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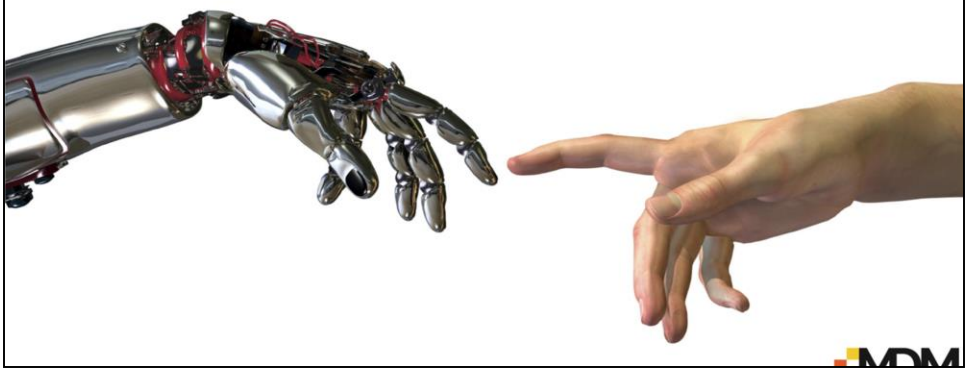
CPS813/DG8010 Human Robot Interaction

Introduction

Alex Ferworn



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Today

- The Course Management Form
- Concept: Robot
- Some History
- Concept: Defining Human-Robot Interaction
- Case study: Janken robots
- Practical Matters: Building a Tele-operated Robot

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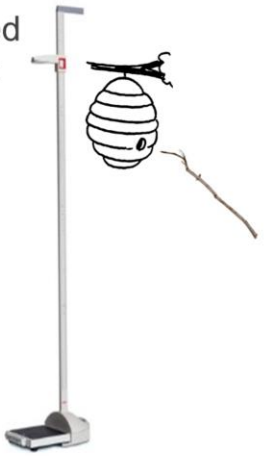
Course Management 1: Brief Description

- From the first time humanity picked up a stick and attempted to knock down some food from an unreachable location we have attempted to use technology to extend our influence in the world.
  - Why?



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Course Management 2: People

- Instructor
  - Alex Ferworn, aferworn@ryerson.ca
    - Prof. in Comp. Sci.
    - Area of Interest
      - Officially: computation public safety
      - Unofficially: Dogs and Robots, Anything that moves
    - Will tell you how your robots should work
- Graduate Teaching Assistant
  - Jimmy Tran, ENG209, q2tran@ryerson.ca
    - Doctoral Candidate in Comp. Sci.
    - Area of Interest
      - Computational public safety, machine vision, mechatronics…
      - Graduating
    - Will help you make your robots work.

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Course Management 3: Prerequisites and Reference Material

- Prerequisite:
  - CPS607 (undergraduate) or permission of the instructor
- Course materials:
  - Lecture: ~3 hours/week (KHE 121)
  - Labs: ~2 hours/week (ENG 273). No Lab week 1
  - Course Web Site:
    - http://www.scs.ryerson.ca/~aferworn/courses/CPS813/INDEX.HTML
  - Course Media:
    - Readings and other media will be provided.

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Course Management 4: Learning Outcomes

- Successful participants shall be able to
  - explain HRI principles, paradigms and metrics,
  - construct appropriate robots that can survive and function in a defined environment, and
  - employ robots to solve problems.

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Couse Management 5: Evaluation

Item	Value (%)	Date Due
ᵅ Mid-Term test (take home, 1 week to complete)	30	Given 13 March, Due 20 March
Ω Term Paper (Research paper, 10 pages minimum with citations from the literature)	30	Given 13 March, Due 3 April (last day of classes)
Lab 1: Multiple interface wired robot maze	10	Given Week 1, Due Week 3 (31 Jan)
Lab 2: The handicapped access door	10	Given Week 3, Due Week 5 (14 Feb)
Lab 3: Wireless robot soccer	10	Given Week 5, Due Week 7 (7 Mar)
Lab 4: Passing objects between robots	10	Given Week 7, Due Week 10 (25 Mar)
Final Exercise	30	Exam Week

ᵅ applies to a student registered in CPS813

Ω applies to a student registered in DG8010

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Course Management 6: Assignments and Labs

- Late assignments, tests and labs will not be accepted for marking.
- Labs and assignments must be submitted in the format detailed on the course web site.
  - If they are submitted in any other fashion they will be deemed garbage and will be filed in a wastebasket (will not be marked!)
- Labs will be marked by a TA.
  - The TA has the final say on the mark you receive...don't whine to the course instructors and be careful about whining to the TA.
- All labs and the final exercise must be completed in teams of three.
  - A team will share marks for each of the labs. Do not screw-over your team. If you wish to change teams you must receive instructor permission.
- All labs are performance-based.
  - the team will be expected to demonstrate a robot that does what is required when the lab is due. Normally, this is a lot of work.
  - If you do not wish to actually build robots, DROP THE COURSE BEFORE IT'S TOO LATE.

