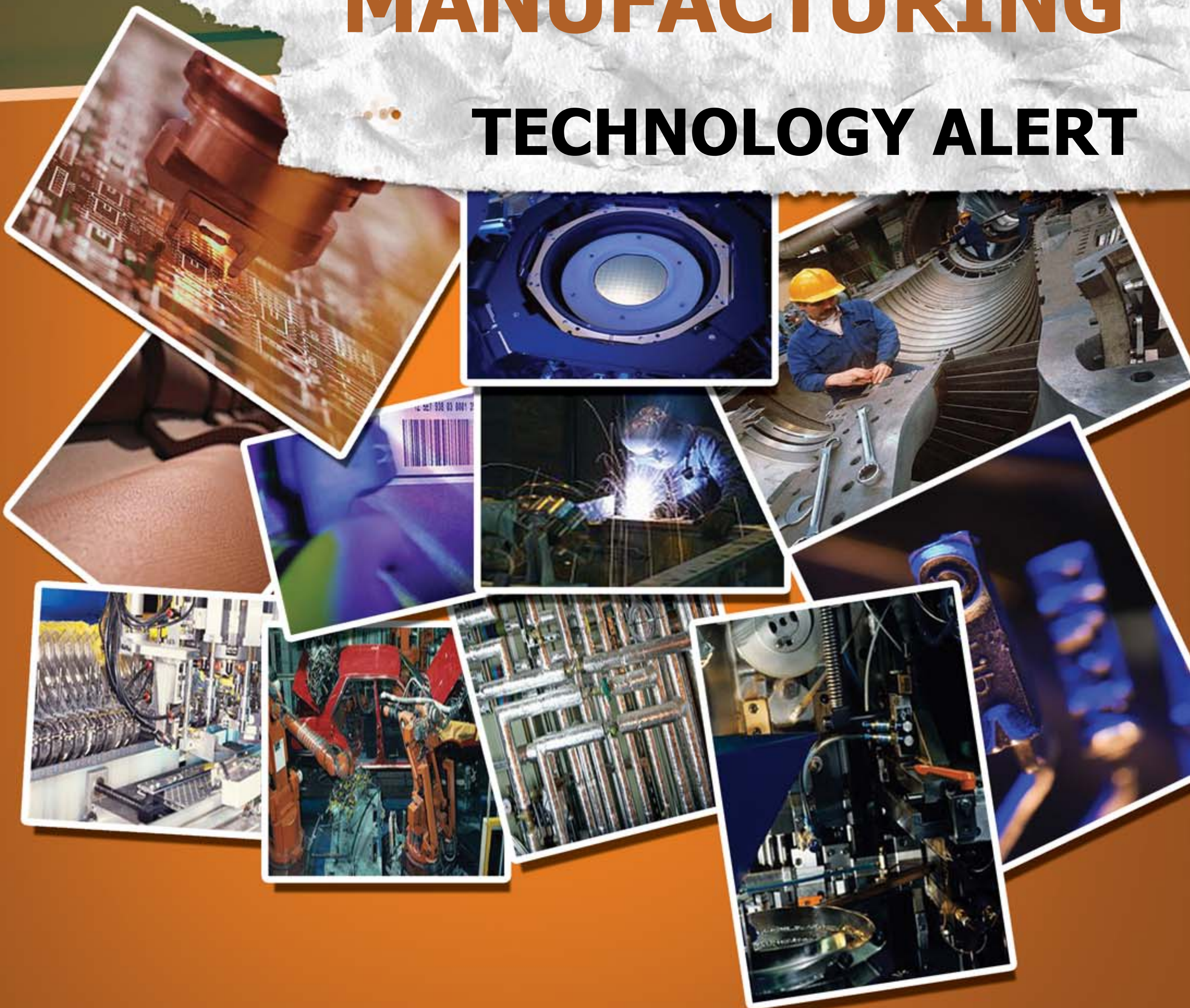
# TECHNICAL INSIGHTS

## ADVANCED MANUFACTURING

### TECHNOLOGY ALERT



06th November 2015

## 1. ADVANCEMENTS IN ARTIFICIAL ELECTRONIC SKIN

There is significant, ongoing interest in being able to create electronic, artificial skin that can more accurately and comprehensively mimic human skin, or better allow robots to feel objects in order to identify objects and perform more tasks effectively. Key desired attributes in electronic skin include the ability to sense pressure and temperature and to stretch and, ideally, heal itself. Most of the developments and advancements in electronic skin have focused on improved pressure or touch sensing capability.

