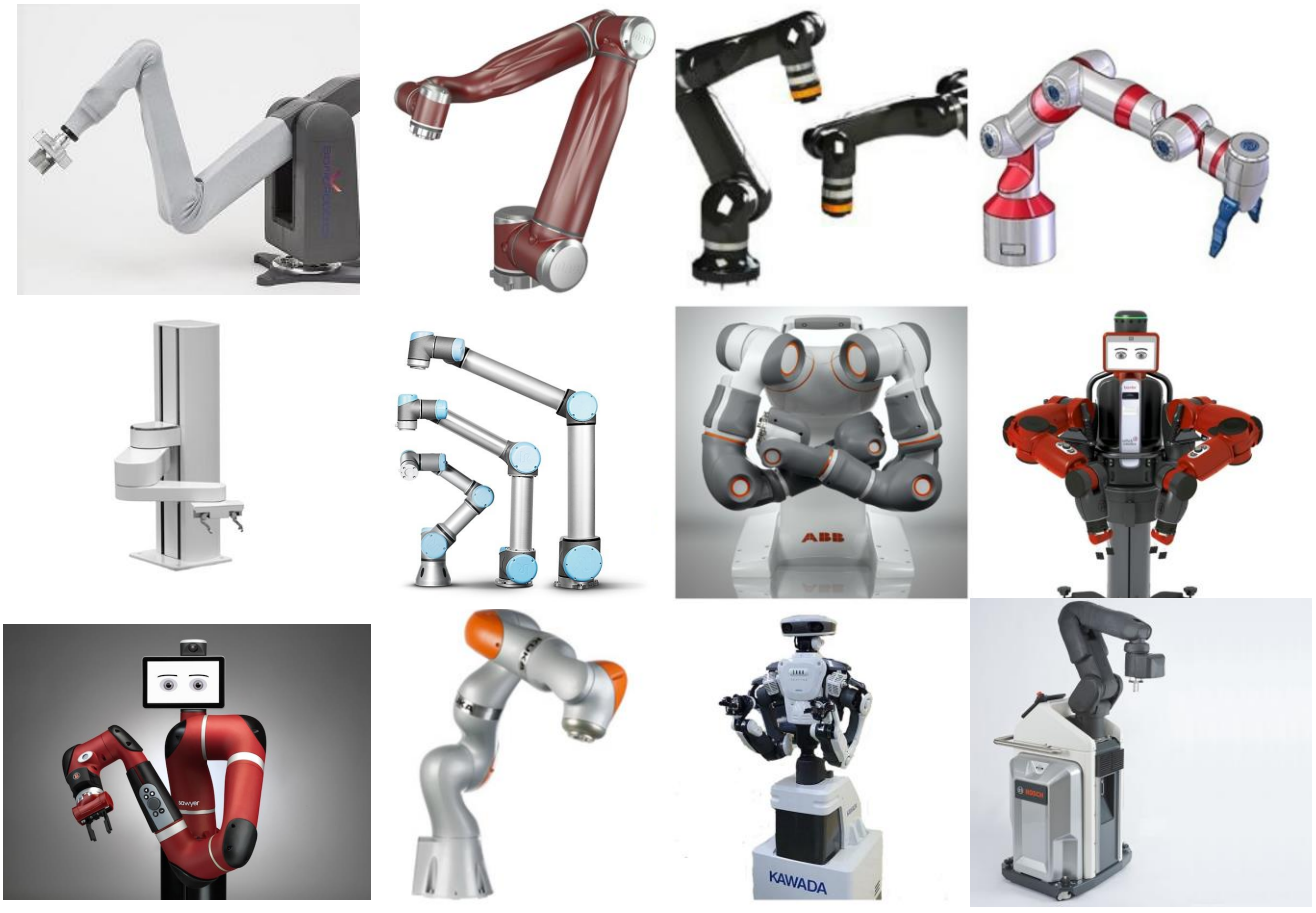
ROBOTIQ

COLLABORATIVE ROBOT EBOOK

– FOURTH EDITION –

PRob – ROBERTA – SPEEDY-10 – BAXTER – SAWYER
ABB YUMI – KUKA IIWA – UNIVERSAL ROBOTS
PF 400 – NEXTAGE – APAS – BIOROB



robotiq.com

TABLE OF CONTENTS

INTRODUCTION

A new kind of robot has made its way in the industry changing all the preconceived thoughts about robotics. Their main feature is the ability to work safely alongside humans. Therefore, human-robot collaboration is the new wanted characteristic for robots. There is a lot of talk about them on the web, but what are they really?

Up to now, robots have always been big, strong and robust devices that work on specific tasks designed for them. They were surrounded by fences and guards for safety purposes. Their bright color was used to warn the surrounding workers about the danger they represented. A lot of programming skills were also necessary to set up these robots.

Collaborative robots are in fact the opposite of the industrial robots which came before them. They are compact, lightweight and dexterous. The new technologies allow them to have up to 7 degrees-of-freedom. It is one more than necessary, but it allows for more configuration of the arm.

Moreover, these robots have integrated sensors, passive compliance or overcurrent detection as safety features. The integrated sensors will feel external forces and, if this force is too high, the robot will stop its movement. Passive compliance is made by mechanical components. If an external force acts on a joint, this joint will submit itself to this force. So, in case of a collision, the joint will move in the opposite direction avoiding any injury. Also, an overcurrent can be detected when a collision occurs. This is another safety feature because the software can generate a security stop when it detects a current spike.

Some collaborative robots can be taught very easily by demonstration instead of using a deep knowledge of programming. Thus, they can be implemented very easily and brought on-line fast since no big setup is needed (no fences or guards). Also, they are less expensive than the big robots used in hard automation. The majority of collaborative robots can also be moved around the factory floor with ease in order to make it do another task at another station.

Being more dexterous and flexible, they can perform more tasks and even do whatever a human can do. They also now have more soothing colors inspiring confidence in the humans who work with them.

In brief, collaborative robots are the new ideal co-worker. Since this subject really interests the robotic community, we decided to do a second updated edition of our previous eBook on collaborative robots.

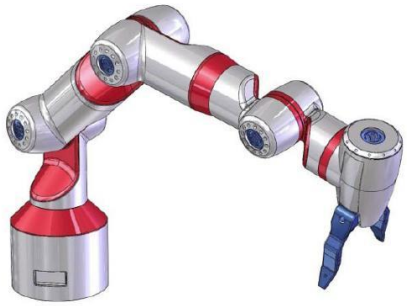
Discover all kinds of collaborative robots: from Universal Robots to Roberta from Gomtec. Moreover, a technical comparative chart of the robots is included to help you make your choice among this new kind of robot.

N.B. Robot manufacturers claim their robots to be safe according to the safety requirements for industrial robots stipulated by the ISO standard 10218. Even by assuming that the robot is safe, a risk assessment is necessary to make sure the robot's environment is fully secured.