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Getting Started: Technology is Agnostic

The Good

The Bad

The Ugly

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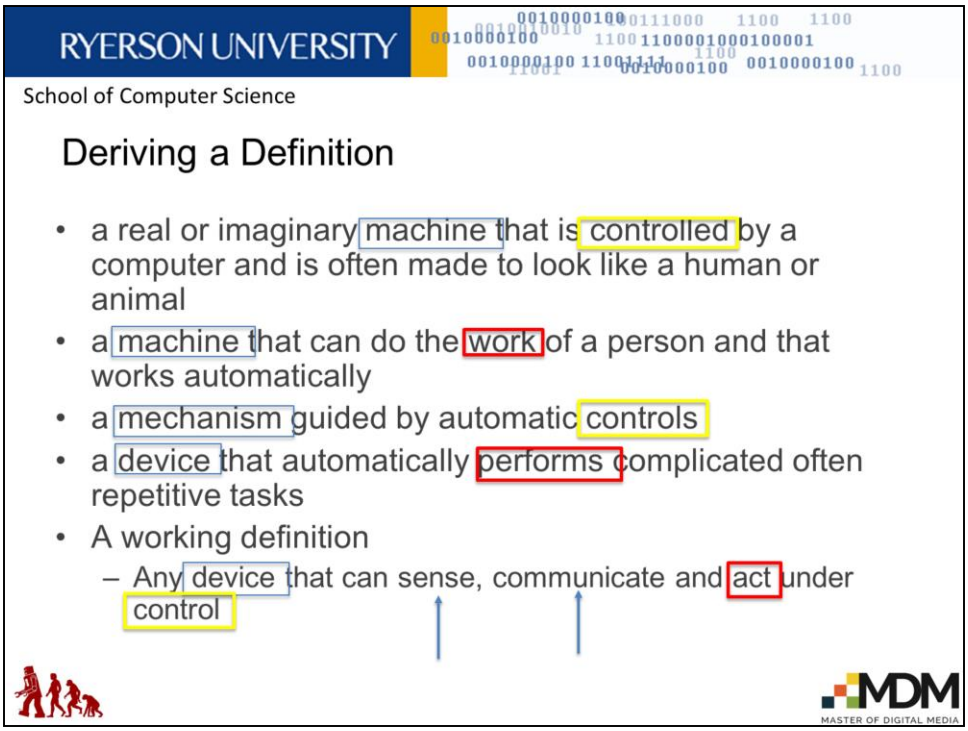
The basics: What is a robot?

- Term robot first used in "Rossumovi Univerzální Roboti" (R.U.R.) (1920) a science fiction play by the Czech writer Karel Čapek.
  - "Roboti"—compulsory laborers (slaves)



"Robot." *Merriam-Webster.com*. Merriam-Webster, n.d. Web. 18 Jan. 2016.

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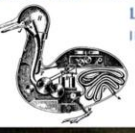
History: *Canard Digérateur*

- Mechanical duck invented by Jacques de Vaucanson,1739
- Not a robot but an "automaton"
- Appeared to eat kernels of grain, metabolize them and defecate.
- Actually grain was collected in a hidden pocket
- no actual digestion took place
  - Feces was pre-stored and "produced"
- Vaucanson hoped that a truly digesting automaton could one day be designed.
- Voltaire wrote "without...the duck of Vaucanson, you would have nothing to remind you of the glory of France."



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Canard Digérateur

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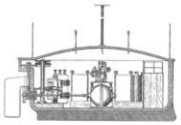
History: Nicola Tesla Remote Control Boat

- U.S. Patent 613,809
- Demonstrated at Madison Square Garden in 1898.
- Small, radio-transmitting control box, he was able to maneuver a tiny ship about a pool of water and even flash its running lights on and off,
- Tesla:
  - "…you see there the first of a race of robots, mechanical men which will do the laborious work of the human race." He even envisioned one or more operators simultaneously directing fifty or a hundred vehicles."



