DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Identifying Applications of Autonomy Applicable to Naval Activities

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ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense information analysis center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

DSIAC serves as the national clearinghouse for worldwide scientific and technical information for weapon systems; survivability and vulnerability; reliability, maintainability, quality, supportability, and interoperability; advanced materials; military sensing; autonomous systems; energetics; directed energy; and non-lethal weapons. We collect, analyze, synthesize, and disseminate related technical information and data for each of these focus areas.

A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit www.DSIAC.org.

ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) received a technical inquiry requesting examples of applications of autonomy in the commercial sector relevant to the naval enterprise. DSIAC worked with subject matter experts from the West Virginia University Innovation Corporation to compile a list of technologies that fit the inquirer's request. The research was compiled and sent to the inquirer.

Contents

1.0 TI Request

1.1 SUBJECT: Applications of Autonomy in the Commercial Sector Relevant to the Naval Enterprise

1.2 DESCRIPTION

The inquirer requested examples of applications of autonomy in the commercial sector (logistics, medicine, data/cyber, etc.) that might be good candidates for implementation/deployment in naval enterprises (U.S. Navy, U.S. Marine Corps, and supporting civilian infrastructure).

2.0 TI Response

The Defense Systems Information Analysis Center (DSIAC) reviewed the request and assigned the inquiry to a subject matter expert (SME) at the West Virginia University Innovation Corporation (WVUIC). The SME researched examples of applications of autonomy in the commercial sector relevant to naval enterprises and compiled a list of technologies. The technologies fall under logistics, medicine, and data.

2.1 LOGISTICS

2.1.1 Magazino: Toru

Toru is an autonomous warehouse robot that can identify and grasp individual objects (books). Toru was developed by Munich-based start-up Magazino GmbH, which is partly owned by Siemens.

- Excerpt from "Meet Toru the Tireless Warehouse Worker" by Seimens [1]:

  > Toru is, in essence, a picture of the future of warehouse logistics. 'We're taking a completely different approach to those used in traditional automation solutions,' says [Nikolas] Engelhard. To date, automated warehouse systems have only been able to move entire boxes or pallets; but the retrieval of individual items has always been done by human beings. This is not the case with Toru, however. Toru has a 'brain' — an industrial computer, whose software consists of large numbers of standardized and specially developed algorithms. He also has 'eyes,' which consist of a 2D camera and a crosshair laser that enable him to identify objects, and is equipped with 'muscles' and a 'sense of touch.' This is made possible by sensors that measure how Toru touches an object as well as by drive units that enable Toru's gripper to grab a book. What's especially important is that Toru 'knows' he must stand still whenever a person crosses his path. Certified safety lasers continuously scan Toru's immediate surroundings, causing him to stop if necessary.

For more information about Toru, see the following:

- "Meet Toru the Tireless Warehouse Worker" by Seimens at the following link: https://www.siemens.com/innovation/en/home/pictures-of-the-future/digitalization-and-software/autonomous-systems-start-up-magazino.html
- "World's First Independently Operating Warehouse Robot" by Seimens at the following link: https://www.siemens.com/innovation/en/home/pictures-of-the-future/industry-and-automation/digitale-factory-autonomous-systems-magazino.html [2]

- Magazino at the following link: https://www.magazino.eu/toru/?lang=en [3]
- "A Dexterous Warehouse Robot Does Things Amazon's Automated Helpers Can't" by Kremen at the following link: https://www.technologyreview.com/s/601690/a-dexterous-warehouse-robot-does-things-amazons-automated-helpers-cant/ [4]
- "Magazino's TORU Inventory-Grabbing Robot Rolls Into Major German Logistics Center" by D. Coldewey at the following link: https://techcrunch.com/2016/09/07/magazinos-toru-inventory-grabbing-robot-rolls-into-major-german-logistics-center/ [5]

2.1.2 Amazon Robotics: Kiva

Amazon uses Kiva robots in its warehouse operations to move racks of merchandise. Kiva Systems, purchased by Amazon in 2012 and renamed Amazon Robotics, was developed to use robots to move the "pods" on which the products are stored instead of searching for and moving individual products.

- Excerpt from "Amazon Robotics: IoT in the Warehouse" by P. Valerio [6]:

    Storage pods can hold hundreds of different types of products, but the size and shape of each pod is exactly the same….

