ROBOTICS BUSINESS REVIEW

WHITEPAPER

Trends in AI

Ed O'Brien, *Robotics Business Review*

For years Universal Logic has been the leader in AI-based robot control.

Flexibility @ Speed®

Half the Cost of Labor

Neocortex® G2R Cell

PROVEN SUCCESS:

- 4 years handling freezer cases
- 3 years picking 90,000 different parts
- 1 year sorting strawberry plants
- 1 year order fulfilling 100,000's of consumer goods

Using ABB, Adept, FANUC, KUKA, Motoman robots.

info@universallogic.com
(615) 366-7281

UNIVERSAL LOGIC

TABLE OF CONTENTS

Cover image courtesy of Universal Logic, Inc.

Neocortex® artificial intelligence identifies boxes that vary in size from hour to hour due to frost buildup, and guides a robot to pick and place boxes for shipping.

INTRODUCTION

Both the tech media and a variety of vertical markets are increasingly viewing artificial intelligence as a way to improve industrial efficiencies through better use of data. The term *AI* has been around for more than half a century. At the same time, the idea of amplifying the capabilities of computers to simulate humans' iterative learning was becoming a popular theme.

This increased interest has coincided with improvements in AI capabilities, which are often mentioned in conjunction with machine learning. Also, there have been advancements in areas such as logic, data analytics, and predictive analytics.

In addition, the publicity around systems such as IBM Watson, which has appeared on *Jeopardy* and has been used in healthcare and tax preparation, has helped with public awareness and business acceptance.

In this whitepaper, we'll review the latest AI research and development, changing opinions about AI, and different applications.

We'll also take a look at how AI is evolving to serve real business needs across industries, specifically in manufacturing and robotics, as well as the market size and growth prospects.

BULLISH ON AI

The market for artificial intelligence is poised for explosive growth. McKinsey estimates that tech giants spent $20 billion to $30 billion on AI across industries in 2016, with 90% of this spent on R&D and deployment, and 10% on AI acquisitions.

The use of AI in manufacturing is also expected to grow. According to Markets and Markets, this market will grow from about $270 million in 2016 to just under $4.9 billion by 2023.

PWC notes that global industrial firms are projected to invest up to 5% of annual revenues on robotics and the Internet of Things (IoT).

Some of the key factors affecting adoption for AI and related technologies include a need to better understand demand and the desire to anticipate customer needs.

Until recently, most of the solutions available were based on historical information, and users needed deep knowledge about market forces. Some of their assumptions could be flawed because of changes occurring due to unknown factors. This has opened up an opportunity for innovative uses of systems powered by machine learning.

AI is combining sensors with image recognition systems for greater flexibility in materials handling, as seen in this Neocortex-powered picking operation.

Broadly speaking, artificial intelligence includes systems that combine sensors or data with assessing, learning, and modeling to better understand patterns. It can also include an ability to process language and understand spatial relationships, which can be particularly useful in manufacturing and autonomous vehicles.

Rather than depending solely on historical data, AI is fundamentally changing how organizations are assessing customer, productivity, and inventory information. They can use it to take a more forward-looking approach.

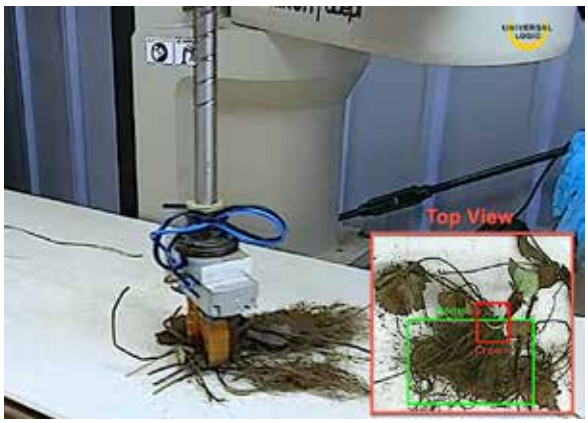
Another trend is the incorporation of machine learning techniques to better understand market dynamics. Enterprises of all sizes can begin focusing their attention on future demand and events.