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History: Radio Remote Control Aircraft System

- Edward M. Sorensen US Patent 2490844 (1940)
- invention communicated with ground terminal via radio signals
  - Rate of climb/descent,
  - altitude,
  - banking,
  - direction,
  - rpm and other
- Enabled tele-operations outside of visual range

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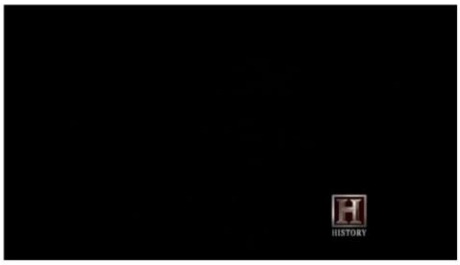
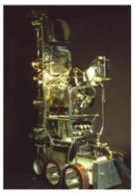
US Patent 2,490,844 filed in May of 1940; Patent 2,408,819 filed May 16, 1940 and patent 2,482,804 filed May 16, 1940

History: Three Mile Island Mitigation

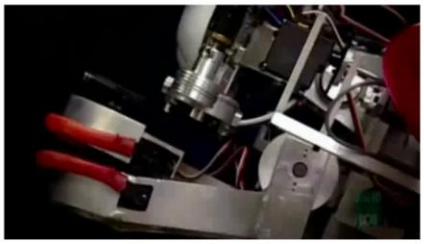
- nuclear meltdown March 28, 1979
  - reactor number 2
- Worst accident in U.S. commercial nuclear power plant history.
- What do you do with all the contaminated stuff?
  - Prof. Bill "Red" Whittaker and his Carnegie Melon Grad Students
  - "Remote Reconnaissance Vehicle" and the "Core Sampler", built in 1984 and 1985, respectively
  - sent into the flooded basement of the damaged reactor building and operated remotely.
    - cameras, lights, radiation detectors, vacuums, scoops, scrapers, drills and a high-pressure spray nozzle.
  - Surveyed the site, sent back information and drilled core samples to measure the radiation level of the basement walls.
  - robots worked for four years inside the reactor building and remain there to this day.

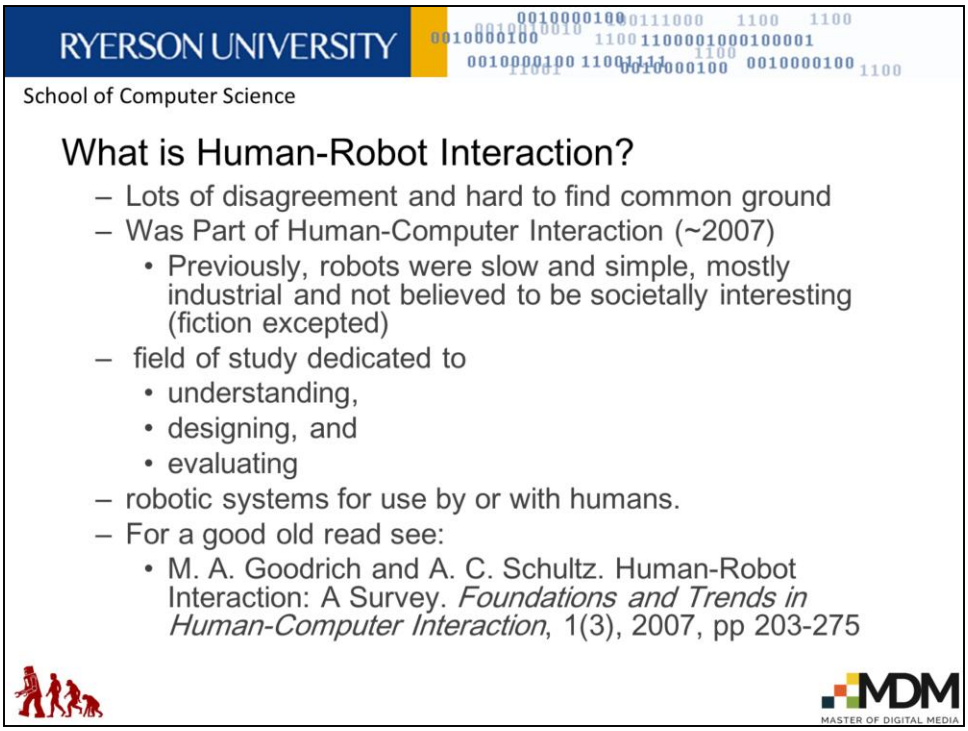




History: Kismet-Social Interaction Robot

- 1997 MIT AI Lab
- Creator: grad student Cynthia Breazeal (now Prof.)
- Kismet:
  - experiment in affective computing; a machine that can recognize and simulate emotions.
  - **Kismet** comes from a Turkish word meaning "fate" or sometimes "luck".