Spearheading further advancements in artificial electronic skins, researchers from the Ulsan National Institute of Science and Technology and Dong-A University, both in South Korea, have developed a unique artificial skin that is able to detect both pressure and heat simultaneously, with a high degree of sensitivity.

Their document, "Fingertip skin-inspired microstructured ferroelectric skins discriminate static/dynamic pressure and temperature stimuli," published in *Science Advances* 30 Oct 2015, noted that taking inspiration from the structure and functionality of human fingertips, the researchers fabricated fingerprint-like patterns and interlocked microstructures in ferroelectric films that can improve piezoelectric, pyroelectric, and piezoresistive sensing of static as well as dynamic mechanothermal signals.

Such flexible and microstructured ferroelectric skins, which have potential in applications such as robotic skins, wearable sensors, or medical diagnostic devices, can detect and discriminate between multiple spatiotemporal tactile stimuli, including static and dynamic pressure, vibration, and temperature, with a high degree of sensitivity. In a proof-of-concept demonstration, the sensors have been used for simultaneous monitoring of pulse pressure and temperature of artery vessels, accurate detection of acoustic sounds, and discrimination of various surface textures.

The artificial skin constitutes a sandwich of materials. At the top is a flexible surface designed to sense texture to mimic the human fingerprint. Beneath this surface are sensors sandwiched between graphene sheets. The domed shaped sensors compress to different degrees when the skin is exposed to varying amounts of pressure. The compression also induces a small electrical charge to move through the skin, as well as heat or sound, which is also transmitted to sensors. The more pressure, heat or sound exerted, the greater the charge. The degree of sensation felt can be measured using a computer to measure the charge. The artificial skin was found in testing to detect sound better than an iPhone microphone.

To better enable the artificial skin to be ready for practical applications, the team plans to develop a means for communicating data from the skin to a robot or human being. The researchers intend to develop a communications method that will dovetail with or accommodate the particular capabilities of the skin they are developed, as opposed to simply hooking up the artificial skin to an existing system.

Details: Dr. Hyunhyub Ko, Associate Professor, School of Energy and Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST), 50, UNIST-gil, Eonyang-eup, Ulju-gun, Ulsan, Republic of Korea. Phone: +82-52-217-2532. E-mail: hyunhko@unist.ac.kr. URL: http://hko.unist.ac.kr.

## 2. MICROFLUIDICS ENHANCES MONITORING OF BLOOD SUBSTANCES

Microfluidics allows for manipulating and controlling fluids, generally in the range of microliters or picoliters, in tiny (micrometer-sized) channels. Microfluidics, a form of lab-on-chip technology, has found expanding opportunities due to factors, such as the increasing popularity of microscale analytical chemistry techniques and the ongoing advancements in microelectronic technologies.

Microfluidics provides key advantages in chemical and cellular analysis compared to conventional instruments, such as higher speed and throughput along with greater sensitivity due to their small size and the small volumes involved; small footprint; ability to be used in non-laboratory settings; and lower manufacturing, operating, and maintenance costs.

However, to optimize opportunities for microfluidic devices and technologies, it is vital to focus on applications that can particularly benefit from analysis via microfluidic devices.

Researchers at Integrated Systems Laboratory (ISL) of École polytechnique fédérale de Lausanne (EPFL) in Switzerland have developed a tiny, minimally-invasive, prototype miniature microfluidic device that can streamline monitoring and tracking of the blood levels of key metabolites (glucose, lactate, bilirubin) and ions (calcium, potassium), which indicate changes in the health condition of individuals in intensive care units (ICUs).

The device, which is not larger than a pack of chewing gum, contains embedded microsensors to measure the different substances in the blood or blood serum and an array of electronics to transmit results in real time to a tablet computer using Bluetooth communications.

The system, which is able to be connected to an in-place drainage tube, is considerably less invasive than the typical monitoring instruments it is geared toward replacing. It could constantly monitor the blood level of the five aforementioned substances. It is important to be able to provide real-time monitoring of the levels of such substances, since in certain cases, any change in the level can require an immediate response. Presently, several of these levels tend to be monitored periodically with the existing systems. Leveraging this technology, up to 40 molecules could be monitored in real time. The microfluidic technology has promise for reducing the number of machines surrounding patients.

The prototype device, made using a 3D printer, was successfully tested on rodents. The researches have been exploring arrangements to test the device at the University Hospital of Lausanne (CHUV). Furthermore, certain manufacturers have expressed serious interest in developing the device, which could be on the market around 2017 or 2018.