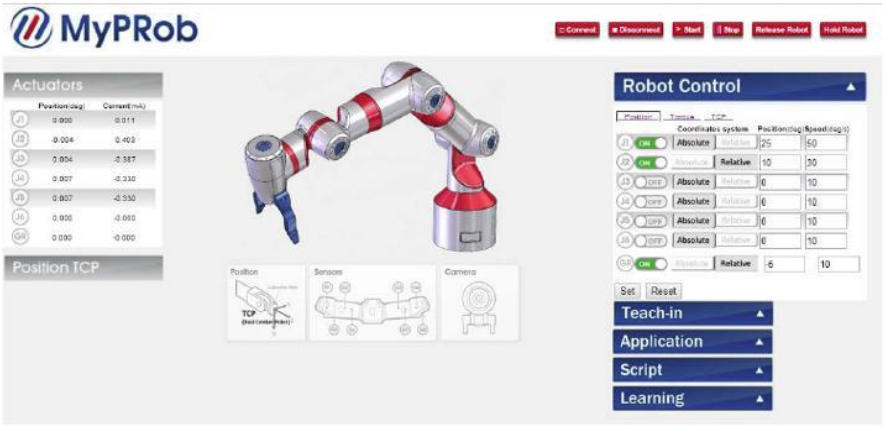
THE VERSATILE LIGHT-WEIGHT ROBOT ARM

PRob 1R FROM F&P PERSONAL ROBOTICS

The PRob 1R collaborative robot was developed to make customers' lives easier. In fact, when most people think about robotics, they are usually afraid of programming complex routines with a non-intuitive platform. This is what F & P Personal Robotics focuses on with its newest platform.

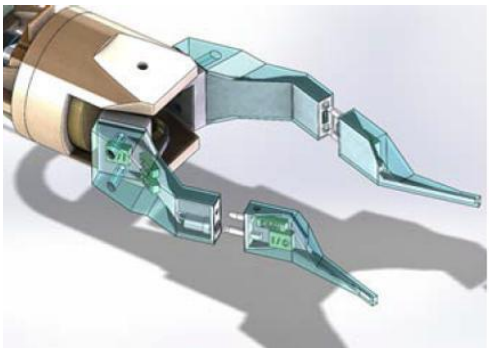


The robot includes a simple, user friendly, online software for programming. All devices that can support HTML5 and Java Script can be used to program the robot. In fact, most smartphones, tablets and laptops are able to control the different aspects of this collaborative robot. Since a lot of devices are supported by the software, it is easy to monitor or change different aspects of the program on the go. The robot also supports ROS (Robot Operating System) and can be programmed with all kinds of 4th Generation Software Packages (LabView or MatLab/Simulink), as well as all major programming languages. The software architecture is focused on adaptive behavior. Thanks to its deep learning network, including neural and Bayesian probability network algorithms, the robot can adapt to a specific task and improve its performance based on feedback.



PRob Collaborative Robot Advantages

- Easy to program and monitor
- Built-in gripper and tool changer
- Possibility to change gripper configuration
- Learning capability



The other interesting thing about this new collaborative robot is the built-in 2 finger gripper (PGrip 1). The modular end effector is made of a soft material which makes it safe for humans. The fingers are easy to change using only 2 screws. A fingertip exchanger can be added into the robotic cell to adapt the end effector. The switch is made through a patent-protected interface that engages a mechanical and electrical connect-disconnect operation. The fingertips of the robot gripper can be adapted for your specific application and are easy to switch once the robot is in operation. The end effector is incredibly safe and has a large opening range (60 degrees). This allows the user to grasp big objects such as a 1.5 L (l) water bottle.

PRob stands for the family name of the innovative and versatile lightweight robot arm manipulator. The PRob 1R weighs only 10 kg and has an operating range of 700mm. Its payload is low at only 1.5kg. The robot is dedicated to performing human-robot collaborations. Like most collaborative robots, the PRob includes soft material, rounded shapes, limited forces and stop functions. PRob can be integrated into your actual working environment without any risk of injury to humans. This collaborative robot comes with different peripherals, such as a camera and a movable base. With all of this equipment, you can bring PRob onto the assembly line and get started in a very short amount of time.

THE FLEXIBLE AND EFFICIENT ROBOT ARM

ROBERTA FROM GOMTEC

This 6-axis collaborative robot from Gomtec, called Roberta, was designed to suit small to medium sized enterprises who want to achieve flexible and efficient industrial automation. The design was focused on building an agile and lightweight robot that could easily be moved around the shop floor. With a weight of 19.5 kg, it can handle a payload as high as 8.0 kg. A payload like this means that Roberta has a good payload to structural weight ratio and this means that Roberta's motions can easily match a large number of applications. This characteristic is due to the highly optimized weight and power servomotors, which for a given torque, reduces power losses by half compared to a conventional motor. This means that Roberta has a lower energy consumption for the equivalent operation. Gomtec states that Roberta’s movements perform more quietly than most of its robot competitors.

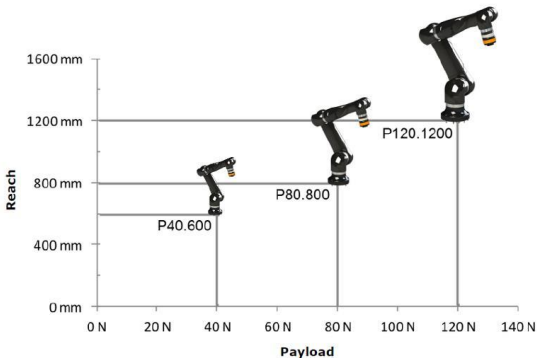
The software and firmware have been developed to simplify the programming and provide complete liberty to the robot. In fact, with the RoboCommander device, the 6 axes of Roberta can easily be moved to any point in the working area with any desired orientation for the end effector. The joints allow unrestricted rotation, which means that the robot can always take the shortest route to its next desired position without passing through singularity points. This collaborative robot is delivered with a graphical user interface software that is very intuitive to program. Roberta can also be fit with a range of industrial controllers. Programming is done by demonstration, like most collaborative robots. The only difference is that the robot wrist is equipped with an illuminated rotating ring. This device provides information about the different points or motions by showing a color-coded acknowledgment.

Robot Main Characteristics

- Lightweight
- 6 degrees of freedom without singularity points
- Good payload to structural weight ratio
- Inexpensive

The other interesting feature about Roberta is that it presents several integrated safety concepts. For example, it has characteristics such as safety nodes on each axis and dual safety nodes for overall robot monitoring functions. The robot can be fixed with a specific gripper that is safe for human-robot collaboration. In fact, because it is camera equipped, the system can detect the presence of abnormal objects in the robot gripper, such as a hand or tools. The end effector is also equipped with fingertip force sensors, another safety aspect that reduces the risk of any bodily injuries. The illuminated rotating ring that is used for the programming steps also informs its co-workers of the robot's different statuses. This can be a game changer, in terms of safety, for a robotic cell.

The Gomtec robot gripper, as previously mentioned, is equipped with vision devices. This characteristic is not just for safety—it can be used to see the object that it is handling. With the force sensor and camera, the robot is able to feel and see its payload. This can be used to guide the end effector to the right position, but also to react if something goes wrong during the motion.