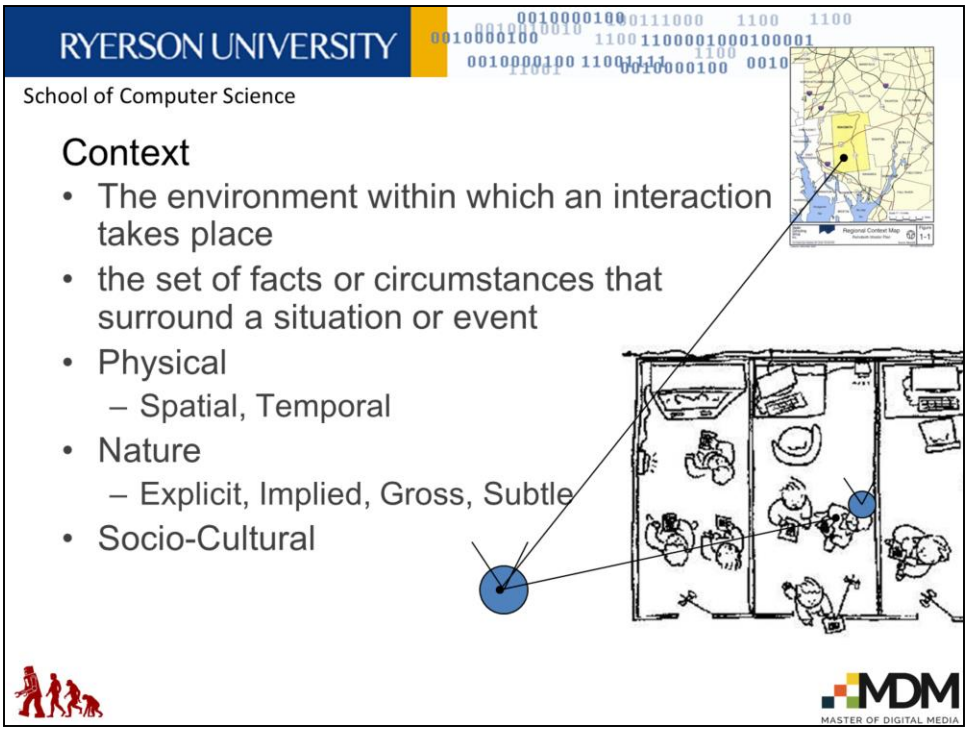


This research topic was traditionally part of the human-computer interaction field.

However, emphasis is put on the requirement of robustness with respect to all sources of noise present in "real-world" environments of (usually) mobile robots.

Some salient factors in interaction

- Context
- Intention
- Information
  - Presentation
  - Interpretation
- Communication
  - Formal
  - Informal
- Sensing
- Other



The words “red”, “read” and “read” when spoken and in written form provide confusion. We remove the confusion by speaking them in context or writing them in context. This does not always work. Ask a friend what the following means to them when you say it to them…”The books are red in this class.”

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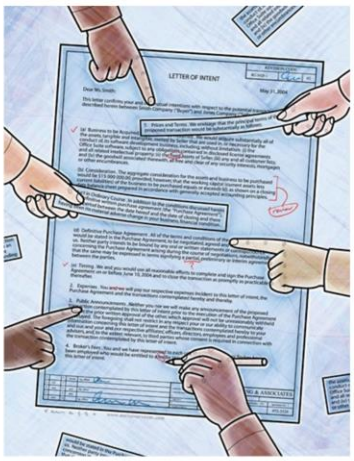
Intention

