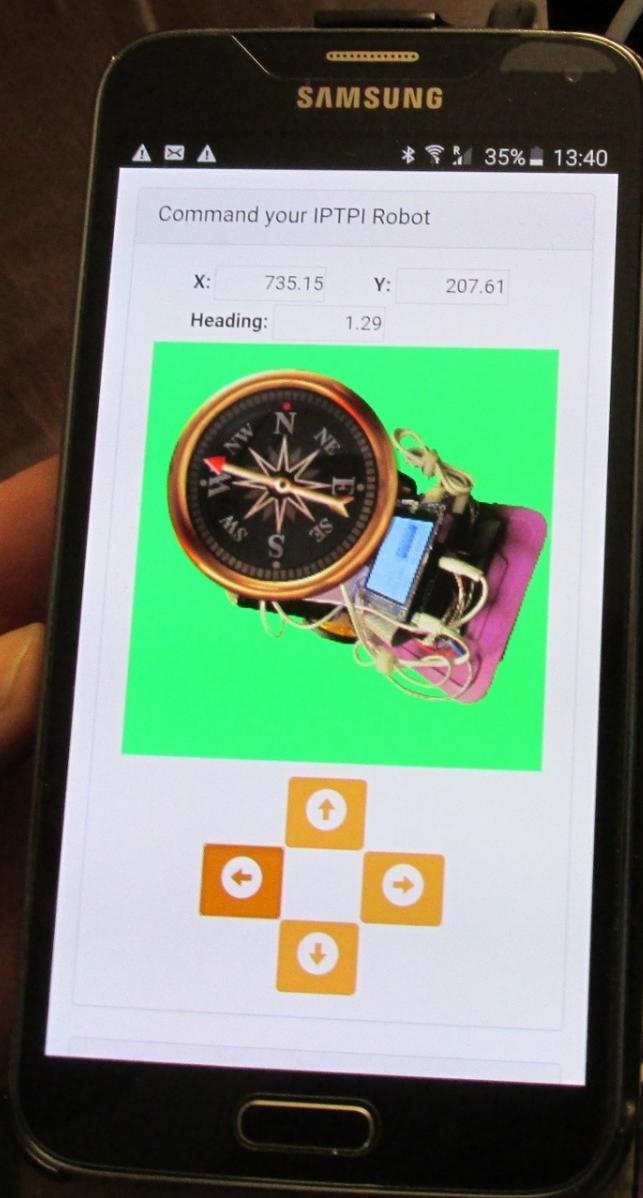


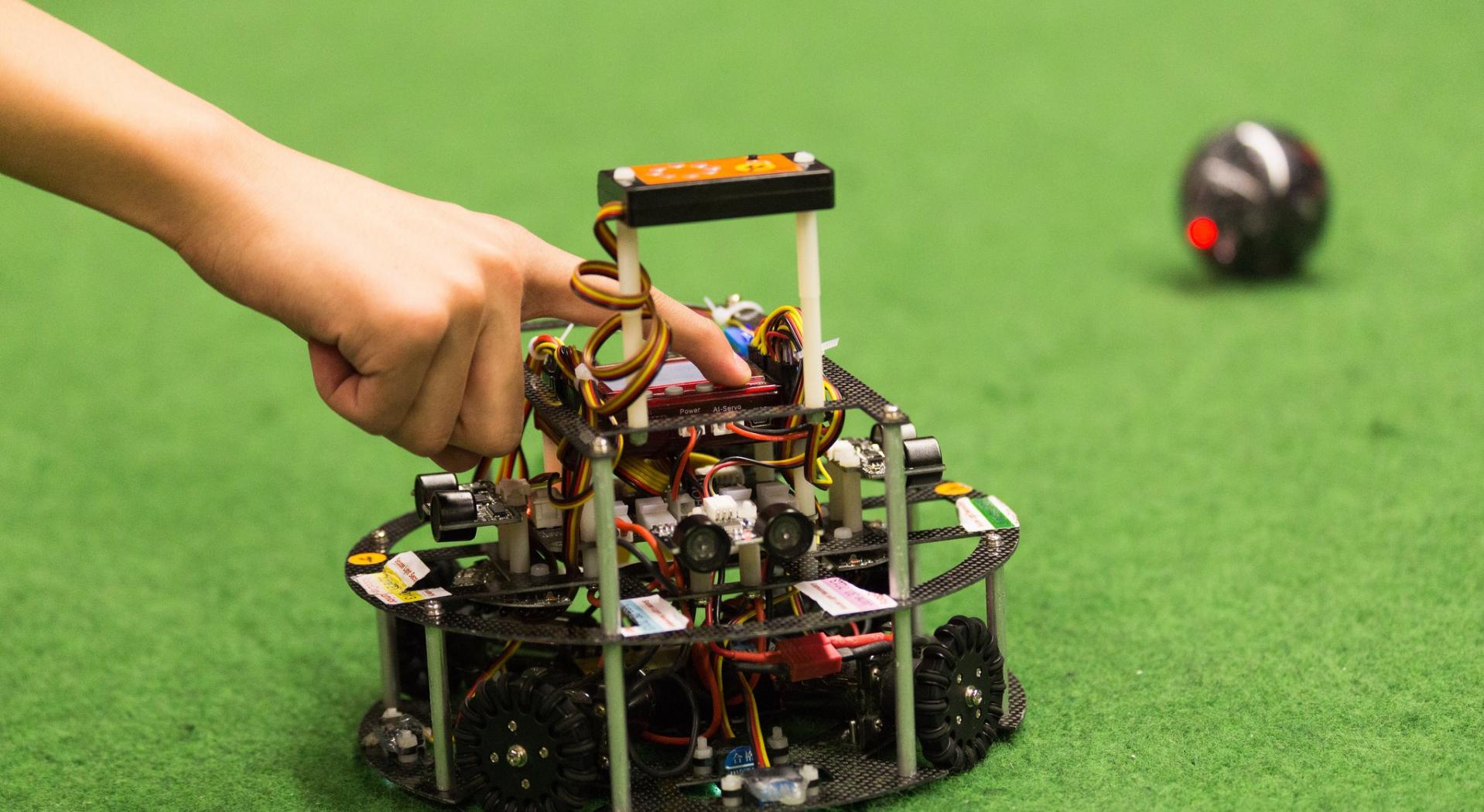
IPTPI Reactive Streams



<http://robolearn.org/>

Let's move!





RoboCup 2013 – Eindhoven by Albert van Breemen

[<https://www.flickr.com/photos/robocup2013/10151792836>]

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Допълнителни ресурси

Ресурси към курса „**Многоагентни системи и социална роботика**“ в GitHub:

<https://github.com/iproduct/course-social-robotics/wiki/Study-Materials>

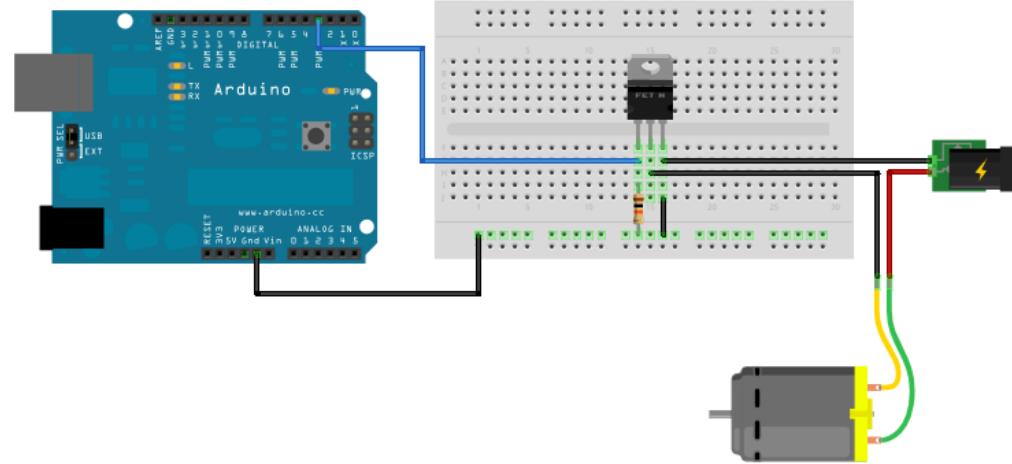
I2C, SPI, Serial комуникационни протоколи

- General-purpose input/output (GPIO) – allow digital (and Analog on Arduino) input and output
- Allows listeners to be registered for events connected with the signal
- Supports I²C (Inter-Integrated Circuit) – slower but uses only two pins for bidirectional data transmission with many devices (different addresses) - <https://en.wikipedia.org/wiki/I%C2%B2C>
- Serial Peripheral Interface (SPI) – much faster but requires additional wires - https://en.wikipedia.org/wiki/Serial_Peripheral_Interface
- Pulse-width modulation -
https://en.wikipedia.org/wiki/Pulse-width_modulation
- See for more details IPT repository @ GitHub:
<https://github.com/iproduct/course-social-robotics/wiki/Study-Materials>

Cocktail Maker: Make You Wish No Alcohol in FMI :)