Roberta comes in 3 different sizes with payloads of 4.0 kg, 8.0 kg and 12.0 kg. The main difference between the models are its reach and payload; all other characteristics remain the same. This collaborative robot family will be launched shortly and should be well received by the market and the robot community. Let's see what the future has reserved for Roberta!

THE SWISS LIGHTWEIGHT ROBOT

SPEEDY-10 FROM MABI

MABI AG is manufacturing two different robot types: Speedy-10 and Max-150, we will take a look at the first one, which is the collaborative one.

The small Swiss family business manufactures machines for sheet metal transformation and just released what looks like a twin of the UR10. The Speedy 10 is similarly priced, but uses an 18-bit absolute encoder and a KeMotion controller by KEBA. Furthermore, it has a simpler wrist that causes no mechanical interferences (when no tool is attached).

The requirements of flexible manufacturing are the rationale behind the development of Speedy-10, which is based on a lightweight design with excellent damping characteristics. This 6-axis kinematics system with standard wrist is a lightweight in its class; nonetheless, it offers high precision positioning for high-speed applications thanks to a high-resolution, absolute feedback encoder. The robot is controlled through an intuitive graphic user interface, which all operators will find easy to understand.

Features:

- Lightweight design
- 6-axis kinematics system with standard wrist
- High-resolution 18-bit absolute encoder
- High precision positioning
- Intuitive graphical user interface

N.B. At the time this eBook was being written, the information about this collaborative robot was limited.

A FLEXIBLE DUAL ARM FOR SMALL ASSEMBLY

YUMI FROM ABB

Formerly known as FRIDA (which stands for Friendly Robot for Industrial Dual-Arm) is a dual-arm robot with 14 axes of freedom (7 in each arm). The size of this industrial robot is similar to a small adult. This concept has been created in response to requests from ABB's customers who desired a robotic solution for manufacturing environments where robots and humans have to work together.

Originally built for the consumer electronics industry and other small assembly applications, this collaborative robot has been designed to be as compact as possible. In fact, it takes the same work space as a human. Compact, this robot is portable and can easily be carried around the production floor, as well as mounted onto different work stations. Its controller is integrated into its torso making its installation and change of location even easier.

YUMI: KEY FEATURES

The size and the look of this robot really clash with the usual ABB robot. Instead of being massive and orange (meaning: hey I'm big and tough, so don't come too close), FRIDA is small, compact, lightweight and its colors are different shades of gray.

Here are the key features of this collaborative robot:

- Harmless robotic co-worker for industrial assembly
- Human-like arms and body with integrated IRC5 controller
- Complements human labor with scalable automation
- Padded dual arms ensure safe productivity and flexibility
- Lightweight and easy to mount for fast deployment
- Agile motion based on industry-leading ABB robot technology

Considering that this robot was designed for electronics assembly, we can assume good precision and repeatability.

ABB YUMI: CHALLENGES

This robot is still not a commercial product even though it has been "released" in 2011. So there are still some questions that remain unanswered, especially about programming. Will YuMi be as easy to teach as a robot from Universal Robots or the Baxter of Rethink Robotics? Will we need in-depth knowledge in programming to use it? We still don't know. Release is scheduled for April 2015.

There is also the question about its price. It has been promoted as an affordable robot, but will it still be affordable compare to Baxter or a robot from Universal?

I guess we can only wait and see!

THE ROBOTIC CO-WORKER

BAXTER AND SAWYER FROM RETHINK ROBOTICS

Intended to support a rebirth of domestic production, Baxter and Sawyer are aimed at making North American manufacturing more competitive by lowering production costs in the US and thus avoiding the need to outsource to lower wage countries.

Targeting a range of businesses – from small job shops to major manufacturing players – these robots from Rethink Robotics are intended to automate repetitive tasks actually done by humans in an environment of high-mix production.

This is also coupled with the idea of breaking the usual barriers between the robot and the end user by:

- Making robotic programming as intuitive as possible for the people on the plant floor.
- Making the robot itself an accessible tool in the production process (i.e.: not having the robot surrounded by fences and signs warning about the danger of getting too close).

So instead of having people doing work which doesn't add value to the process, we would now have someone who does not have in-depth knowledge of programming managing a group of robots who are doing this no value added work.

BAXTER: KEY FEATURES

No Programming

Rethink Robotics highlight that Baxter can be trained in minutes without in-depth programming knowledge.

No Integration

Being a complete system, Baxter requires no integration. Only minimal training to be able to teach tasks to the robot.

Works Intelligently

Baxter is designed and programmed to perform a wide range of manufacturing and production tasks; it is aware of its environment, and can automatically adjust to changes.

BAXTER: CHALLENGES

Bringing the cost where it needs to be

At a starting price of just above $ 20k, it represents a good value for your investment. However, reaching this price point, while Rethink and their distributors make money, is a real tough design and manufacturing challenge. As their sales pitch is about reshoring manufacturing in the US, they have to “walk the walk and talk the talk” and produce their robots domestically, which they do. Baxter has a lot of features and is a big piece of hardware. In several talks that Rethink's founder Rodney Brooks has given in the past, he showed examples for the cost of a bearing 30 years ago and it is the same as today's price for the same bearing. Since material costs are not cheaper today, the trick is to have lower end mechanical costs and to compensate by having clever software and electronics. For this reason, we can envision that the Baxter will evolve continuously as its software does.

SAWYER: A SINGLE ARMED ENHANCED BAXTER VERSION

Rethink Robotics seems to have found the right balance with their effort to build a more robust and more complete solution for users that were looking for a smaller robot than Baxter but with all its proven sensors and safety features.

New and Enhanced Platform

As you can see, Sawyer has many things in common with Baxter, but there are also major differences. The same elastic actuators are used to allow the robot to be mechanically compliant. However, the actuators have been slightly redesigned to enhance the rigidity of its joints. Baxter uses springs made out of “C”-shaped pieces of steel, whereas Sawyer uses springs

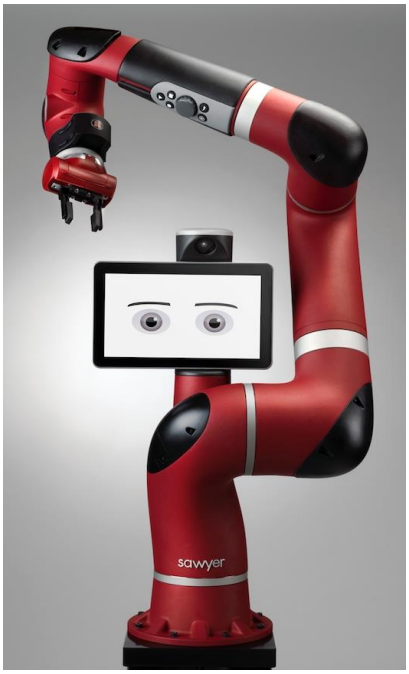
made out of titanium in the shape of a symmetrical, curvaceous “S.” The spring redesign (and running cables through the joints) allows Sawyer’s arm to be made considerably smaller. You can also notice that the joints are more integrated into the robot shape which reduces the possibility of sharp edges and gives a smoother look (and feel) to the robot. One major upgrade has been done to the arm's vision system, which now includes a built-in light. This allows for clearer vision and limits any obstruction a camera might have had with the gripper. The same easy-to-program devices are integrated into the robot arm. The smiley Baxter interface remains mostly the same with small graphical upgrades. Notice that Sawyer is not designed to be mobile, as Baxter was, it is a fixed robot.