Development of the technology was given impetus by the Nano-Tera initiative, which is financed by the Swiss Government. The goals of the Nano-Tera i-IronIC (Implantable/Wearable System for on-line Monitoring of Human Metabolic Conditions) project were to develop a fully implantable sensor system, with multi-panel sensors capable of real-time sensing of several metabolites in parallel, and a CMOS design for the fully-implanted, complex, and low-consumption electronics for sensing and remote powering. Menarini Diagnostics, one of the industrial partners, asked the team to push the technology for applications in intensive care units. A new proposal was written and the project was funded. The new project phase under the new grant began in late 2013. Moreover, the researchers were able to successfully integrate carbon nanotubes in a selective manner on the multi-panel platform.

Details: Dr. Sandro Carrara, Senior Scientist, École polytechnique fédérale de Lausanne (EPFL) ISIM LSI1 INF 338 (Bâtiment INF) Station 14, CH-1015 Lausanne, Switzerland. Phone: +41-7924-88-632. E-mail: sandro.carrara@epfl.ch. URL: http://people.epfl.ch/sandro.carrara

## 3. ADVANCEMENTS IN ANISOTROPIC MAGNETORESISTANCE SENSORS

An anisotropic magnetoresistance (AMR) magnetic field sensor undergoes an increase in resistance when current is applied in the same direction as the magnetic field and a decrease in resistance when the current is applied at a 90 degree angle to the magnetic field or force.

AMR sensors can offer key benefits compared to Hall magnetic sensors, which, over the years, have become well-established, especially in high-field applications. Such benefits of AMR sensors include a wider air gap between the sensor and target (which allows for larger tolerances in the mechanical setup and sensor housing to simply the application), higher sensitivity, a larger output signal (which improves the signal-to-noise ratio), greater immunity to vibration and immunity to extraneous magnetic fields, and lower power consumption.

AMR sensors that provide measurement along all three orthogonal axes (X, Y, and Z) offer enhanced accuracy and reliability compared to using three independent sensors. The three-axis solution can eliminate any interference between the axes, which could degrade the output signal. Moreover, the ability to provide the AMR sensor and the electronics on a single chip in a monolithic process improves the economy, performance, and functionality of the sensing solution and allows for reducing package size and cost.

Taiwan-based Voltafield Technology Corporation, founded in 2009, develops and offers AMR sensors that leverage the company's innovative manufacturing technology and specialized foundry process to achieve the monolithic integration of the AMR sensor element and the ASIC on a single chip. Voltafield utilizes a more user-friendly, state-of-the-art manufacturing solution; and the company's AMR sensors are able to provide key benefits, such as higher sensitivity, considerably lower power consumption, immunity to external magnetic fields, and economical cost.

Indicative of the company's capabilities, Voltafield developed a unique, cutting-edge monolithic AMR 3-axis integrated magnetic sensor solution that provides a more streamlined, cost-effective, high sensitivity and low power solution. Moreover, the company's magnetoresistive sensor product portfolio includes geomagnetic sensors for e-compasses that can precisely detect azimuth; angle sensors for linear, angular, and rotary displacement measurements; and linear sensors for low-field magnetic sensing. Voltafield also can offer soft gyro solutions (in which the use of an accelerometer, AMR sensor and software eliminates the use of a gyro) for sensor fusion/sensor hub applications, and with the use of a microcontroller, for Internet-of-Things (IoT) applications.

Voltafield focuses on consistently enhancing its products and making them more user friendly. The company can enhance its ASICs to best suit an application; for example, scaling down the die, or increasing the die to accommodate additional features and functions, such as enhanced logic or wireless communications capability.

A key initial application area for Voltafield's AMR sensors is the consumer arena, such as e-compasses in smart phones and other handheld electronic devices. A key target market over the near-term entails wearables. The company is also interested, and finding opportunities, in industrial, automotive, robotics, as well as home appliance, smart city (such as smart parking) applications.

Voltafield is, moreover, looking at and finding opportunities in motion sensing in such areas as consumer electronics; for example, using motion sensors and e-compasses to replace a gyro. The company also sees opportunities to combine motion sensing and environmental sensing.

Voltafield views IoT as an emerging, tremendously significant area, where sensors will be vital for providing information about the environment, including direction, motion, and so on. IoT includes applications, such as traffic flow detection, parking lot space monitoring, location-based services, and extends to a plethora of applications, such as cell phones, wearables, automotive, robots, home appliances, and so on. Voltafield sees opportunities to create sensor-based subsystems for IoT.

