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Dear KWT readers! I wish all KWT readers a Happy New Year! And I would like to express my heartfelt gratitude for your kind patronage of KOBELCO group products.

In Japan, calendars can mark the years using both the Christian – or Common – era as well as the Japanese era, which gets reset each time a new emperor starts his reign. Although we are now in the 2nd year of the Reiwa era, we just celebrated the first New Year of the Reiwa era, which started in May 2019, following the Heisei era. While people in the West are familiar with a year being divided into the twelve months of the Zodiac, in Japan – as in most of East Asia – it is the years that follow the twelve-year cycle of the Chinese animal zodiac. 2020 is the Year of the Mouse - the first in the cycle of twelve animals. I wish for this year to be a real New Year for the future generation, in Japan and around the world. I would like to welcome the new era together with KWT readers.

At the Welding Business group, we have been acting under the slogan, “aiming to be the most reliable welding solutions company in the world.” Currently trade friction all over the world has influenced our environment, and shipbuilding, offshore structures as well as the automobile industries have remained stagnant. On the other hand, expectations for further automation in welding are continuing to increase. As we are the only group in the world that provides welding consumables, robotic welding systems, and power sources - in addition to technologies and products related to IoT and AI – we can be optimistic about the future. In order to respond to market expectations, we are continuing to do our best to develop new technologies day by day.

The welding solutions we aim to achieve are not limited to automating robotic welding but for solving the whole range of problems customers experience in relation to welding. We want customers to utilize KOBELCO products with ease, thus contributing to their MONODZUKURI (production system innovation).

We promise to continue improving marketing capabilities from establishing appropriate product strategies in particular markets, and making and executing sales plans with all of our group’s strength. We will continue contributing to respective enterprises, regions and countries, meeting customers’ needs while developing our welding and joining technologies.

The overall welding environment has been changing rapidly – as have our clients’ needs. By responding promptly to those changes, we will provide products that match our client’s requests, and in this way, we can differentiate ourselves and add more value in the future.

The customers’ needs are in the voices of our KWT readers. When KOBELCO associates visit your countries and regions this year, please let them hear your voices, and know your needs and problems.

And finally, I wish all of you and your family a prosperous 2020!

Akira Yamamoto
Managing Executive Officer
Head of the Welding Business
KOBELCO STEEL, LTD.

Figure 1: ARCMAN™ A40

The earlier small-sixed SR had an arm size suitable for overhead systems. It received high marks from customers needing a system that could fit into a narrow installation area and was lower than a crane lift.

How the new ARCMAN™ A40 (hereinafter called A40) improves upon the earlier SR is the topic of this article.
2 Features of ARCMAN™ A40

The main features of A40 and SR are compared in Table 1.

Table 1: Comparison of SR and new A40

<table>
<thead>
<tr>
<th>Items</th>
<th>SR</th>
<th>A40</th>
<th>Advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>New function</td>
<td>Installation of torch cable</td>
<td>Wired outside</td>
<td>Built-in to S1 axis. Torch cable interference is minimized.</td>
</tr>
<tr>
<td>Improved function</td>
<td>Movable range of upper arm (S3 axis)</td>
<td>140°</td>
<td>260°</td>
</tr>
<tr>
<td>Improved function</td>
<td>Load capacity</td>
<td>6 kgs</td>
<td>8 kgs</td>
</tr>
<tr>
<td>New function</td>
<td>Controller</td>
<td>CA type</td>
<td>CR type</td>
</tr>
<tr>
<td>Improved function</td>
<td>Teaching pendant</td>
<td>Black &amp; white</td>
<td>Color</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
<td>Teaching locus is usable by other units.</td>
</tr>
</tbody>
</table>

2-1. Improvement of functions for overhead systems

1. Newly-installed function: Installation of the torch cable

Figure 4 shows how the torch cable is installed on an SR mounted on an overhead system. In order for the torch cable to trace the robot movement, the balancer is placed near the robot’s turning part to accommodate the torch cable.

However, this arrangement was known to cause problems such as the torch cable winding around the robot’s turning part, or the robot being unable to take up a position due to the interference between the torch cable (or balancer) and the workpiece. In response to these issues, the torch cable on the A40 is designed to go through the S1 (turning) axis and to move along with the robot’s arm as shown in Figure 5. This prevents the torch cable from winding around the robot when the robot turns. In addition, the torch cable’s interference with the workpiece is minimized by letting the torch cable move along with the robot’s arm. These changes should greatly expand the adaptability of robotic welding.

2. Improved function: Movable range of the upper arm (S3 axis)

The A40 features a reverse elbow posture that allows the upper arm (S3 axis) to bend to the back side of the robot because the moving area of the upper arm (S3 axis) has been expanded.