In this short video you can detect right away the rigidity difference between Sawyer and its older brother. Baxter was looser and more shaky, and it always looked like it was just barely able to reach its targeted position. Now with Sawyer's more enhanced platform, we see a more rigid system that leads to a more accurate robot. Since the robot is designed for applications such as electronic assembly, you surely want to design a more precise robot arm!

Sawyer has a smaller and more robust platform to be able to achieve tasks such as machine tending and small assembly, tasks that Baxter wasn't able to do since it was such a big robot. The fact that the bulky Baxter had a big footprint and big segments, was a huge downside when it came to entering small spaces like those required for CNC machines.

Specifications

- **Weight:** 19 kg (42 lbs)
- **Payload:** 4 kg (8.8 lb)
- **Reach:** 7 degrees of freedom and 1-meter reach
- **Actuation:** Series elastic actuator and Harmonic Drive, with optical encoder
- **Repeatability:** N/A
- **Force sensing:** High-resolution force sensing embedded at each joint
- **Vision:** Camera in the head for wide field of view and Cognex camera with built-in light source in the wrist for precision vision applications
- **Software:** Intera
- **Body:** Sealed against dust and spray [Baxter isn’t]
- **Expected lifetime:** 30,000 hours
- **Price:** US $29,000 (available in North America, Europe, China, and Japan)



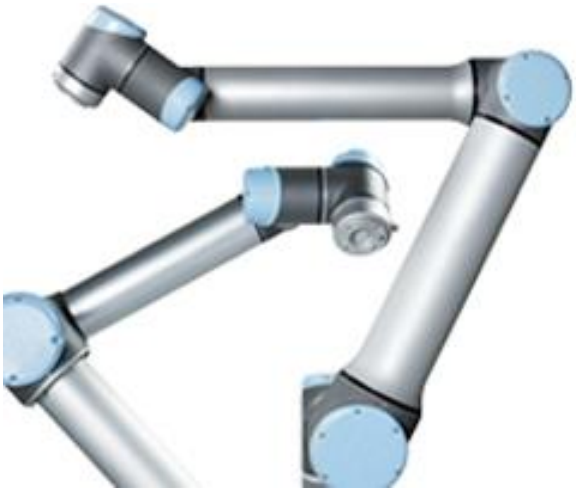
THE LOW-COST ROBOT ARM

UNIVERSAL ROBOTS

Universal Robots is a Danish company that entered the market with a new vision for robotics. When the industry is surrounded by big, heavy and expensive robots, they decided to provide low-cost, flexible and easy-to-use automation solutions for all kinds of companies. Whether you are a small company making small batches or a large company with a huge manufacturing process, robots from Universal could be a good fit for you.

Their robots consist of a six-axis arm that allows them great flexibility to do a variety of tasks. They offer three products: the UR3, UR5 and UR10 that can handle 3, 5 and 10 kilos respectively.

UNIVERSAL ROBOTS: KEY FEATURES



- Low-noise robots
- Energy efficient
- UR can be very precise (+\- 0.004 in)
- The programming is simple. You just have to move the arm and record points for the trajectory. Then you use the touch-screen tablet (12'') to set different options. The software has a graphical interface that makes it easy to use. The UR can be up and ready to work in less than an hour without further knowledge in programming.
- Also, their compact design and light weight give them good portability around the plant floor. So they can be assigned to other tasks easily and rapidly.
- Universal Robots can work with humans without risk. In case of collision, the robot delivers less than 150 Newtons (33.72 lbs) of force and this amount of force is acceptable according to the "force and torque limitation" set by the ISO Standard. They also operate without safety barriers in about 80% of the company's current installations. This reduces the space and cost for the robots.
- Universal Robots' starting price is pretty low. They can also be customized for the client's needs. In average, according to the company, the payback period is a relatively short 6 to 8 months.

UNIVERSAL ROBOTS: NEW GENERATION

Universal Robots has release their next generation of collaborative robots at the opening of Automatica 2014. The manufacturer remains on the same robotic platform, the UR5 and UR10 still have the same safe human-robot collaboration, but with a couple of add-ons. The addition of absolute encoders, adjustable safety features and an increased number of I/Os are the main upgrades for this lightweight robot. These collaborative robots still remain strong in their well-known characteristics such as ease-of-use and quick ROI.

NEW HARDWARE

The main innovation of this new generation of collaborative robots is really the true absolute encoders. This device allows the robot to achieve faster start-up because its position is recognized from start-up. There is no need to frequently reinitialize the collaborative robot since its position in space is known, although the robot doesn't need any battery power to achieve this function. Another addition to the hardware is the redundant electronic board so the robot can comply to performance level D (ISO standards).

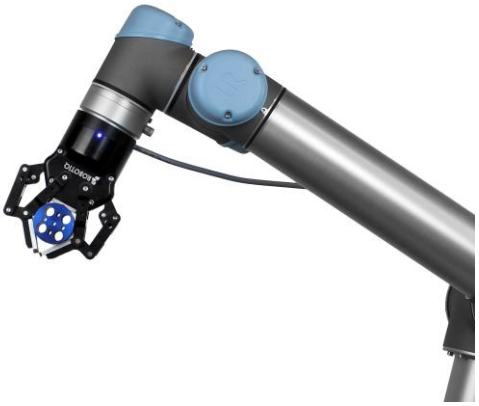
NEW SOFTWARE

These new safety features allow the user to set the collaborative robot for each situation. The robotic settings can be achieved by monitoring eight different safety functions such as: Joint positions and speeds, TCP positions, orientation, speed and force, as well as the momentum and power for the robot. Doing so, the robot can operate at different speeds depending on the context. For example, the collaborative robot can run full speed when working in conjunction with the CNC machine and slow down once it is working along humans outside the machine. Those safety features can be changed using a unique password, although the configuration can be done on 8 different safety planes in space, which means 8 different areas where the robot can change its parameters automatically. UR went through the process of 3rd party certification for their new collaborative robot generation. All the new features have been certified by TÜV (Technischer Überwachungs-Verein - a German organizations that work to validate the safety of products) and tested in accordance with EN ISO 13849:2008 PL d and EN ISO 10218-1:2011, Clause 5.4.3.

OTHER FEATURES

Other features include the addition of sixteen digital I/Os that are easy to configure either as safety signals or as digital signals. The controller and the control box have also been improved.

ROBOTIQ GRIPPERS NOW PACKAGED FOR UNIVERSAL ROBOTS



Since the release of Universal Robots' UR5 and UR10, we are compelled to admit the great fit of these robots with our 2-Finger 85 and 3-Finger Adaptive Robot Grippers. Indeed, this spring, robots from Universal have become one of the most popular platforms (in terms of sales) for our electric Grippers.