Details: Dr. Futai Liou, President and CEO, Voltafield Technology Corporation, 6F-1, No.1, Taiyuan 1st St., Jhubei City, Hsinchu County 30265, Taiwan. Phone: +886-3-6590888. E-mail: futai.liou@voltafield.com. URL: www.voltafield.com.

## 4. NOVEL 3D PRINTING TECHNIQUE TO PRINT MICRO OBJECTS

Three-dimensional (3D) printing is creating a wave of activity in the world of manufacturing with its intense capabilities to create macro objects of the desired properties in various materials. Moreover, the structural details of objects produced through 3D printing not only provide an increased aesthetic appeal to the 3D printed objects, they also add functional value to the objects.

Expanding from the macro object dimension, a group of scientists at the Henry Samueli School of Engineering and Applied Science at the University of California, Los Angeles (UCLA) have successfully demonstrated a 3D printing technique to print micro-objects. The team has been able to make objects in the micro-scale that have complex shapes that are smaller than the width of a strand of hair.

One 3D printing or additive manufacturing method is to use a liquid precursor material that is extracted out of a nozzle drop by drop. Each layer of the object is formed through the drops. As the liquid hardens, another layer of the liquid precursor is deposited to form the desired object. This approach has been incredibly helpful in creating objects of complex shapes and intricate geometries in the macro (visible to the naked eye) scale. However, an attempt to use the same technique to make complex objects in the sub-millimeter scale has failed. This is simply because the drop created at the nozzle of the 3D printing system has always been bigger than the size of the desired micro-object.

This is the challenge that the researchers have addressed by creating a novel 3D printing technique to print objects in the micro scale. The technique, called optical transient liquid modeling, has been found to be extremely useful to create objects with folds, holes and other desired features in the micro scale with great precision. The new technique consists of a series of microfluidic and optical technologies alongside a technique developed previously by the research group under the leadership of Dino Di Carlo, the principal investigator and professor of bioengineering at UCLA, which simplifies the fluid flow shape.

In the 3D printing system developed by the researchers, the precursor material required for printing, a polymer, is taken in the liquid form. The mold used in the printing process is also in the liquid form. Both these fluids are combined in a series of tiny pillars that are placed on the 3D printing system. The mixing and intertwining of both the fluids are determined by the arrangement of pillars in the system. In order to determine the shape that will be produced for different arrangements of pillars, the researchers used software previously developed by them. The software will rapidly predict the shape of the polymer produced when the pillars' positions are changed.

The desired object is then created by the outflow of the fluids from the pillar. When the material (precursor and liquid mold material) flow from the pillars is stopped, an ultraviolet light slices the stream into smaller pieces.

The research team has been able to produce objects of sizes ranging from 100 to 500 micrometers using the novel technique. They were able to imbibe features ranging from 10 to 15 micrometers on the objects printed.

The team believes that the 3D printed microstructures could be very useful in tissue engineering, where biomaterials printed using this novel technique can act as interlocking particles and accelerate tissue regeneration. Further, they believe that the new technique can be used in industrial applications to print new coatings and paints with unique properties.

Details: Dino Di Carlo, Associate Professor of Bioengineering, Di Carlo Laboratory, 5121E Engineering V, University of California, Los Angeles, CA 90095-1600. Phone: +1-310-983-3235. E-mail: dicarlos@seas.ucla.edu. URL: www.ucla.edu

## 5. PATENT ANALYSIS OF ROBOT GRIPPERS

The evolution of robotics has transformed the industrial sector. Robots have been able to greatly improve the quality of industrial output. More specialized robots capable of performing multiple tasks are emerging, offering greater functionality.

In industries, new robotic systems work on tasks that mimic human hands. A main factor that affords robots this level of human hand-like capability is the gripping mechanism embedded in the robots. Generally, such robots have a peripheral or an element that contains the gripper device which helps the robot in holding the materials while they are being worked on.

Robotic gripper devices are an important and integral part of humanoid robots, which are designed to largely mimic human actions, such as lifting things, placing an object from one place to another.

The patent analysis of robotic gripper devices reveals that there is intense research and development activity taking place to develop new and improved robotic grippers across the world.