How a robot approaches a workpiece from overhead is shown in Figure 6. The left image shows how the reverse elbow posture and expanded upper arm allows the robot to reach a welding spot. In contrast, the right image shows how the arm of the SR encounters interference and cannot reach the same spot.

As the reverse elbow posture expands the means of avoiding interference, the robot moves faster and cycle time can be cut, accordingly.

3. New controller and improved teaching pendant

The ARCMAN™ robotic welding systems include the CB-type controller in which a diverse range of functions for the welding of medium to heavy steel plates is installed.

The principal characteristics of the CB-type controller are as follows:

- High quality: Increased CPU processing speed reduces sensing time and tact time.
- High function: Visualization of production, supported by high functioning of automated welding conditions.
- Simple operation: In addition to color display, the teaching pendant offers instinctive operation by icons and a touch panel.
- Others: Features collision detection function, multi-language display and light weight.

For more detailed information on the CB controller, please refer to the catalog: WELDING ROBOT ARCMAN™ WELDING SYSTEM LINEUP and the Technical Highlight of KOBELO Welding Today Vol. 19 2016 No. 3.

2-2. Suitable specifications for welding medium to heavy steel plate

1. Load capacity

Compared with the SR, the load capacity of the A40 is increased from 6 kgs to 8 kgs. Table 2 shows the welding torches available to each robot.

Table 2: Welding torches available to the SR and A40 robots

<table>
<thead>
<tr>
<th>Type of robot</th>
<th>Single</th>
<th>Tandem</th>
<th>Ultra High Current GMAW process</th>
</tr>
</thead>
<tbody>
<tr>
<td>A40</td>
<td>❌</td>
<td>❌</td>
<td>✗</td>
</tr>
<tr>
<td>SR</td>
<td>❌</td>
<td>❌</td>
<td>✗</td>
</tr>
</tbody>
</table>

Note: ❌: Possible to mount; ✗: Not possible to mount

3 Postscript

This article discussed the new ARCMAN™ A40 robot which comes mounted on an overhead welding system mainly for medium to heavy steel plates. The A40 offers a significant advancement over the earlier ARCMAN™ SR robot in terms of improved design and functions.

There is much more information about the A40 that is certain to satisfy customers. Please contact KOBE STEEL offices or agents for more details.
2 Outline of the laser sensor

2-1. Advantage of the laser sensor

There are three advantages when a laser sensor is applied for the robotic welding system.

① Wide range of joints

As shown in Figure 3, root gap detection has been applied not only to the conventional single-V and single-bevel grooves but also to the flare groove and T joint that could not be covered by the touch sensing method.

② Highly accurate measurement

Because the maximum measurement resolving power of the laser is 0.1 mm or less, highly accurate measurement is possible, depending on the condition of measurement and workpiece.

③ Reduction of cycle time

Because the action of irradiating against a groove and measuring the root gap with the linear laser beam needs to occur only one time, the sensing cycle time is shortened. By contrast, the touch sensing method as shown in Figure 4, requires repeated operations for detecting the workpiece and measuring the root gap.

The robot’s operation orbit varies, depending on measuring and workpiece conditions.

2-2. Disadvantages associated with laser sensing

Despite the advantages of applying the laser sensor to the robotic welding system, some problematic issues have held back the adoption of laser sensing systems.

① Decreased operation ratio

Because the laser sensor must be placed close to the welding torch so that the laser sensor can additionally be mounted onto welding systems, the robot’s operation ratio may drop due to the laser sensor’s possible interference with workpieces.

② Necessity of safety measures

The installation and use of laser equipment require particular safety measures in accordance with standards by laser classification, because of the need to protect human bodies against harmful exposure to laser beams.

③ Influence of workpiece condition

As measurement is performed by reflecting the laser beam against a workpiece, the surface condition of the workpiece and/or any imperfections may have a large influence on the results.

2-3. A solution to laser sensing’s disadvantages

In order to resolve the issues raised above, KOBE STEEL has partnered with SERVO-ROBOT INC to offer the SFK350 laser sensor, which is custom-made and specially designed for the ARCMAN™ robotic welding systems. How the SFK350 (see Figure 5) improves the productivity of laser sensors is discussed below.

Figure 4: Root gap measurement by touch sensing method

Figure 3: Groove shapes applicable to detection by laser sensing
Figure 5: The custom-made SFK350 Laser Sensor

1. Slim body allows the SFK350 to be used in confined spaces.

2. Laser classification is less restrictive

   According to the Safety of Laser Products (JIS C 6802: 2018), the conventional sensor is classified as Laser Class 3B, which requires isolation of the operating environment; however, the custom-made SFK350 is classified as Laser Class 2M, which does not, thereby allowing the system to be applied more widely.