AI ADDRESSES BUSINESS PROBLEMS AND PROCESSES

Seasonal peaks, changing customer preferences, and global shifts in distribution channels require manufacturers and automation providers to better understand end-user and partner demand for products and services. Too often, existing systems are based on batch processes, with historical tracking not providing enough actionable data to identify potential inflection points or trends. In addition, it's difficult to make forecasts based on real-time data.

AI can help to solve a wide variety of business problems. It can help to identify independent and dependent variables that would otherwise be hidden in the data. It can also adjust production and inventory schedules,

modify instructions for robots, and adjust work processes. Preventive maintenance is another promising application.



Machine learning enables robots to adjust to varied inputs, as seen in this Neocortex-powered robot for plant sorting and picking.

Machine learning, which is often referenced alongside AI and includes an ability to identify and learn from patterns without having to be programmed ahead of time, can also improve overall shop efficiencies and effectiveness. Consequently, this observational and learning process can allow machines to learn and make increasingly more accurate predictions over time based on the underlying data.

This is why there is such interest -- a buzz actually -- around the prospects of the use of AI in 2018. There is an increased awareness of the potential for new AI and machine learning capabilities available within business and industry.

In addition, there is also much anticipation around the prospects of manufacturing and robotics systems engaging in continuous assessing and learning of the underlying data and using it to provide actionable information.

CURRENT TECHNOLOGIES AND SUPPLIERS

An increasing number of industries are experimenting with -- and benefiting from -- artificial intelligence. They range from agriculture and consumer packaged goods to discrete and process manufacturing. The number of AI and cognitive solutions providers is also increasing, as AI improves the ability of robots to manipulate a variety of objects and maneuver in dynamic, unstructured environments.

Top software vendors are investing billions of dollars into AI, including IBM, Microsoft, and PTC. Here are a several examples of AI initiatives occurring by industry thought leaders:

AIBrain Inc. has a stated goal of building fully autonomous solutions by unifying three essential aspects of intelligence, namely problem solving, learning, and memory.

Alphabet Inc. is the parent of Google and purchased DeepMind Technologies in 2014. It is developing programs that can learn to solve

any complex problem without needing to be taught how. The company is conducting research in the field of games, a useful training ground for machine learning, to develop algorithms that can provide a foundation for a wide variety of practical uses in business and industry.

IBM Watson was initially designed to beat chess grandmasters. It can process over 500 gigabytes of information (or the equivalent of 1 million books every second) with its natural language processing capabilities.

Microsoft Corp.'s Project Oxford includes research in image, text, and speech recognition capabilities. One area of research includes a facial recognition algorithm that can work with Windows phones.

PTC's acquisition of ColdLight and its big data expertise bolsters the ThingWorx IoT platform. The solutions use machine learning technology to automatically and continuously discover patterns, build validated predictive models, and send information to virtually any type of application or technology.

SingularityNet enables AI-as-a-Service by offering an open platform allowing access to AI services. Its founders have developed AI for industrial and humanoid robots.

Still, there are limitations on what AI and machine learning can do. First and foremost, they can't learn and analyze by themselves. They need a strong data management and analytics framework to provide clean and accurate data, otherwise the accuracy of systems learning and prediction capabilities.

Also, the success of AI solutions is dependent on the underlying security of networks and the adaptability of anti-intrusion and anti-fraud frameworks.

THE USE OF AUTOMATION EXPANDS

For many people, their initial exposure to AI has been with such consumer products as Apple's Siri and Amazon's Alexa.

Still, understanding and anticipating customer and partner expectations is more difficult than ever, with some organizations having to store as much as dozens or hundreds of terabytes of both structured and unstructured data. This data often resides in databases and data warehouses throughout these companies, sometimes in siloed, disparate systems.