- What was/is intended
  - Through knowledge, observation, guesswork



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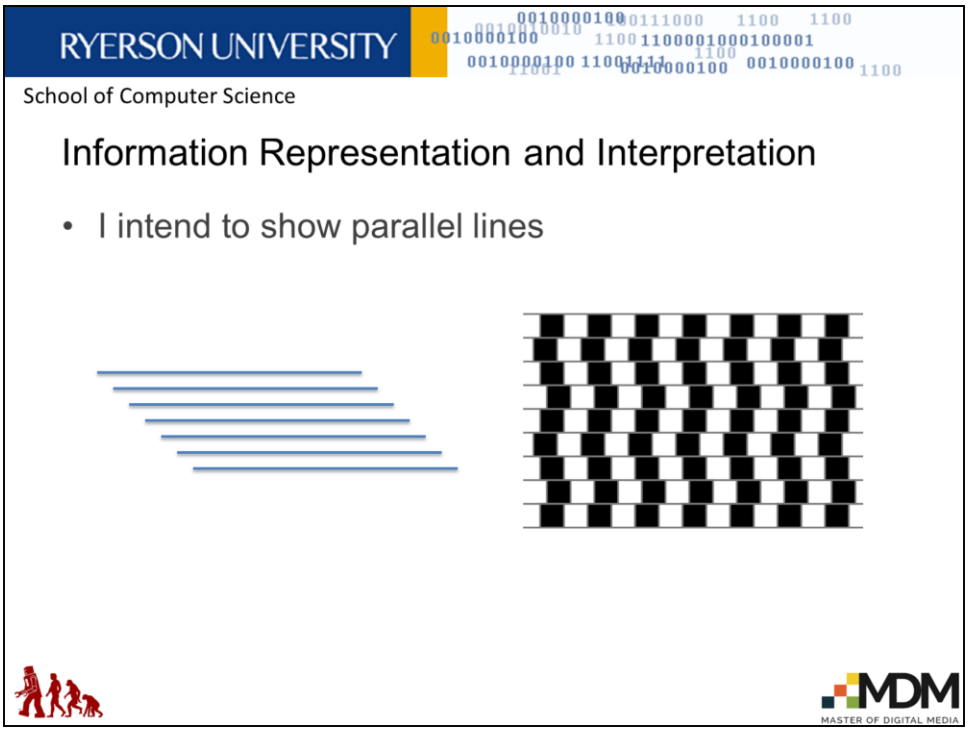
It is always difficult to gauge intent and we have many many thousands of years of cultural cues to provide us this information.

When I was a soldier one of my platoon commanders told me the following story. The old Canadian army field rations (Individual Ration Packs or IRPs) were issued for field operations when access to dining facilities were limited. The IRPs came with enough food for breakfast, lunch and dinner with a surprising array of desserts. One day a load of rations arrived at the platoon. Each IRP had the word “poison” prominently displayed on it in several places. An order arrived with the IRPs from higher command indicating that the soldiers were not to eat the tinned peaches in the IRPs as they were poisonous and this was the reason that the word “POISON” appeared on the packaging. The IRPs were fine to eat except for the peaches. Each platoon commander was to visually inspect each IRP, remove the peaches and send a message to higher command that this had been done before issuing the modified IRPs to the soldiers.

The platoon commander entered the tent with the platoon Sergeant in order to comply with the orders. As they were modifying the meals a few soldiers were watching them through the tent flap. The platoon commander asked the platoon Sergeant what he thought the soldiers were thinking. The platoon Sergeant responded: “When they get their IRPs they will be very hungry because we have delayed issuing them, they will read the word written on the package and think we are trying to kill them but, worst of all, we will have stolen their dessert.”



The **cafe wall illusion** is an optical illusion, first described by Doctor Richard Gregory. He observed this curious effect in the tiles of the wall of a caf׳ at the bottom of St Michael's Hill, Bristol.This optical illusion makes the parallel straight horizontal lines appear to be bent.

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Formal Communication (Context Independent)