One of the interesting patents filed from the exhibit belongs to Fanuc Corporation (US 20150123416), which pertains to a robot system for successively taking out stacked workpieces and a method for assessing the gripping state of the workpiece.

| Title | Publication Date/Publication Number | Assignee | Inventor | Abstract |
|---|---|---|---|---|
| Robot system for taking out bulk stacked workpieces and judgment method for judging workpiece gripping state | September 17, 2015/ US 20150258689 | FANUC CORPORATION | Tadanori Suzuki | A robot system for successively taking out bulk stacked workpieces of the same type, wherein a hand of a robot comprises: a base part attached to an arm, a cylinder device with a cylinder and a piston rod, and a gripping part attached to a front end part of the piston rod. The robot system further comprises a fluid pressure adjusting device which adjust a fluid pressure inside of the cylinder, a movement detecting device which detects a retracting movement of the piston rod, and a judgment device which judge if the hand is gripping a designated number of workpieces, based on a magnitude of fluid pressure inside the cylinder and detection results of the movement detecting device. |
| Gripping device for a co-handling robot, and co-handling robot equipped with such a device | May 21, 2015/ WO/2015/071161 | COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES | Colledani, Frédéric | The invention relates to a gripping device (5) comprising a gripping member (10) designed to come into contact with an object to be manipulated (100) and control means for controlling a joining and a separation of the gripping member and the object to be manipulated, the control means being associated with a contact (16) able to generate a joining and/or separating control signal intended for the control means when the contact is activated. According to the invention, the gripping member is slidably mounted in the device between a non-pushed-in position and a pushed-in position, the contact being positioned in the device so as to be activated by the gripping member when the gripping member is in the pushed-in position. The invention also relates to a co-handling robot comprising such a device. |
| Robot hand for gripping cylindrical object and robot having the robot hand | May 7, 2015/ US 20150123416 | FANUC CORPORATION | Ryoji Kitamura | An inexpensive and compact robot hand and a robot having the robot hand, wherein the robot hand is configured to rotate a cylindrical object gripped by the robot hand and does not negatively affect a cable, etc., connected to the robot hand. N number of fingers are moved by a first drive part so that a circumcircle of a N-sided polygon constituted by the fingers is arranged in a concentric pattern about the center axis of the object. Each first roller is rotatable about an axis parallel to the center axis of the object, and is configured to contact the inner peripheral portion of the object by movement of the finger relative to a hand base. By rotationally driving at least one first roller while a radially outward force is applied to the object, the object may be rotated relative to the hand base. |
| Gripping apparatus, robot, and gripping method | April 29, 2015/ CN 104552322 | -N.A- | -N.A- | The invention provides a gripping apparatus, a robot, and a gripping method. The gripping apparatus includes a plurality of holding sections. Each of the plurality of holding sections includes a flexible film-like member. The plurality of holding sections are capable of gripping a plurality of different kinds of objects to be gripped having different softness indexes in a range of 3 mm<3>/gf to 10 mm<3>/gf. |