Table 2 displays an excerpt from Hazards and Preventive Measures against Damages Caused by Laser Beam, provided by the Head of Standards Bureau of the Ministry of Health, Labor and Welfare (Japan) for reference.

Table 2: Action standards by class of laser equipment

<table>
<thead>
<tr>
<th>Protective equipment</th>
<th>Class 2M</th>
<th>Class 3B</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Safety glasses</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>· Working clothes</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>· With little exposure of skin</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>Peripheral isolation</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>Designated laser-controlled area</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>Designated laser safety officer</td>
<td>Not required</td>
<td>Required</td>
</tr>
</tbody>
</table>

Because the conventional laser sensor has a strong output laser beam, it is classified as Laser Class 3B, and a number of hazard prevention measures are required. In addition to peripheral isolation, wearing protective equipment, and setting a designated laser-controlled area as well as a laser safety officer are required.

The specifications of SFK350 are listed in Table 3. A laser sensor with seam-finding function for detecting root gaps, it is enclosed in a strong casing that can tolerate any welding environment. Moreover, the algorithm that measures workpieces fabricated from steel plates of middle to heavy thickness steel plates that KOBELCO has shown in is programmed for every groove configuration.

Table 3: SFK350 specification

<table>
<thead>
<tr>
<th>SFK350</th>
<th>Conventional laser sensor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubic volume (cm³)</td>
<td>368</td>
</tr>
<tr>
<td>Weight (g)</td>
<td>600</td>
</tr>
</tbody>
</table>

3. Reduction of influence on workpiece surface condition

In laser sensing, scanning is conducted to reduce the influence of the surface condition of the workpiece. Adhesions from welding fume or spatter to the surface of the workpiece or the inside of the groove, or even the scars left from processing or assembly, can change the apparent groove shape in a particular spot, resulting in incorrect measurements when one point only is measured by the laser sensor.

For these reasons (as shown in Figure 6), the laser sensor first scans a certain distance along the direction of the welding line in order to obtain measuring data, which are then averaged, thereby reducing the possibility of using incorrect measurements.

2.4. Comparison of laser sensing with touch sensing

Table 4 shows a comparison between laser sensing and touch sensing. Because both sensing methods have advantages and disadvantages, it is necessary to determine first whether the use of the laser sensor is applicable to a particular target workpiece.

Table 4: Comparison of laser sensing with touch sensing

<table>
<thead>
<tr>
<th>Applicable joint</th>
<th>Laser Sensing</th>
<th>Touch Sensing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many</td>
<td>Few</td>
<td></td>
</tr>
<tr>
<td>Measurement resolving power</td>
<td>0.1 mm or less</td>
<td>About 0.5 mm</td>
</tr>
<tr>
<td>Sensing time</td>
<td>About 1 sec (scanning time)</td>
<td>About 10 sec (detection time)</td>
</tr>
<tr>
<td>Influence on operation ratio</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Influence of surface condition</td>
<td>Influenced by reflection</td>
<td>Influenced by non-conductive parts</td>
</tr>
<tr>
<td>Influence from disturbance</td>
<td>Direct sunlight Arc light</td>
<td>No</td>
</tr>
<tr>
<td>Accuracy (i.e. difference in sizes and processing conditions between the workpiece and drawing)</td>
<td>Necessary for adding the sizes and measurement of the workpiece based on processing conditions.</td>
<td>The same setting can be applied even if there is some extent of dispersion.</td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

Note: Blue text indicates advantages.

System components

The laser sensing system is composed of a laser sensor, the ARCMAN™ robot and CB controller, shown in Figure 7.

When laser sensing is carried out, groove information on the target workpiece is sent from the CB controller to the laser sensor, and then sensing is conducted by means of an algorithm based on the groove information. The CB controller acquires the results measured by the laser sensor such as the distance up to the groove center, the root gap (or gap width) and other characteristics of the target groove. The accumulated information is displayed as laser sensing results on the screen of the teaching pendant as shown in Figure 8.

The teaching program is made by utilizing the exclusively programmed command for laser sensing (see Figure 9). It should be noted that laser sensing is composed of three treatments (or functions): laser radiation, measurement and acquisition of results. Although it is possible to use more than one command in combination with the versatile command for each function, it is also possible to carry out laser sensing by executing the one exclusively programmed command.

The detailed contents fall under three points as follows:

1. Groove configuration or algorithm number to measure
2. Storage location of correction amount measured by laser sensor
3. Storage location of root gap measured by laser sensor

The root gap detection function in combination with measured root gap and robotic functions enable welding under the welding condition adjusted to the measured root gap. Details of the teaching method are provided in the SFK350’s laser sensing operation manual.