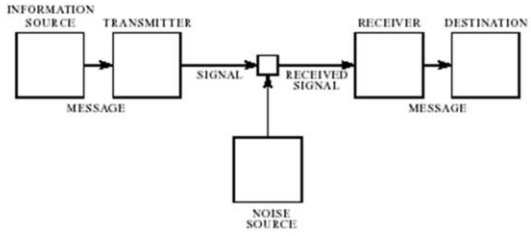
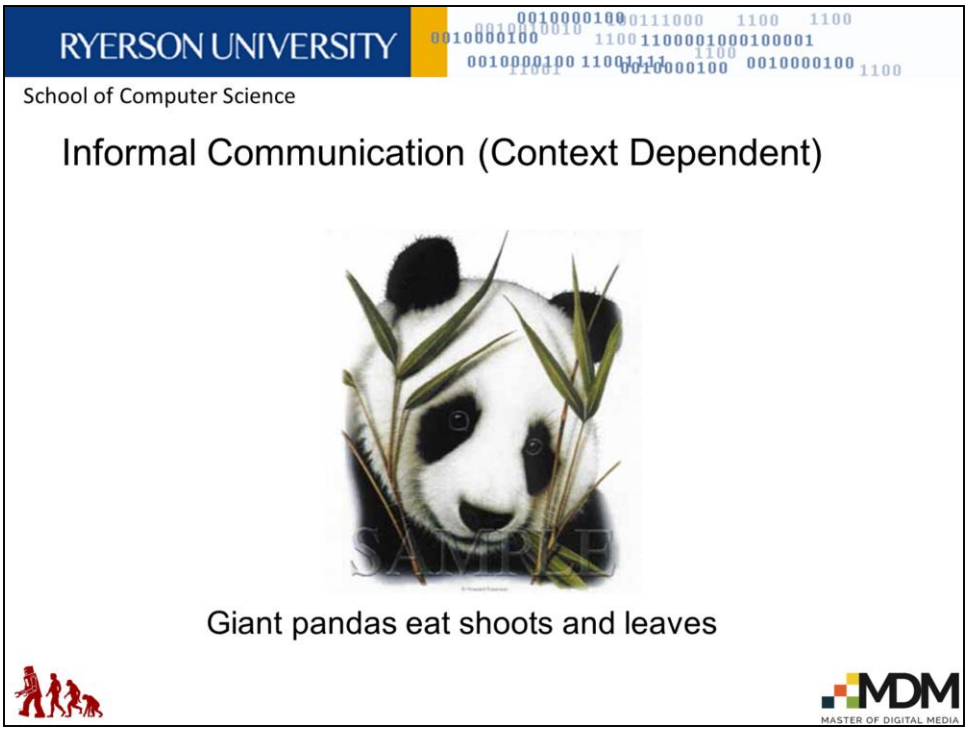


Fig. 1 — Schematic diagram of a general communication system.

Claude Shannon

"only infrmatn esentil to understandn mst b tranmitd."

In 1948 Claude Shannon published his landmark "*A Mathematical Theory of Communication"*. He begins this pioneering paper on information theory by observing that "the fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point." He then proceeds to so thoroughly establish the foundations of information theory that his framework and terminology remain standard. Information Theory regards information as only those symbols that are uncertain to the receiver. For years, people have sent telegraph messages, leaving out non-essential words such as "a" and "the." In the same vein, predictable symbols can be left out, like in the sentence, "only infrmatn esentil to understandn mst b tranmitd." Shannon made clear that uncertainty is the very commodity of communication. The amount of information, or uncertainty, output by an information source is a measure of its entropy.



A giant panda goes into one of those expensive and pretentious restaurants serving French/Asian fusion cuisine and takes a table for one. The surprised waiter for that table explains unctuously that his name is Marcel, he will be your server tonight, and we 'ave a number of specials (he is French), etc., etc. The panda listens impassively to the list of $27 chili-pepper encrusted swordfish specials and so on, and then orders a delicately flavored dish of young bamboo tips and mixed greenery served with steamed jasmine rice. On finishing his meal, the panda gets up, reaches into his fur for a handgun, brings down the waiter with one shot, and calmly heads for the door.The head waiter is near the door and exclaims in shock, "Oh, monsieur, what 'ave you done? You 'ave killed Marcel! Why 'ave you done zis, monsieur? You 'ad some problem? Ze service was not acceptable? "The panda scowls at him and says, "I'm a fucking panda. Go look it up." He stalks out into the night.The baffled staff huddle round the compact encyclopedic dictionary that they keep on the premises, and turning to **Panda, giant**, they read this:

Panda, giant. Large bear-like animal, *Ailuropoda melanoleuca*, with distinctive black and white markings, related to raccoon family. Rare; found

only in bamboo forests of Tibet and western China. Eats shoots and leaves.

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Sensing

- Sampling input from the environment
  - Conversion
  - Representation

Input

Conversion

Representation

…100101…

It's not the input that is the problem. Usually you need to do something with the input.

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The New Idea Problem

- How do you explain something new when all you have are words about something else?

