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# Educational robotics critical for the future of Linux

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# Abstract

Jobs are being automated. Students aren't getting sufficient STEM literacy. Many lack the problem solving skills to be effective at driving that automation, rather than being a victim. Educational robotics is a compelling and effective way to reverse that trend. Lower-cost, easier-to-use and inherently collaborative platforms can help ensure these programs expose all participants to programming and electronics. Computing is inextricably a human endeavor to get machines to serve our will. Linux provides opportunities to teach critical concepts including how to collaborate, aide understanding with instrumentation, simplify various tasks with existing solutions and expose students to the possibilities of their endeavors. Not only do these students need Linux, but Linux needs them and the solutions to the challenges they'll tackle for the next generation.



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We need jobs for youth

## “Let them flip burgers”

- If they don't have something productive to do,
  - ➡ then they are going to mooch off you
- Robots took the manufacturing sector jobs
  - ➡ and the service sector is next



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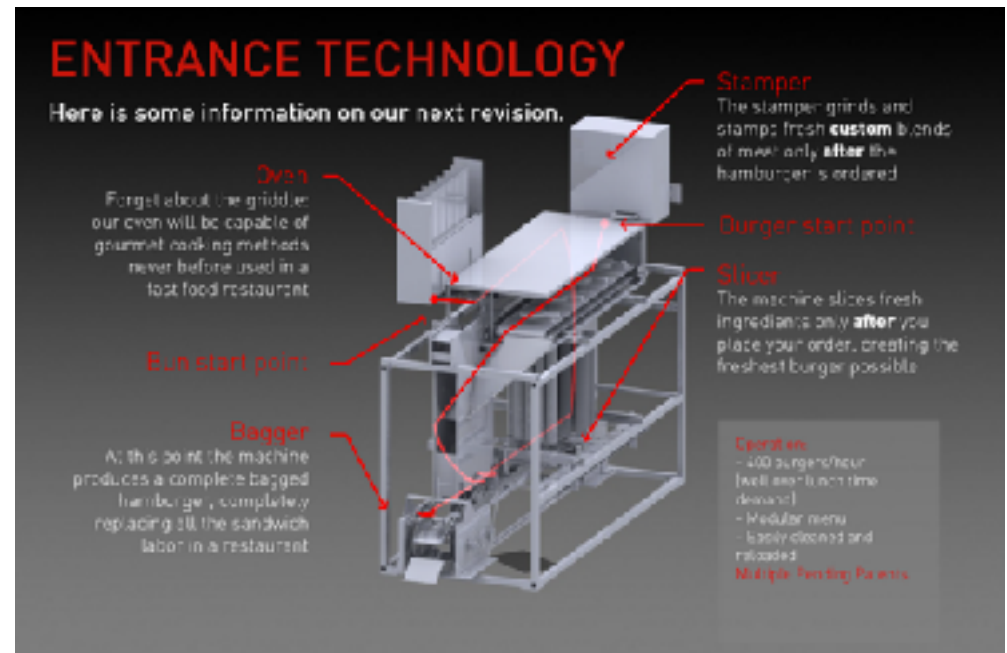


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## “Sorry, our burgers are flipped by robots”

Images borrowed from <http://www.businessinsider.com/momentum-machines-is-hiring-2016-6>





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# So, from where are the jobs coming going to come?

[https://en.wikipedia.org/wiki/Population\\_growth](https://en.wikipedia.org/wiki/Population_growth)

Growth rates of the world's most populous countries

Rank ⇅	Country ⇅	Population 2010 ⇅	Population 1990 ⇅	Growth (%) 1990–2010 ⇅
	World	6,895,889,000	5,306,425,000	30.0%
1	China	1,341,335,000	1,145,195,000	17.1%
2	India	1,224,814,000	873,785,000	40.2%
3	United States	310,384,000	253,339,000	22.5%
4	Indonesia	239,871,000	184,346,000	30.1%
5	Brazil	194,946,000	149,650,000	30.3%
6	Pakistan	173,598,000	111,845,000	55.3%
7	Nigeria	158,423,000	97,552,000	62.4%
8	Bangladesh	148,692,000	105,256,000	41.3%
9	Russia	142,958,000	148,244,000	-3.6%
10	Japan	128,057,000	122,251,000	4.7%

<https://www.bls.gov/ooh/fastest-growing.htm>

OCCUPATION ⇅	GROWTH RATE, 2014-24
<a href="#">Wind turbine service technicians</a>	108%
<a href="#">Occupational therapy assistants</a>	41%
<a href="#">Physical therapist assistants</a>	41%
<a href="#">Physical therapist aides</a>	39%
<a href="#">Home health aides</a>	38%
<a href="#">Commercial divers</a>	37%
<a href="#">Nurse practitioners</a>	37%
<a href="#">Physical therapists</a>	34%
<a href="#">Statisticians</a>	37%
<a href="#">Ambulance drivers and attendants, except emergency medical technicians</a>	31%
<a href="#">Occupational therapy aides</a>	31%
<a href="#">Physician assistants</a>	30%
<a href="#">Operations research analysts</a>	30%
<a href="#">Personal financial advisors</a>	30%



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<https://www.bls.gov/ooh/most-new-jobs.htm>