- Assemble RPi2 / Arduino, low voltage pumps (3x), liquid flow-meters and hoses to a machine able to dose precisely 3 types of liquids
- Assemble breadboard with 3 MOSFET transistors (IRL 540N)



Референции (1)

1. Iliev, T., Ontology Based Multi-Agent Architecture for Adaptive Courseware Delivery, Int. Workshop on Interactive Computer-aided Learning ICL'2003, Villach, Austria, September 24-26, 2003
2. Iliev, T., E-ACADEMIA: Adaptive Courseware Authoring and Delivery Using Learning Support Agents, Int. Workshop on Interactive Computer-aided Learning ICL'2003, Villach, Austria, September 28-30, 2005.
3. Russell, S.; Norvig, P.: Artificial Intelligence: A Modern Approach, Prentice Hall, 1995 – Ch. 2:
<http://www.cs.berkeley.edu/~russell/aima1e/chapter02.pdf>

Референции (2)

4. Jennings, N.; Sycara, K.; Wooldridge, M.: A roadmap of agent research and development, *Autonomous Agents and Multi-Agent Systems*, 1 (1), 1998, pp.7-38
5. Weiss, G. (editor): *Multiagent Systems: A Modern Approach to Distributed Intelligence*, MIT Press, 2000
6. Brooks, R.: A robust layered control system for a mobile robot. *IEEE Journal of Robotics and Automation*, 2(1), 1986, pp. 14-23
7. Brooks, R., Intelligence without representation, *Artificial Intelligence*, 47, 1991, pp.139-159

Благодаря за вниманието!



Trayan Iliev

<http://robolearn.org/>

<https://github.com/iproduct>

<https://twitter.com/trayaniliev>

<https://www.facebook.com/IPT.EACAD>