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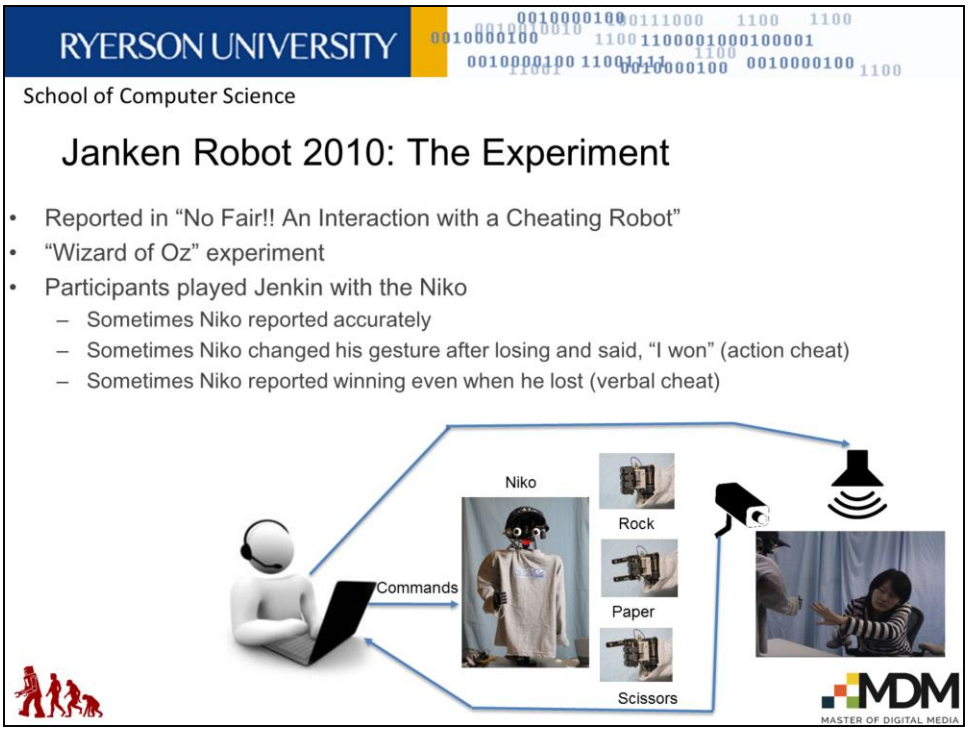
A bicycle seat is also know as a “saddle” because the people who designed it only had a horse for a model. The prototype bicycle was something called a “hobby horse”, it had a wooden seat and wheels and was pushed by the rider by a running motion of the legs on the ground. So much for extending an idea too far.

It's the Interaction

- Useful interaction implies,
  - 1 or more humans, and
  - 1 or more robots
- And they must be doing something together.

Case Study: Janken

- A game derived from a Chinese zero-sum hand game
  - Players show hand gestures to each other.
  - Each gesture defeats or is defeated by another hand gesture
- Mentioned in the Han dynasty (206 BC–220 AD)
- Introduced to Japan in the 17th century where it became known as “Jenken”
- Rock, Paper, Scissors



Short, E., Hart, J., Vu, M., & Scassellati, B. (2010, March). No fair!! an interaction with a cheating robot. In *Human-Robot Interaction (HRI), 2010 5th ACM/IEEE International Conference on* (pp. 219-226). IEEE.

Janken Robot 2010: What people reported

- Participants who received **verbal cheat** group were circumspect about what was happening with Niko:
  - "Sometimes I won but he said he did... did he just misrecognize my symbol?"
  - "Sometimes he would pronounce the results of the match wrong [...] but he would never make a mistake in my favor."
- Participants in the **action cheat** group were often quite certain of what the robot was doing:
  - "He cheats! Would change his sign after he saw mine!"
  - "It was unusual that it KNEW how to cheat. I did not expect that at all."
- Anthropomorphize
  - When one speaks of a thing or animal as if it were human.
  - examples:
    - The Easter Bunny is an anthropomorphized rabbit.
    - Niko becomes an anthropomorphized human.