Figure 7: Laser Sensing System components

Figure 8: Screen of laser sensing result display

Figure 9: Laser sensing teaching program
An important contribution to high quality welding is the gap sensing function, which automatically adjusts welding conditions according to the measured results of root gaps that vary in size in the groove. Changes in the root gap must be measured in advance of the welding of a workpiece.

Figure 10 shows a root gap with a tapered shape in a groove that changes from 8 mm to 4 mm. In this case, teaching would be programmed with the 4 mm root gap.

Even though the root gap on the actual workpiece differs from that of the teaching workpiece, the weaving width as well as the welding speed is automatically adjusted to provide uniform reinforcement of the bead.

KOBE STEEL will continue developing such products so that all of our customers will experience complete satisfaction with robot welding.

**References**
1. JS C6802, 2018, Safety of Laser Products; Japanese Industrial Standard (February, 2005)
3. Operation Manual of Laser Sensing Function (for SFK30F)
   Chapter 2, Column 1 Teaching Method of Root Gap Detection Command, KOBE STEEL, LTD.

This report discussed the laser sensor’s root gap detection function, which allows robotic welding systems to carry out higher quality welding. Specifically, the article examined some of the differences between laser sensing and touch sensing, and their respective features and discussed examples of actual application.

As the basis of developing this function, the following two functions are added:
1. Exclusively programmed command for laser sensing
2. Screen to display sensing results

These functions provide easier operation of the ARCMAN™ robotic welding systems that have a laser sensor installed.

KOBE STEEL will continue developing such products so that all of our customers will experience complete satisfaction with robot welding.

**Postscript**

ABTECH, one of the biggest annual exhibitions in North America, is held in Chicago and then either Atlanta or Las Vegas every other year. Besides the main exhibition, ABTECH exhibitions are held in Canada and Mexico as well. It targets not only welding-related industries but also metal forming, fabricating and finishing industries and welcomes manufacturers as well as processors.

In 2019, ABTECH was held in McCormick Place in Chicago, drawing around 50,000 attendees from 95 countries as well as 1,700 exhibitors over four days from November 11. In 2020, ABTECH will move to Las Vegas.

ABTECH has many sides, serving not only as a place for carrying out business but also networking and job seeking and recruitment. I noticed the following:

- Exhibits and sales: ABTECH allows business negotiations and on-the-spot purchasing. Machinery sellers, for example, offered special ABTECH prices.
- Recruiting: I wondered why so many students were taking part in the exhibition. Then I saw that both new graduates and those changing jobs used the exhibition for seeking employment.
- Business: At ABTECH, participants forge business alliances (partnerships, investments, M & A), carry out negotiations, and build relationships through conversations and networking.

FABTECH, the one of the biggest annual exhibitions in North America, is held in Chicago and then either Atlanta or Las Vegas every other year. Besides the main exhibition, FABTECH exhibitions are held in Canada and Mexico as well. It targets not only welding-related industries but also metal forming, fabricating and finishing industries and welcomes manufacturers as well as processors.

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1. Grow awareness of the KOBELO brand as welding solutions company
   On display was an operational ARCMAN™ robotic welding system composed of the ARCMAN™MP, laser sensor and P-MX-50R, the flux cored wire for robotic welding and flat & horizontal position welding. A video display showed an actual example of the robotic system carrying out welding for steel frame fabrication at a North American customer.
2. Display the line-up of flux cored wires for steel fabricators
   Featured was DW-50, the flux cored wire for positional welding that matches AWS D1.8/D1.8M: 2016 Structural Welding Code – Seismic Supplement. Also on display was OW-S50P, a self shielded flux cored wire for steel fabricators that provides high notch toughness in positional welding.
3. Promote a wide variety of stainless steel flux cored wires
   This display featured the DW Series for flat and horizontal position welding, the DW-P Series for positional welding, the DW-G Series for thin sheet welding and the XR Series flux cored wires with low hexavalent Cr.

The KOBELO exhibit presented the ARCMAN™ robotic welding system as the solution for automating welding and maintaining high quality. The display of flux cored wires for steel fabricators was new this year, and clients showed a keen interest in the line-up as well as the catalog. As FABTECH brought together KWAI’s sales associates from all over the USA, I could see that they enjoy meeting each other and working with their customers in harmony as a team.

Taking this exhibition as an opportunity, I will do my best to further promote sales throughout North America.

Reported by Marie Ichikawa,
Global Operations & Marketing Department, Marketing Center, Welding Business

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