Analyzing this data often requires the use of AI, machine learning, and predictive analytics techniques to sift through the data to identify trends and predict behaviors. These tools are becoming increasingly necessary, considering McKinsey estimates that the volume of all data continues to double every three years as information from digital platforms, wireless sensors, and

mobile devices are shared across systems.

Many organizations are finding that in order to deliver on customers' heightened expectations, faster and more accurate ways to predict demand and behaviors are critical to successfully interact and engage with both prospects and customers.

Analytics, AI, and machine learning can be instrumental in meeting these goals. These solutions can offer timely and relevant alerts and next-best-action suggestions, which can augment outreach efforts and improve the overall customer experience across industries.

Call and contact centers are increasingly using AI through chatbots and similar tools. The algorithms in these systems can learn from the data they are exposed to. And, as more data is processed, more insights are gained, leading to better interactions. Machine learning is adept at discovering patterns, enabling improved prediction capabilities.

Similar benefits can be seen in the retail and manufacturing sectors as well. For example, McKinsey found that over the past five years, U.S. retailer supply chain operations that have adopted data and analytics solutions have seen up to a 19% increase in operating margins.

While organizations have realized much value from data management and analytics to date, there's still plenty of room for improvement. The estimated potential value captured from the use of data and analytics has been uneven, with the retail industry capturing approximately 30% to 40% of potential value from such systems, and manufacturing only capturing about 20% to 30% of potential value, per McKinsey.

Also, PwC estimates that almost half of all manufacturing activities might be automated through robotic process automation (RPA), which could translate into a $2 trillion reduction in global workforce costs.

End users of automation increasingly require interoperability among a wide variety of systems. Common attributes of such systems often include:

Data: Includes both structured data that can be found in databases and data warehouses, as well as unstructured, text-based data. Data is often transformed into information, allowing a virtual representation of various systems.

Integration and interoperability: This includes integration with machines and devices within systems, as well as interoperability across systems. Such interoperability capabilities are often the backbone for Internet of Things capabilities.

Autonomous management: This includes the ability to make simple decisions about such things as equipment condition and adjustments as conditions change, and make appropriate adjustments to schedules, sequences, or timing of actions.

Robots and unmanned systems: This often includes some form of machine learning or artificial intelligence capabilities.

Another trend in business is greater end-user reliance on higher-level reporting, business intelligence, and analytics systems. This is a major change, as in the not-too-distant past, analytics solutions were used solely by quant staffs residing in some IT department.

However, over the past few years, new solutions that do not require deep knowledge of tools such as SQL, R, or SPSS have become available.

Newer solutions are designed to better understand and infer users' intentions. They offer common result sets that are likely appropriate for specific scenarios.

These systems are not designed to replace quant teams; their primary role is to allow business users to try "what-if" scenarios. From these, subject-matter experts can test and refine various business and economic models.

In the end, the models can be better leveraged through higher-level analyses along with line-of-business experts.

Industrial AI Example 1: Comet Labs

Adam Kell, an investment partner at Comet Labs, shared some interesting observations about advances that are occurring in AI and machine learning.

"Learning theory in AI requires continuous improvement and a deep understanding of the underlying elements in various industries," he said. "There is also a time lag between early experimentation and the availability of practical applications within the underlying solution infrastructure."

Another observation is the use of gamification to provide an environment for systems to learn.

"For example, some firms, like Google, are using repetitive motion tests so robotic arms learn about finding and grasping objects without damaging them," offered Kell. "The result could be improvements in applications like farming, recycling, and warehouse order-picking applications, where robot arm dexterity can be so important."

Industrial AI Example 2: Bell and Howell

PTC's ThingWorx IoT platform has provided insights into equipment

AI and robotics are improving throughput in forward-thinking operations.

performance, said Don Bullock, vice president of technical and professional services at Bell and Howell. This has helped fine-tune predictive maintenance and deployments through remote mechatronic diagnoses.