| Title | Publication Date/Publication Number | Assignee | Inventor | Abstract |
| --- | --- | --- | --- | --- |
| Automatic placing and locating device for gripped objects in robot machining process | March 25, 2015/ CN 104440363 | ZHEJIANG QIANJIANG MOTOR CO., LTD. | Lyu Junchao | The invention provides an automatic placing and locating device for gripped objects in the robot machining process and belongs to the technical field of machines. The problem that a robot can not grip objects in place in the existing robot machining process is solved by the automatic placing and locating device. The automatic placing and locating device for the gripped objects in the robot machining process comprises a supporting frame used for containing the gripped objects and is characterized in that the supporting frame comprises transversely-arranged and parallel supporting beams and limiting rods, the limiting rods are located below the supporting beams, multiple guide pins and multiple locating pins are arranged on the supporting beams, the guide pins are used for suspending the gripped objects and incline upwards, the locating pins correspond to the guide pins one to one, and the locating pins are located under the guide pins. The gripped objects placed by a robot can be automatically located, so that accurate robot gripping localization is achieved. |
| Internal-external gripping type crawling robot | April 8, 2015/ CN 104494722 | NANJING UNIVERSITY OF AERONAUTICS AND ASTRONAUTICS | Ding Liping | The invention relates to an internal-external gripping type crawling robot, and belongs to the technical field of work of manipulators. The internal-external gripping type crawling robot comprises an inner robot and an outer robot which are respectively arranged on the inner side surface and the outer side surface of a magnetic permeating thin plate; the inner robot comprises an inner frame, an oscillating spring, and an outer frame which is fixedly equipped with a guide rail; a first telescopic foot is arranged on the outer frame; a secondary oscillator and a second telescopic foot are arranged on the inner frame; a third foot and a primary oscillator are arranged on the outer robot; when the first foot and the second foot are in contact with the inner side surface of the magnetic permeating thin plate by means of a steel ball, and the excitation frequency applied by a tangential force on the inner frame is basically consistent with the intrinsic vibrating frequency of the inner frame, the inner frame is driven by the tangential force to move along the guide rail by a resonance manner. According to the internal-external gripping type crawling robot, the outer robot provides the power energy for moving; the inner robot is not independently equipped with the power energy, so that the inner robot can move without the limitation from the length of an energy conveying cable and the trouble caused by the coiling of the cable, and moreover, the inner robot can freely move in a long-distance thin plate with poor spatial accessibility. |
| Robot gripping device | March 5, 2015/ JP 2015042431 | FANUC LTD | Nakayama Kazutaka | PROBLEM TO BE SOLVED: To provide a robot gripping device that can grip a workpiece with high reliability, regardless of the orientation and shape of the workpiece. SOLUTION: Each finger part of a robot gripping device (60) includes: a finger part body (1) consisting of a plate-shaped elastic member; a first anti-slip part (2) provided at a top end inside of the finger part body; and a reinforcing member (20) that is arranged along an outer surface of the finger part body and connected to the top end of the finger part body, having higher rigidity than that of the finger part body. The reinforcing member has a first rotary joint (4) that makes the reinforcing member rotate about a first rotation shaft perpendicular to a longitudinal direction of the finger part body. The robot gripping device has a drive part (62) that moves the proximal end of the finger part body along a gripping center (a) to open and close the finger part. |

| Title | Publication Date/Publication Number | Assignee | Inventor | Abstract |
|---|---|---|---|---|
| Robot gripping device | January 29, 2015/ US 20150028613 | FANUC CORPORATION | Kazutaka Nakayama | A robot gripping device (60) where each finger part has a finger part body (1) which is comprised of a plate-shaped elastic member, a first anti-slip part (2) which is provided at an inside of a front end side of the finger part body, and a reinforcing member (20) which is arranged along an outer surface of the finger part body, is connected to the front end of the finger part body, and is higher in rigidity than the finger part body, the reinforcing member having a first rotary joint (4) which makes the reinforcing member pivot about a first axis of rotation which is vertical to a longitudinal direction of the finger part body, and the robot gripping device having a drive part (62) which makes a base end of the finger part body move along the center of grip to make the finger part open and close. |
| Robot hand and method for gripping work in robot hand | January 19, 2015/ JP 2015009326 | CANON INC | Kadotani Tsukasa | PROBLEM TO BE SOLVED: To provide a robot hand that can draw in to the center of gripping and grip a roughly supplied work without having complex device constitution nor biting into the work and also hold the work tightly enough not to drop the work.<br><br>SOLUTION: There is provided a robot hand having three finger parts which are provided on the same circle apart from one another and arranged at intersections of the circle and lines extending radially from the center of the circle, and can grip a work. Each finger part has a high-friction face formed at a contact of an inscribed circle of its grip part on the center side of the circle, and also has a low-friction face formed on a face excluding the high-friction face of its grip part.<br>COPYRIGHT: (C)2015,JPO&INPIT |
| Robot hand, gripping method of robot hand and robot | December 14, 2015/ JP 2014233807 | SEIKO EPSON CORP | Sasai Shigenori | PROBLEM TO BE SOLVED: To provide a robot hand, a gripping method of a robot hand and a robot in which an installation number of force sensors can be reduced as far as possible and plural objects to be gripped can be held certainly by a desirable force.<br><br>SOLUTION: A robot hand 10 comprises a first holding member 5 which is tabular, a second holding member 6 which is arranged at the outer peripheral side of the first holding member 5 and is tabular, a third holding member 7 which is arranged at the outer peripheral side of the first holding member 5 and the opposite side to the second holding member 6, and is tabular, and a support mechanism 8 which supports the first holding member 5 and the second holding member 6 as capable of approaching and separating and supports the first holding member 5 and the third holding member 7 as capable of approaching and separating. The first holding member 5 includes a distortion sensor 52 which detects the own distortion of the first holding member 5.<br>COPYRIGHT: (C)2015,JPO&INPIT |

**Exhibit 1 lists some of the patents related to robotic grippers.**

*Picture Credit: WIPO Frost& Sullivan*

**Back to TOC**