    The robots are controlled by a centralized computer using a secured WiFi network for communication. They have two powered wheels that allow them to rotate in place, IR for obstacle detection, and floor cameras to read QR codes on the ground. The QR codes are used by the robots to determine their location and direction. When the robots have been working for an hour, or are running low on battery power, they go to power stations and plug in for a quick charge.

For more information about Kiva, see the following:

- "Amazon Robotics: IoT In The Warehouse" by P. Valerio at the following link: http://www.informationweek.com/strategic-cio/amazon-robotics-iot-in-the-warehouse/d/d-id/1322366 [6]
- "Meet Amazon's Busiest Employee -- the Kiva Robot" by D. Tam at the following link: https://www.cnet.com/news/meet-amazons-busiest-employee-the-kiva-robot/ [7]
- "Inside Amazon's Warehouse, Human-Robot Symbiosis" by W. Knight at the following link: https://www.technologyreview.com/s/538601/inside-amazons-warehouse-human-robot-symbiosis/ [8]
- "Amazon Now Has 45,000 Robots in its Warehouses" by S. Shead at the following link: http://www.businessinsider.com/amazons-robot-army-has-grown-by-50-2017-1 [9]

2.1.3 PINC Solutions: Aerial Inventory Robots (AIRs)

PINC's unmanned aircraft system AIRs perform automatic inventory checks in warehouses [10]. PINC also has been approved by the Federal Aviation Administration (FAA) to operate in geo-fenced commercial zones.

For more information about PINC AIR, see the following:

- "Warehouse Drones: Real-Time Inventory Tracking by Air" by PINC at the following link: http://www.pinc.com/inventory-robotics-cycle-counting-drones [10]
- "PINC Air Cleared for Take Off by the FAA" by UAV Expert News at the following link: http://www.uavexpertnews.com/pinc-air-cleared-for-take-off-by-the-faa/ [11]
- "Intelligent Energy to Supply PINC with Hydrogen Fuel Cells for UAVs" by Drone Life at the following link: http://dronelife.com/2017/03/28/intelligent-energy-supply-pinc-hydrogen-fuel-cells-uavs/ [12]

2.1.4 Airobotics: Automated Drone

In 2017, Airobotics was authorized to fly fully automated drones in Israel for site surveying, power lines inspection, and other industrial applications.

For more information about Airobotic's drones, see the following:

- "Airobotics Scores Authorization to Fly Autonomous Drones in Israel" by L. Kolodny at the following link: https://techcrunch.com/2017/03/27/airobotics-scores-authorization-to-fly-autonomous-drones-in-israel/ [13]
- "Airobotics Is Granted World's First Approval to Fly Fully-Automated, Commercial Drones Without a Pilot" by the Israeli Civil Aviation Authority at the following link: http://www.airobotics.co.il/press-releases/airobotics-granted-worlds-first-approval-fly-fully-automated-commercial-drones-without-pilot/ [14]

2.2 MEDICINE

2.2.1 APSARA: Cardboard Drones

Excerpt from "Meet APSARA: a cardboard drone for humanitarian emergencies" by W. Deiderichs [15]:

> In recent years, drones have slowly cemented themselves as an integral part of our future, providing us with a whole new dimension of possibilities. One of the latest additions to the drone family is the APSARA drone, a drone designed to potentially deliver supplies such as medicine in humanitarian crises.

For more information about APSARA's cardboard drones, see the following:

- "Meet APSARA: A Cardboard Drone for Humanitarian Emergencies" by W. Diederichs at the following link: https://gearburn.com/2017/03/apsara-cardboard-drone-emergencies/ [15]
- "The Brilliant Drone That'll Deliver Medicine – Then Rot Away" by P. Farrell at the following link: https://www.wired.com/2017/02/brilliant-drone-thatll-deliver-medicine-rot-away/ [16]
- "Vanishing Acts: A Call for Disappearing Delivery Vehicles" by the Defense Advanced Research Projects Agency (DARPA) at the following link: http://www.darpa.mil/news-events/2015-10-09 [17]
- "Swarms of Disposable Drones Will Make Critical Deliveries and Then Vanish" by E. Ackerman at the following link: https://spectrum.ieee.org/automaton/robotics/drones/otherlab-apsara-aerial-delivery-system [18]

2.3 DATA

2.3.1 Saffron Technology: Natural Intelligence Platform (NIP)

Saffron Technology's NIP is a "… key-value, incremental learning, fast-query, graph-oriented, matrix-implemented, semantic, and statistical knowledge store inspired by the associative structure and function of real neural systems" [19]. It uses autonomous learning to analyze large and small data groups for manufacturing, financial services, healthcare, and defense.

