The Transformative Force of Robotics & Vision in Industry & Society

Peter Corke
What is a robot?
Perhaps super-intelligent machines
or perhaps not…
Robotics put us “inside” people
Robots move things from A to B
Robots move themselves and things from A to B
Robots move themselves and BIG things from A to B
Where are all the robots?
The sense of sight

• Vision is our most impressive sense

• We use it to help with almost everything we do
  ➡️ we can see close, and we can see far
  ➡️ we see shape, texture, color and movement
Human vision data sheet

120Mpixel
20bit dynamic range
3 colors

Vision engine
- $3 \times 10^{10}$ neurons
- 500g
- 6W

3 gyroscopes
2 accelerometers

3 × 2

MATLAB EXPO 2016
Average annual rates of population change show that Africa has experienced considerably faster growth than any other major area, for most of the 1950-2000 period (figure 2). Growth rates reached a higher peak in Africa (2.86 per cent) than anywhere else—in the early 1980s, at least 15 years after growth had begun to decline in every other major area. The projection for Africa, consequently, shows growth declining belatedly, though nevertheless following a downward path similar to that in other major areas. Europe is at the other end of the spectrum, with growth rates having just turned negative and continuing to fall up to 2050.

Though growth rates are at different levels, their decline is projected to be similar across major areas. The more developed regions show slightly slower decline in growth rates than the less developed regions, mainly because of international migration. If net migration were set to zero, the lines would be more nearly parallel. International migration is particularly important for Northern America (i.e., the United States and Canada), accounting for 0.5 percentage points of the growth rate for 2000-2050. For Europe, migration boosts the growth rate by 0.1-0.2 points, and for Oceania by around 0.25 points. (For Australia alone, migration adds about twice that to the growth rate.)

Growth rate declines are parallel (international migration aside) largely because assumptions about fertility change are similar. Figure 3 shows the substantial gap that currently exists—but is projected to narrow—between total fertility in Africa and total fertility in every other major area. A gap in fertility levels also exists between the other major areas of the world, but by 2050 levels are expected to converge in a narrow band between 1.84 and 1.92 children per woman. Europe will take the longest to enter this band, and will do so through rising fertility, in contrast to falling fertility in other major areas.

Mortality exerts some additional influence on the growth rate. Across major areas, its effect on growth largely counteracts that of fertility, since where fertility is higher, mortality also tends to be higher. Over time, life expectancy is expected to rise fairly smoothly.
Graphs of our times

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World population

- more food
- more transportation
- more resources (energy, metals, water)
World population

- more food
- more transportation
- more resources (energy, metals, water)
70% increase in food production by 2050
E30
MINIMUM
30%
ETHANOL

E50
MINIMUM
50%
ETHANOL

E85
MINIMUM
70%
ETHANOL

clean power with
30
FLEX-FUEL
3 % ethanol for flex-fuel vehicles

50%
ethanol for flex-fuel vehicles

85%
ethanol for flex-fuel vehicles
Agricultural revolution(s)

better genetics  mechanisation  herb/pesticides
Agricultural revolution(s)
SOIL COMPACTION LEADS TO POOR DRAINAGE, SURFACE RUNOFF, AND STUNTED ROOT GROWTH

TIMELINE

SOIL STRESS AT 0.4M DEPTH - PRESSURE (BAR)

<table>
<thead>
<tr>
<th>Year</th>
<th>Soil Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>0.5</td>
</tr>
<tr>
<td>1940</td>
<td>1.0</td>
</tr>
<tr>
<td>1980</td>
<td>1.5</td>
</tr>
<tr>
<td>2010</td>
<td>2.0</td>
</tr>
<tr>
<td>2012</td>
<td>2.5</td>
</tr>
</tbody>
</table>

VEHICLES HAVE BECOME PROGRESSIVELY LARGER TO OPTIMISE THE INDIVIDUAL FARMER'S PRODUCTIVITY
The weeds are fighting back

herbicide resistant weeds are on the rise
The median age of farmers in 2006 was 52 years, much higher than the median age of 40 years in all other occupations. - Australian Bureau of Statistics, Australian Social Trends, March 2009, Catalogue No. 4102.0

Farmer population by age group:

- Australia 2020 Summit, The Future of Rural and Regional Australia, April 2008
just like we used to do, and did for thousands of years...
Graphs of our times

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Dependency ratio

- dependents / workers
- low is good
- high means we need more work per person (greater productivity)
Population pyramids

Japan  Germany  USA  China  India

populationpyramid.net
Health care need

Figure 10.3: Elective admissions involving surgery, by sex and age group, all hospitals, 2010–11

Note: See boxes 10.1, 10.2 and 10.3 for notes on definitions of elective surgery, data limitations and methods.
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Environmental change
Three laws of asset management

- Inspect
- Inspect
- Inspect
ARGO floats

3739 Floats
30-Oct-2016
CH4 from water storages
1.4 Color Analysis

Automatic color description

In order to perform a better analysis and color thresholding of the images, the amount of color in the HSV (hue, saturation, value) color space is determined in each image. It was found a close relationship between the amounts of color, e.g., blue, yellow, brown and the color level in which each animal appears in the image. This value is used to determine the appropriate color level for thresholding described in the next section.

The following figure shows the result of applying the operations described above in a sample image. We use a disk-shape structuring element of radius 25 pixels.
The future
Robotics is emerging as the next generation of high technology business:

“Robotics, $10T’s of new business”
—McKinsey report on disruptive technologies

http://www.mckinsey.com/insights/business_technology/disruptive_technologies
Smart co-workers that
• understand the task you are doing
• anticipate what comes next
• Share the physical load
• Knowing where everything and everybody is
• Enhanced safety
• Safe transport of material
• Smart machines as co-workers
Inspecting our growing and ageing infrastructure base
Improved productivity for surgery and handling patients, meals, drugs, linen, samples etc. Smart co-workers understand the task you are doing and anticipate what comes next.
Robots to enhance agricultural productivity
• sustainable production of more food
• with less land, lower inputs and fewer farmers
• treating individual plants
Take home messages

• Computers move information, robots move stuff from A to B
• Robots can work 24/7 and are very precise
  • increase productivity
• Robots don’t look like what you might think
• The applications are almost unlimited
• Robots are getting better and better (quickly)
• In the near future robots will be as “normal” as a smart phone