OCCUPATION	NUMBER OF NEW JOBS (PROJECTED), 2014-24	2015 MEDIAN PAY
<a href="#">Personal care aides</a>	458,100	\$20,980 per year
<a href="#">Registered nurses</a>	439,300	\$67,400 per year
<a href="#">Home health aides</a>	348,400	\$21,920 per year
<a href="#">Combined food preparation and serving workers, including fast food</a>	343,500	\$18,910 per year
<a href="#">Retail salespersons</a>	314,200	\$21,780 per year
<a href="#">Nursing assistants</a>	262,000	\$25,710 per year
<a href="#">Customer service representatives</a>	252,800	\$31,720 per year
<a href="#">Cooks, restaurant</a>	159,900	\$23,100 per year
<a href="#">General and operations managers</a>	151,100	\$97,730 per year
<a href="#">Construction laborers</a>	147,400	\$31,910 per year
<a href="#">Accountants and auditors</a>	142,400	\$67,190 per year
<a href="#">Medical assistants</a>	138,900	\$30,590 per year
<a href="#">Janitors and cleaners, except maids and housekeeping cleaners</a>	135,300	\$23,440 per year
<a href="#">Software developers, applications</a>	135,300	\$96,260 per year



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We need STEM education for youth

**“My job is secure,  
the world will always need embedded Linux experts”**

- Just because we are scarce, doesn't mean the demand is high
- Why should the public *know* they should care about
  - free and open source (as in any type of visibility or control),
  - privacy and security (in the broadest embedded system sense) or
  - their ability to impact the future of technology?
- The “Gandalf Effect”
  - ➡ He was probably pretty lonely



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We need hardware

**“I have plenty of challenging algorithms to solve  
without needing to touch hardware”**

- OK, maybe that's not *this* Linux audience
- Ask yourself, “What is the likely impact of what I’m creating?”
- Today’s hardware is an impediment to productivity
- I’ll say it again, atoms are valuable and electrons are cheap





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Technology looks different to youth

**“A Z80, EPROM and a speaker  
were all I needed to get excited about programming”**

- Kids are growing up where “Halo” is their idea of “Hello World”
- Arduino-style blinky-LED is cool, but is it empowering enough?
- Robots can be
  - ➡ different enough from their experience today to be exciting,
  - ➡ simple enough to be accessible and
  - ➡ complex enough to invest a lifetime of exploration



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We need community

“That’s cool, but I don’t really need  
**Linux *in* the robots”**

- Consider why LEGO MINDSTORMS added Linux
- Eyes on the security, network and otherwise
- Support for configuration management across hundreds of units
- Linux enables us to go in and understand what is going on in the robot



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## Relevant projects to Linux

- ROS - Robot Operating System - messaging layer, hardware abstractions
- Dronecode, ArduPilot, Paparazzi UAV, others - Auto-pilots, flight planners
- [ev3dev.org](http://ev3dev.org) and [lejos.org](http://lejos.org) extend LEGO MINDSTORMS EV3 open source
- OpenCV - vision
- IIO - a likely way to get to the interfaces
- BeagleBone Blue and libroboticscape



## libroboticscape - C functions

<http://www.strawsondesign.com/#!/manual-install>

- **Init/Cleanup**

`int initialize_cape();`

`int cleanup_cape();`

`int kill_robot();`

- **Flow state**

`rc_state_t rc_get_state();`

`int rc_set_state(rc_state_t);`

`int rc_print_state();`

- **Buttons**

`int rc_set_pause_pressed_func(void_fp);`

`int rc_set_pause_released_func(void_fp);`

`int rc_set_mode_pressed_func(void_fp);`

`int rc_set_mode_released_func(void_fp);`

`rc_button_state_t rc_get_pause_button();`

`rc_button_state_t rc_get_mode_button();`



## libroboticscape - C functions

<http://www.strawsondesign.com/#!/manual-install>

- **DC motors**

```
int rc_set_motor(int motor, float duty);  
int rc_set_motor_all(float duty);  
int rc_set_motor_free_spin(int motor);  
int rc_set_motor_free_spin_all();  
int rc_set_motor_brake(int motor);  
int rc_set_motor_brake_all();
```

- **Encoders**

```
int rc_get_encoder_pos(int ch);  
int rc_set_encoder_pos(int ch, int value);
```

- **Servos and ESCs**

```
int rc_send_servo_pulse_us(int ch, int us);  
int rc_send_servo_pulse_normalized(int ch, float input);  
int rc_send_esc_pulse_normalized(int ch, float input);  
int rc_send_one_shot_pulse_normalized(int ch, float input);
```



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## libroboticscape - example utilities

<http://www.strawsondesign.com/#!manual-install>

- kill\_robot
- rc\_bare\_minimum
- rc\_blink
- rc\_test\_buttons
- rc\_test\_motors
- rc\_test\_encoders
- rc\_test\_servos
- rc\_test\_dsm
- rc\_bind\_dsm
- rc\_calibrate\_dsm
- rc\_test\_imu
- rc\_test\_dmp
- rc\_test\_barometer





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We need Linux education

**“These microcontroller hacks  
are going to are going to screw up the kernel”**

- OK, *this* audience the lieutenant process prevents that, *mostly*
- Seriously, they need help
  - IIO needs more sensors
  - Kernel drivers (*falsey?*) seen as adding too much latency
  - Even Linux Foundation projects are using other kernels