For more information about NIP, see the following:

- "Saffron Technology: How Intel's Cognitive Computing Acquisition Thrives on Chaos" by C. McLellan at the following link: http://www.techproresearch.com/article/saffron-technology-how-intels-cognitive-computing-acquisition-thrives-on-chaos/ [19]
- "Introducing Intel Saffron Quality and Maintenance Decision Support Suite" by Intel Saffron Technology at the following link: http://saffrontech.com/platform/ [20]
- "Saffron Gets $7M to Build Brain-Like Learning Machine" by A. Woodie at the following link: https://www.datanami.com/2014/03/20/saffron_gets_7m_to_build_brain-like_learning_machine/ [21]

2.3.2 Automation Anywhere Enterprise: Digital Workforce

Automation Anywhere Enterprise uses a digital "workforce" composed of software bots that complete business processes end to end. It combines traditional robotic process automation software with cognitive elements, including reading unstructured data and natural language processing.

For more information on Automation Anywhere's digital workforce, see the following:

- "How Robotic Process and Automation Will Transform the Workplace" by J. Morgan at the following link: http://www.inc.com/jacob-morgan/what-happens-when-your-co-worker-is-a-bot.html [22]
- "The Future of Work" by Automation Anywhere Enterprise at the following link: https://www.automationanywhere.com/digital-workforce [23]
- "Automation Anywhere Unveils Industry's First Analytics Solution Designed for Bots" by Automation Anywhere Enterprise at the following link: http://www.marketwired.com/press-release/automation-anywhere-unveils-industrys-first-analytics-solution-designed-for-bots-2165764.htm [24]

2.3.3 Woods Hole Oceanographic Institution (WHOI): Autonomous Underwater Vehicles (AUVs)

WHOI developed several AUVs that operate autonomously to collect data via sensors and cameras. WHOI uses AUVs to investigate climate change, oil spills, ocean acidification, and other environmental concerns.

For more information on AUVs, see the following:

- "Autonomous Underwater Vehicles" by WHOI at the following link: http://www.whoi.edu/main/auvs [25]
- "ROV Captures New Images of USS Arizona" by M. Rees at the following link: http://www.unmannedsystemstechnology.com/2016/11/marine-imaging-technologies-rov-captures-images-of-uss-arizona/ [26]
- "Underwater Vehicles Follow Tagged Turtles in the Wild" by Robotics Tomorrow at the following link: http://www.roboticstomorrow.com/news/2016/12/07/underwater-vehicles-follow-tagged-turtles-in-the-wild/9234/ [27]

2.3.4 Other Virtual Agents

There are several virtual agents currently used in customer service and home management that could benefit the naval enterprise. Amazon, Apple, Google, Creative Virtual, Artificial Solutions, IPsoft, Microsoft, and Satisfi provide virtual agents with varying degrees of artificial intelligence and autonomy.

For more information on these virtual agents, see the following:

- "Amazon Echo Review: The Smart Speaker That Can Control Your Whole House" by R. Crist and D. Carnoy at the following link: https://www.cnet.com/products/amazon-echo-review/ [28]
- "Amazon Echo – Black" by Amazon at the following link: https://www.amazon.com/Amazon-Echo-Bluetooth-Speaker-with-WiFi-Alexa/dp/B00X4WHP5E [29]
- "Siri" by Apple at the following link: http://www.apple.com/ios/siri [30]

- "The Difference Between Google Now and Google Assistant" by S. J. Purewal at the following link: https://www.cnet.com/how-to/the-difference-between-google-now-and-google-assistant/ [31]
- Creative Virtual at the following link: http://www.creativevirtual.com/ [32]
- Artificial Solutions at the following link: http://www.artificial-solutions.com/ [33]
- IPsoft at the following link: http://www.ipsoft.com/ [34]
- "Cortana" by Microsoft at the following link: https://www.microsoft.com/en-us/cortana [35]
- Satisfi Labs at the following link: http://biz.satis.fi/ [36]

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