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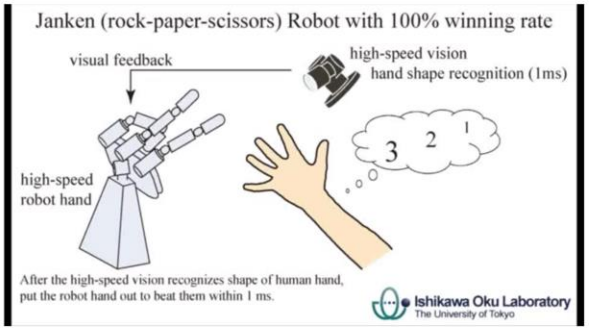
Janken Robot 2013

- Reported in "Japanese Rock-Paper-Scissors Robot Never Loses"



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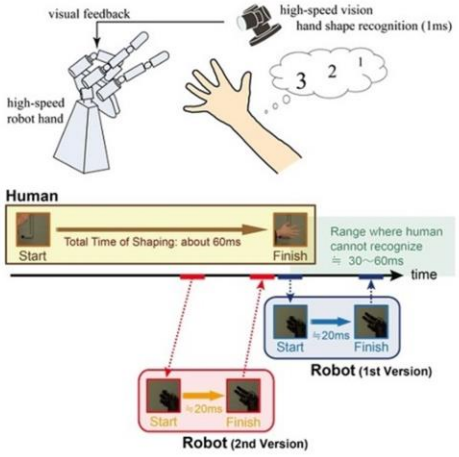
"Japanese Rock-Paper-Scissors Robot Never Loses"

BY DAMON POETER NOVEMBER 5, 2013 02:21PM EST found at http://www.pcmag.com/article2/0,2817,2426780,00.asp accessed on 18 Jan 2015

Janken Robot 2013

- Take advantage of increases in speed of computation and actuation



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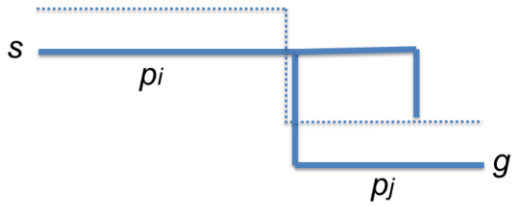
Lab 1: What is a maze

- Let M represent a connected set of paths p_n *where* $n \in +Z$
- Let s represent a starting location on path p_i
- Let g represent a goal location on path p_j
- M is a maze if $i == j$



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Lab 1: Autonomous Robot Strategies for negotiating a Maze

- Random Mouse Algorithm
  - Start at *s* on p_0, follow p_i until there is a junction, make random turn. Repeat until *g* is reached. Stop.
- Wall following
  - Start at *s*, place sensor on a wall, keep going (do not lose wall contact). Stop when *g* is reached
- Jon Pledge Algorithm
  - Start at *s,* place sensor on a wall, keep going
  - Track direction, turns bring you back to original direction, place sensor on other wall. Stop when *g* is reached
- Many others…see https://en.wikipedia.org/wiki/Maze_solving_algorithm

This ain't 607

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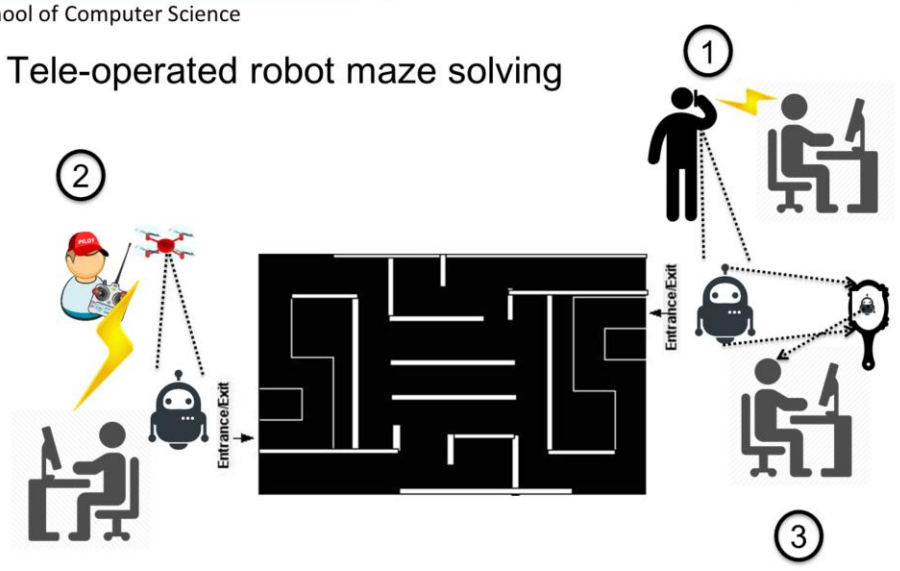
Tele-operated robot maze solving



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Things to do

- Check out the web site
- Form groups of 2 or 3
- Create a wired mobile robot
- Practice

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