Considering the popularity of our Robot Grippers and UR's robots, the engineers at Robotiq have designed a package for this collaborative robot which includes: A Robotiq Adaptive Gripper, software component and a "How-to" Guide to easily and quickly program our 2-

Finger 85 Adaptive Gripper. This package is another way for Robotiq to pursue its mission of making automation more and more accessible for end-users, while helping them to maximize their ROI by providing tools that reduce costs related to tooling, programming and changeovers. **You can get the free Robotiq package for Universal Robots here.**

Universal Robot to Launch UR3 in 2015

The Danish robot manufacturer Universal Robots just release its new version of collaborative robot: The UR3. Universal Robots has had huge success with their UR5 and UR10 in many different kinds of applications because of its safety features, flexibility, easy to use specifications and fast payback. The missing link was a smaller robot that met the same requirements to complete the robot family. Following its two older brothers, the UR3 is more compact and designed for smaller applications.

As you can see, the UR3 is literally a scalded down UR5. The goal of bringing a smaller robot to their product line was to target smaller applications, such as electronic assembly and general dispensing applications. With more and more electronic assembly tasks being done autonomously, it was a logical move for UR.

"With the UR3, table-top automation is easy, safe and flexible; a single worker can accomplish what traditionally would be a two-person task by having the UR3 robot as a third-hand helper. It's an ideal choice for applications that require 6-axis capabilities where size, safety and costs are critical." says **Eben Oestergaard, UR CTO.**

UR3 Specifications

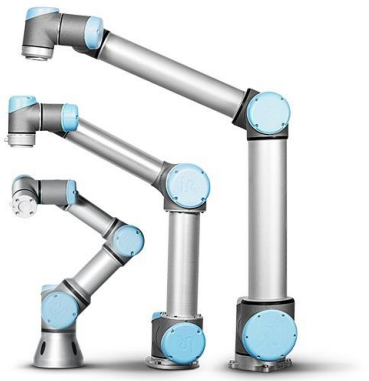
Since it is a scaled down version of the other UR robots, you can figure that the specification are pretty much the same as its older brothers. Notice that the same teach pendant and controller are used for this new version. The user-friendly built-in programming software remains Polyscope. It uses the same specifications and programming methods. Here are the general specifications for the new robot.

- 6 axis, collaborative table-top robot
- Weight: 11 kg (24.3lbs)
- Payload: 3kg (6.6lbs)
- Reach: 500 mm (19.7in)
- 360 degree rotation on all wrist joints, infinite rotation on end joint
- Repeatability: ±0.1 mm (±0,004 in)
- 15 adjustable, advanced safety settings; force limit: Default 150 N , can be adjusted down to 50 N

- Modular design: exchanging a joint takes less than 30 minutes with one day delivery
- Improved force control
- New motherboard with faster boot-up

UR3 Targeted Applications

The bigger versions of the robots are beginning to make their way into machine tending, product testing, assembly and general pick and place applications, however the UR3 has been designed for smaller applications. The same ease of integration and programming, but on a smaller scale, it is now easier to automate your small part process since the robot is more compact. It can basically be fixed on a table. Some targeted applications might include:



- Soldering
- Gluing
- Screwing
- Painting
- Pick and place
- Operating hand tools
- Laboratory work

THE FIRST COLLABORATIVE SCARA ROBOT

PF 400 FROM PRECISE AUTOMATION

Precise Automation is a company founded in 2004 and their main goal is to help customers "automate with ease". They are interested in collaborative robots and want to develop products that could be safely integrated into work-cells. They have spotted a market where automation would be appreciated, but has not yet been developed; laboratories. In factories, it is common to see big robotic cells working behind barriers, but in a laboratory there are certain limitations. The major one is space. So, this particular market needs a robot with a small footprint. Moreover, the product needs to be safe to work around, without any barriers to allow proximity of other workers. Also, the majority of laboratory applications don't require the largest and most powerful robots. So, they designed a tabletop robot: the PF 400. According to its creator, the PF 400 is extremely compact and safe to use in desktop applications even without shields.

PF 400: KEY FEATURES

Controller

Its embedded controller enables all its special features. Precise Automation designed a controller especially for science lab automation named, Guidance 1400. This device is a four-axis motion controller and has all the features of bigger and more powerful ones. However, its price, size and power profile are perfect for laboratory use. Talking about

size, it can fit in the palm of your hand. They decided to build the controller into the robot in order to reduce the space required. So, no external devices are needed, except for one AC power cable and an Ethernet communication cable.

Their controller also offers kinetic teaching with a gravity balance mode. Programming is done by simply moving the robot by hand from start to end position. Using a simple communication protocol, Ethernet interface (PC control via an open source TCP/IP command server), the robot can be controlled locally with a PC, a wireless tablet or remotely from anywhere in the world.

The other features of the PF 400 are:

- Low-cost
- Quiet
- Lightweight
- Can be combined with a vision system

PF 400: WHAT NEXT?

Precise Automation continues to add features to their PF 400 family, for instance, they did another version where they put it on a linear rail. Also, they work on improving the software in order to make programming even easier than before. Moreover, they continue to develop the kinematic features of their controller, to reduce its size and price without losing its actual performance.

To accomplish this Precise Automation has a lot of work to do, but we are looking forward to seeing their future innovations.

THE LIGHTWEIGHT ROBOT

IIWA FROM KUKA

At ICRA 2013, KUKA introduced to the world the next generation of Lightweight Robot, LWR 5, designed for industrial applications. KUKA's goal was to develop a lightweight robot for industrial duty. This is why this robot is also named IIWA for Intelligent Industrial Work Assistant. This flexible and sensitive robot enables new possibilities in automation. IIWA can be used to automate complex and delicate assembly tasks that presently robots cannot do.

Kuka Intelligent Industrial Work Assistant and the 3-Finger Adaptive Robot Gripper

IIWA: KEY FEATURES

Its design is based on a human arm with seven axes. It has integrated sensors at each joint that allow for control of position and sensitivity. It can fulfill delicate jobs due to its built-in-high-performance collision detection algorithms. Relatively slim and low weight, it can work in tight spaces and it can be integrated on assembly lines quite easily. It is the first lightweight robot that can handle a payload of over 10 kg. Since IIWA is presented as a collaborative robot, no fences are needed for its implementation.

IIWA presents the same physical features as its previous version, (the LWR 4+) but has a completely new controller architecture. This new controller is called KUKA Sunrise. Its programming paradigm is completely new and it now uses the mainstream programming language, Java. In the past, KUKA's controllers were using KRL, which is a company language. Moreover, the plugin tools of the KUKA Workbench, based on Eclipse, make it easy to integrate hardware modules such as an electric end effector.

IIWA: CAPABILITIES

KUKA's LWR 5 showcased its capabilities at the last 2013 Hannover Messe in four different demonstrations:

Basic Functions

The first one was about showing how fluid and sensitive the arm is. Visitors could handle the arm and move it around to experiment with these features directly.