"The beauty of the PTC ThingWorx platform is it's going to give us the ability to know beforehand when a machine is going to fail," he noted. "Consequently, we can proactively schedule work at a time that is convenient to our customer and replace components and conduct maintenance, knowing that the machine is going to have high reliability."

Industrial AI Example 3: Universal Logic Neocortex

Universal Logic's Neocortex AI integrates vision, grasping, and motion control technologies to give machines human-like flexibility at high speed. Neocortex enables automated supply chain systems to handle high-mix, high-volume applications, such as bin picking, box moving, bag handling, machine tending, 3D inspection, and assembly/kitting.

Universal Logic's software platform is hardware- and sensor-independent and typically provides payback in less than 18 months. A sampling of some their AI solutions for robotic applications is show on the next page

SAMPLING OF NEOCORTEX AI APPLICATIONS

Application	Time in Operation	Neocortex® AI Solution Role	Adaption to Object Variety		Robot Brand
			# Types	Variation	
All the applications below have been handling an average of 700 – 1,800 items per hour					
Case/Carton Handling	3½ years	Identifies boxes with varying shape due to frost, Guides robot pick & place	< 10 box types	13x10x10" – 17x10x10" Weight:10–30lbs	KUKA
Part (Bin) Picking	2½ years	Identifies part, Guides robot pick & place	90,000 items	Size: 3 – 7" Weight: ¼ – 7lbs	ABB
Agricultural Plant Sorting	1 year	Identifies plant, Sorts good/bad, Guides damage-free robot pick & place	Organic, unlimited	Size: 3 – 10" Weight: ¼ – 2lbs	Adept / Omron
Consumer Goods Order Fulfillment	1 year	Identifies item, Verifies SKU#, Guides robot pick & place	100,000 – 500,000 SKUs	Size: 0.5 – 6" Weight: ¼ – 4lbs	Yaskawa Motoman

KEY POINTS

- Neocortex: delivers Flexibility @ Speed®
- Flexibility: Neocortex AI informs perception, grasping, and motion
  - Deep learning provides perception not possible with vision alone
  - Real-time grasping using vacuum, finger, electromagnetic, combination EOAT
  - Real-time robot path planning with any collaborative or industrial robot
- Accuracy: 100% verification with barcode scan, 3D visual inspection to 75 microns using fixed sensors and/or sensors on robot arm
- Speed: typical applications handle 600 – 1,400 items per hour
- Reliability: typical applications > 99.5% without requiring human training
- Prepackaged Neocortex G2R (Goods to Robot) Cell: delivered on a skid, easily redeployed, half the cost of labor
- Standard applications: robotic order fulfillment, random bin picking, robotic bag picking, automatic machine tending, robotic case (de)palletizing, robotic material induction

FUTURE INDUSTRY DEPENDS ON AI

Organizations that are laggards in learning about -- and using -- AI and robotics do so at their peril. The ultra-efficient factories of the future will rely on machine learning to achieve desired line speeds, flexibility, and reliability.

To meet the e-commerce expectations of custom and instant order fulfillment, manufacturing and supply chain operations must carefully tune their system performance. With deep learning, data gathered by sensors (and robots and drones) can be used to autonomously adjust processes in real time.

Also, with lean production and global competition as universal priorities,

AI and machine learning can help to maximize equipment uptime. In some operations, downtime can cost up to $20,000 per minute, so unplanned downtime can have serious implications.

Although the automotive industry was among the first to focus on automation for 24/7 operations, other industries are now also looking to robotics and AI. Logistics, healthcare, retail, and hospitality are joining manufacturing as lucrative markets for automation.

Looking ahead, AI, machine learning, and deep learning will provide tremendous opportunities to increase the value of business data. These benefits are derived from a deeper understanding of equipment use, partner requirements, consumer demand, product throughput, and market trends, as well as identifying new patterns and trends.