Weight

Its delicate touch was demonstrated by making the arm hold a ten kilogram weight over a scale in order to make it read only four kilograms.

Water Glass

In another exhibit, the arm was following a path and someone would place a glass of water in its way to see how it would react. The arm was able to stop without spilling a drop, due to its collision detection system. This demonstrated its sensitivity.

Industrial Application

In the last demonstration, visitors could see an assembly cell on a manufacturing line where IIWA had to position a piece over a pin to precisely assemble the two parts.

Through this type of robot, KUKA offers a flexible solution to any shop floor. This is also the goal that Robotiq aims for; we want to make automation accessible to any company, either big or small. Since our products are synonymous with flexibility, the integration of our end effectors with the KUKA IIWA would be an all-in-one solution for companies.

THE NEXT GENERATION OF INDUSTRIAL ROBOT

NEXTAGE FROM KAWADA INDUSTRIES

Now, we wanted to introduce you to NEXTAGE, a collaborative robot from Kawada Industries in Japan.

NEXTAGE: CHARACTERISTICS

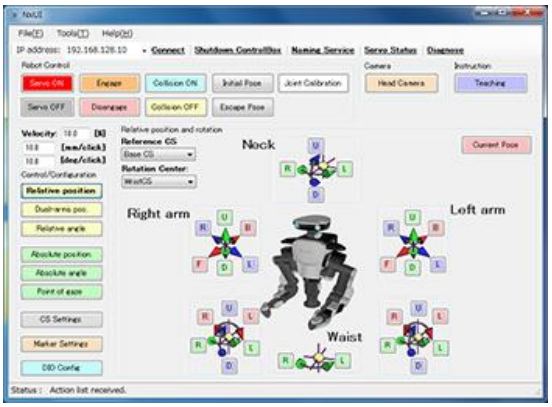
Its overall design includes a “head” with two cameras, a torso, two 6-axis arms and a mobile base.

Its “head” is equipped with stereo vision just like a human. This means that NEXTAGE can attain 3D coordinates with high precision. Moreover, the “head” has two degrees-of-freedom allowing it to adjust its field of vision with the workflow.

Its torso has a LED display to assure visibility of the robot status. Its overall height can also be adjusted by changing the height of an element in the torso.

NEXTAGE has two hand cameras that can capture 3D information of an object by taking different pictures of it from different angles. The cameras bring precision to the robot's work.
Its base has wheels, so it can be moved around and rapidly reassigned to another workstation. Its base contains all its control systems such as the image recognition system through an integrated PC.

Its software uses GUI which helps to operate the robot intuitively with graphical elements. The source code for the software is licensed by GNU General Public License. This means the general public can download, distribute and duplicate it.



NEXTAGE: SAFETY SYSTEMS

NEXTAGE has a very interesting feature. Its elbows won't ever move outward from its working environment, thanks to its axle structure. This is a safety feature unique to NEXTAGE. Even if both arms are in movement, the robot is not likely to bump into a human with its elbows. Moreover, its 15 operational axes (6 per arm, 2 for the head and 1 for the torso) use low-power motors of 80 watts to move, preventing harmful forces.

Additional safety certified sensors can be installed to allow the robot to detect an approaching human. This system will make NEXTAGE stop what it is working on when necessary.

NEXTAGE: HIRO

The research version of NEXTAGE is called Hiro. It uses open source software to develop new functionalities for the robot. In May 2012, Hiro crossed the frontiers of Japan to enter European Industry through Tecnalia Research & Innovation. Kawada put their trust in Tecnalia to adapt Hiro for worldwide use in industry.

Hiro is now being tested at an Airbus production plant and Tecnalia is still

developing its intelligence and flexibility to enable it to perform even more tasks. Hiro will increase productivity in industries and will undertake hazardous or repetitive tasks, which will allow human workers to be reassigned to more meaningful jobs.

We are looking forward to seeing more development from NEXTAGE and its arrival in America.

FIRST CERTIFIED ROBOTIC ASSISTANT

APAS FROM BOSCH

Bosch APAS is the first collaborative robot to be certified as an assistance system, which allows direct collaboration with people without additional shielding. This one of a kind robot has some really impressive specifications and is comparable to other collaborative robots on the market today.

Superior Protection

The robot has a one of a kind look too with a protective leather coat. Even if its look invokes 'rock and roll', it is probably the safest collaborative robot out there. The leather is actually a tactile skin to detect impact. Since the robot will be used in collaboration with humans, the sensors will give instant feedback to the controller when any unusual force is detected.

The robot also has a security perimeter that slows down the robot once a person gets too close to it, essentially invisible shielding. The robot will resume its regular speed once the person has left the security perimeter.

This device must have been seriously tested to get the certification of the German employers' liability insurance association. The robot concept seems to be really focused on security and we think they have actually achieve something unique with this robotic assistant.

Built-in Devices

The robot has integrated cameras. The system can be delivered with a 2D or 3D vision system. These devices allow the robot to get instant feedback from the grasping end effector. It can tell if the part is grasped or if it missed it. That is a good feature to have in your workshop.

APAS also comes with a built-in 3 finger gripper. This gripper can be used for a very wide variety of

objects. Having three fingers instead of the regular two fingers that are on many collaborative robots allows you to have more stability on round parts for example. Though the fingers are such that it can't offer an encompassing grip.

Of course the robot comes with a teach pendant that is easy to use and user-friendly. This kind of teach pendant is now very common in the collaborative robot industry. The robot can also be moved around and be reprogrammed in a few seconds using hand-guiding.

To get the robot specifications go to the BOSCH website and see if the robot might suit your application.

TENDON ROBOT BASED ON HUMAN ARM

BIOROB FROM BIONIC ROBOTICS

Bionic Robotics GmbH was initially a spin-off from the Darmstadt University of Technology. Their robot arm called BioRob is designed to match the rising demand of cost-effective and easy to use automation solutions. They target more specifically small and medium enterprises looking for new ways of automating, since traditional industrial robots often do not match their requirements.

BioRob Arm

The low deadweight, the compliant drivetrain and the low energy consumption lead to an inherently passive safety system allowing the user to run the collaborative robot without any additional safety equipment, such as light barriers or fences even with its high speed movements (although safety assessments are always highly recommended). The robot's movements can also be taught by hand, the setup and programming of the BioRob takes only a few minutes.

The lightweight robot BioRob is used for industrial automation, especially for pick and place, inspection and co-worker applications. Interesting fact: it is based on a patented, antagonistic, elastic actuation which is inspired by the elastic muscle-tendon apparatus of the human arm.

Mimicking the Flexible Mechanics of Biology

Tendon-driven systems mimic the flexible mechanics of biology, and could result in a new class of robots that are lighter, safer, and move in a more natural way. Mimicking human movement is ideal for a robot designed to take on human tasks. But such robots can also help researchers explore how biomechanics can give rise to more intelligent behavior, a field known as embodied intelligence or cognition.

According to the MIT Technology Review, one of the biggest obstacles for tendon-driven engineers is finding a way to effectively model the human body's complex motions. But it's also difficult to ensure that the robots can accurately position themselves, as the tendons are prone to slack and stretch. The calibration of the tendons is also a challenge, which is often compensated by the integration of extra sensors.

CONCLUSION

Even if all these robots have a lot of different features, they are part of the same family and have one goal in common, which is to work alongside humans helping them in their tasks. They are safe and very flexible. This new kind of robot arrives just in time for manufacturers because the industry is evolving. Productions tend to be more versatile and flexible. High mix production with a low volume of parts is the new challenge for manufacturers in order to stay effective. Collaborative robots are flexible and affordable tools to help big or small companies.

To conclude, having a flexible robot is only one part of the solution, because to perform any task a robot needs the right end effector. Robotiq's adaptive end effectors are becoming the reference for flexible automation and the preferred end effectors for collaborative robots.

Come visit our website: **www.robotiq.com**

ABOUT ROBOTIQ

Robotiq makes tools for agile automation; flexible Robot Grippers to handle a wide variety of parts and a robotic teaching device that makes robot programming easier.

Our goal is to enable all manufacturers — especially those dealing with a high mix of products — to take full advantage of robotics.

Robotiq has sold product in more than 30 countries, through our global network of distributors.

TO LEARN MORE

For any questions concerning robotic and automated handling or if you want to learn more about the advantages of using flexible electric handling tools, contact us.

Phone (USA and Canada): 1 888 762-6847 extension 122
Phone (Anywhere in the world): 1 418 380-2788 extension 122

Email: info@robotiq.com

Website: www.robotiq.com
Blog: http://blog.robotiq.com/

Let's keep in touch via social media

ROBOTIQ'S BLOG

LEARN ABOUT ROBOTICS INDUSTRY NEWS, APPLICATIONS AND TRENDS

facebook

GET THE LATEST NEWS ABOUT ROBOTIQ

YouTube

WATCH VIDEOS OF OUR PRODUCTS

LinkedIn

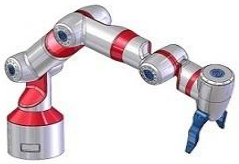
GET THE LATEST NEWS ABOUT ROBOTIQ

APPENDIX 1

COMPARATIVE CHART OF COLLABORATIVE ROBOTS

ROBOTIQ

Collaborative Robot Specifications Sheet

			
Specifications	Speedy 10 - MABI	Prob 1R - F&P Personal Robotics	Roberta - Gomtec
Physical			
Overall design	6-axis kinematics system with standard wrist	6-axis (3 for positioning, 3 for end tool orientation)	One 6-axis arm
Height	N/A	1 m	1,166 m
Weight	28 kg	7-10 Kg	19,5 kg
Portability	By hand	By hand	By hand
Reach	1384.5 mm / 54.5 in	700 mm	800 mm
Vision & Sensors	N/A	The fingertips themselves are optionally equipped with task specific sensors. Software algorithms make use of the multichannel sensor inputs of the gripper (e.g. encoders, torque and proximity sensors).	Flexible force-torque sensor / independent force sensors in each of her fingertips
Performance			
Speed (without payload)	120°/s (A1-A3) / 180°/s (A4-A6)	90°/sec	110 °/s
Payload	10 kg / 22 lbs	Up to 1.5 kg	8 kg
Communication - Physical	N/A	WiFi, EtherCAT, USB	CAN, 1Mbps (Safety Bus - Physical: RS485, 6Mbps)
Communication - Protocol	N/A	CANopen. Optionally, EtherCAT, and RS232 connections are available.	CAN, 1Mbps (Safety Bus - Protocol: Prosisafe)
Programming	Controlled through an intuitive graphic user interface	Next to MyP software, the P-Rob API supports a ROS interface as well as Web Services for communication with standard software environments such as LabView, Matlab/Simulink or any programming language.	Teach-in concept: RoboCommander
Required Power	100-240 VAC, 50/60 Hz	24-48 V	24 V
Life	N/A	N/A	45,000 hours
Available to purchase	Yes	Yes	Yes
Other	High-resolution 18-bit absolute encoder	P-Grip® is the family name of F&P's highly flexible gripper systems.	Was specifically developed for small and medium-size enterprises
Application	**Industrial** Machine Feeding Handling Assembly	**Industrial** Quality Control Assembly **Service Robotics** Health care	Automation, Inspection, Service, Mobile Platforms, Human-Machine Interaction
Website	http://mabi-robotic.com/en/speedy/speedy/	http://www.fp-robotics.com/en/prastandard/	http://www.gomtec.de/gb/home.html

ROBOTIQ

Collaborative Robot Specifications Sheet

			
Specifications	PF400 - Precise Automation	YuMi - ABB	Sawyer - Rethink Robotics
Physical			
Overall design	4-axis SCARA robot Standard 400 mm Z travel unit Option 750 mm Z travel unit	Dual-arm robot 7-axis arms	7-axis arm
Height	Standard : About 680.7 mm (26.8 in) Option : About 1030 mm (40.5 in)	N/A	1524 mm (60 in)
Weight	20 kg (44.1 lbs)	N/A	19 kg (42 lbs)
Portability	By hands	N/A	N/A
Reach	576 mm (22.7 in) Extended Version : 731 mm (28.8 in)	N/A	1000 mm (39 in)
Vision & Sensors	Passive force Compliance Optional machine vision software	N/A	Camera in the head for wide field of view and Cognex camera with built-in light source in the wrist for precision vision applications. High-resolution force sensing embedded at each joint
Performance			
Speed (without payload)	End Effector: Up to 1 m/s (39.4 in/s)	N/A	End Effector: 1 m/s (39.6 in/s)
Payload	0.5 kg (1.1 lbs)	N/A	4 kg (8.8 lbs)
Communication - Physical	10/100 Mbps Ethernet port RS-232 Web based operator interface supports local or remote control via browser connected to embedded web server	N/A	I/O connections : Ethernet, USB, 15 pin D-sub with PLC-compliant connections
Communication - Protocol	TCP/IP Available : remote I/O, modbus-TCP	IRC5	Modbus-TCP
Programming	DIO MotionBlocks (PLC) Embedded Guidance Programming Language (standalone, modeled after Visual Basic.Net) PC controlled over Ethernet usingTCP/IP	N/A	No engineering training required Trainable by demonstration
Required Power	90 to 264 VAC single phase 50-60 Hz 365 W max	N/A	N/A
Life	40,000 hours	N/A	30,000 hours
Available to purchase	Yes	No	Summer 2015
Other	Embeded Guidance Vision-Guided Motion Controller	N/A	Fully integrated systems Interactive screen (face) No charge sofware update with service agreement
Application	**Industrial** Laboratory Assembly	Small parts assembly	**Industrial** Pick-and-place Machine Tending Electronic Assembly
Website	http://www.preciseautomation.com/PF400.html	http://new.abb.com/products/robotics/yumi	http://www.rethinkrobotics.com

ROBOTIQ

Collaborative Robot Specifications Sheet

			
Specifications	Baxter - Rethink Robotics	IIWA - KUKA	NEXTAGE - Kawada Industries
Physical			
Overall design	Dual-arm robot 7-axis arms	One 7-axis arm	Dual-arm robot 6-axis arms
Height	Without pedestal : 939,8 mm (37 in) With pedestal : 1780 - 1900 mm (70 in - 75 in)	7 kg version: 1251 mm (49.3 in) 14 kg version: 1291 mm (50.8 in)	1786 mm (68.3 in)
Weight	75 kg (165 lbs) without optional pedestal	7 kg version: 22.3 kg (49.2 lbs) 14 kg version: 29.5 kg (65.0 lbs)	130 kg (286.6 lbs)
Portability	Rolling pedestal with locking casters	By hands	Mobile platform (on wheels)
Reach	1041.4 mm (41 in)	7 kg version: 911 mm (35.9 in) 14 kg version: 931 mm (36.7 in)	-
Vision & Sensors	1 integrated camera per arm for detecting parts Vision-guided movement and object detection Integrated force sensors 360 degrees sonar and front camera for human detection	Integrated position and torque sensors in each joint	Integrated Stereo Vision and hand cameras
Performance			
Speed (without payload)	End Effector: 1 m/s (39.6 in/s)	End Effector: N/A Joints: 7 kg version - 90°/s to 180°/s 14 kg version - 70°/s to 180°/s	End Effector: N/A Joints: 133°/s to 300°/s - according to the joint
Payload	2.3 kg (5 lbs) (including gripper) - higher possible according to workspace	Two versions with full dynamics 7 kg (15.4 lbs) 14 kg (30.8 lbs)	1.5 kg per arm
Communication - Physical	I/O connections : Ethernet, USB, 15 pin D-sub with PLC-compliant connections	FieldBus, EtherCAT	Ethernet
Communication - Protocol	Modbus-TCP	TCP/IP or UDP/IP	CORBA
Programming	No engineering training required Trainable by demonstration	KUKA Sunrise API (Java), KUKA Sunrise Workbench as Engineering Suite (Eclipse based)	NxProduction
Required Power	120 VAC 6 amps max	200-240 VAC 50-60 Hz	85 to 264 VAC, 50 Hz/60 Hz
Life	Going through an independent analysis and will be published at future date 1 year warranty	N/A	N/A
Available to purchase	Yes	Yes (Q4/2013)	Yes
Other	Fully integrated systems Interactive screen (face) Up to 3 year warantee and no charge sofware update with service agreement	External controller (KUKA Sunrise Controller)	Additional safety certified sensors can be added to detect human workers
Application	**Industrial** Pick-and-place Case Packing Kitting Process Application Packaging	**Industrial** Machine Tending Pick-and-place Process Application Assembly Packaging **Research**	**Industrial** Pick-and-place Assembly Process Application **Research**
Website	http://www.rethinkrobotics.com	http://www.kuka.com/	http://nextage.kawada.jp/en/

ROBOTIQ

Collaborative Robot Specifications Sheet

			
Specifications	Universal Robots - UR3	Universal Robots - UR5	Universal Robots - UR10
Physical			
Overall design	One 6-axis arm	One 6-axis arm	One 6-axis arm
Height	Same as Reach 500 mm (19.7 in)	Same as Reach 850 mm (33.5 in)	Same as Reach 1300 mm (51.2 in)
Weight	11 kg (24.3 lbs)	18.4 kg (40.6 lbs)	28.9 kg (63.7 lbs)
Portability	By hands	By hands	By hands
Reach	500 mm (19.7 in)	850 mm (33.5 in)	1300 mm (51.2 in)
Vision & Sensors	Not integrated Arm stops if an overcurrent, like a collision, is detected	Not integrated Arm stops if an overcurrent, like a collision, is detected	Not integrated Arm stops if an overcurrent, like a collision, is detected
Performance			
Speed (without payload)	End Effector: 1 m/s (39.4 in/s)	End Effector: 1 m/s (39.4 in/s)	End Effector: 1 m/s (39.4 in/s)
Payload	3 kg (6.6 lbs)	5 kg (11 lbs)	10 kg (22 lbs)
Communication - Physical	Ethernet sockets	Ethernet sockets, USB, Euromap67 (optional)	Ethernet sockets, USB, Euromap67 (optional)
Communication - Protocol	TCP/IP and Modbus-TCP	TCP/IP and Modbus-TCP	TCP/IP and Modbus-TCP
Programming	Polyscope graphical user interface	Needed Graphical or Script programming	Needed Graphical or Script programming
Required Power	100 to 240 VAC 50-60 Hz	100 to 240 VAC 50-60 Hz	100 to 240 VAC 50-60 Hz
Life	N/A	35,000 hours, maintenance free	35,000 hours, maintenance free
Available to purchase	Yes	Yes	Yes
Other	External controller	External controller	External controller
Application	**Industrial** Soldering Gluing Screwing Pick and Place Operating Hand Tool	**Industrial** Machine Tending Pick-and-place Process Application Assembly Packaging	**Industrial** Machine Tending Pick-and-place Process Application Assembly Packaging
Website	http://www.universal-robots.com/GB/Products.aspx	http://www.universal-robots.com/GB/Products.aspx	http://www.universal-robots.com/GB/Products.aspx

ROBOTIQ

Collaborative Robot Specifications Sheet

		
Specifications	BioRob - Bionic Robotics	APAS - BOSCH
Physical		
Overall design	One 4-5 axis arm with joint elasticity in A1-A4	One 6-axis arm
Height	1240 mm	1670 mm
Weight	ca. 6kg incl. control, moving arm from shoulder only 2 kg	230 kg
Portability	By hand	Rolling pedestal with locking casters
Reach	956 mm	911 mm
Vision & Sensors	Joint torque sensing using joint elasticity in A1-A4	2D monochrome overview camera, 3D calibrated stereo camera, touchless triggering sensor
Performance		
Speed (without payload)	130°/s (A1), 80°/s (A2), 90°/s (A3-A4), 330°/s (A5) Up to 1,3 m/s at the end effector	Arm: 0.5 m/s
Payload	800g nominal load up to 500g in cooperative operation	Maximum weight of part: 2 kg
Communication - Physical	Real-Time Ethernet	Ethernet
Communication - Protocol	EtherCAT	EtherCAT, E/A optodecoupled
Programming	Intuitive GUI, C / C++ ROS API; Digital I/O Set-up time of a few minutes	N/A
Required Power	120 VAC 50-60 Hz nominal 40 W	230 VAC
Life	1 year warranty, Extended warranty and free of charge software update can be agreed within service contract	N/A
Available to purchase	Yes	Yes
Other	Passive safety due to low robot weight, extremely low effective collision mass, and elasticity in drive Extended warranty and free of charge software update	German employer's liability insurance association certified, integrated 3 finger gripper.
Application	workpieces or finished products unloading machines inspection tasks automation Palletizing Loading and Testing or Laboratory	Machine Tending Pick-and-place Process Application Assembly Packaging
Website	http://www.bionic-robotics.de/en.html	http://www.bosch-apas.com/en/apas/