



# Technology Frontier

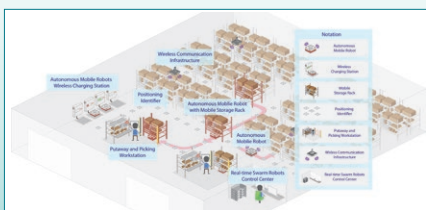
News Bite on PolyU's Innovation

## Industrial IoT-based Smart Robotic Warehouse Management System Smart and cost-efficient solution for congested warehouse space

Industry 4.0 has been the tech buzzword for a few years. But even if goods can be manufactured in the most efficient way with minimal human supervision, raw materials, parts and even finished products have to be delivered and moved efficiently in order to realize the full potential. That means smart logistics are in huge demand. In the same line of thought, researchers from the Department of Industrial and Systems Engineering developed a smart robotic system for warehouses, which engages a number of robots to carry the shelves to the workers, saving much idle time and running cost, while greatly increasing the efficiency.



Dr Carman K. M. Lee and her research team posing with an automated guided vehicle



Conceptual diagram of the IIoT based Smart Robotic Warehouse Management System

Industry 4.0 refers to the emergence of smart factories, where goods are manufactured in completely automated manner; where machines can communicate with each other via the Internet of Things (IoT) to streamline the workflow, so that human supervision can be minimal. However, to fully realize the potential of Industry 4.0, raw materials, parts and end products need to be delivered and moved in equally efficient manner. That's why the logistics need to be updated as well. In light of this, Dr Carman K. M. Lee, Assistant Professor, Department of Industrial and Systems Engineering, in conjunction with RV Automation Technology, led a research team in developing an industrial IoT-based

smart robotics system that subverts pre-conceived warehouse management concepts by moving the shelves to the workers with automated robots. The system has been pilot implemented in logistics and manufacturing companies in the Guangdong-Hong Kong-Macao Greater Bay Area, to increase efficiency and effectiveness, and lower the cost in operations.

### Traditional low-tech approach

It is getting more and more difficult to hire warehouse workers because traditionally, it is a physically demanding job that entails heavy lifting and much walking, highly susceptible to wear-and-tear injuries and accidents. "In the past, workers have to print out a picking list, walk



Control centre of Smart Robotic Warehouse Management System

or drive to a shelf, visually identify and confirm an item, lift the item off the shelf and carry it or drive it back to a workstation. A warehouse easily covers over 10,000 square feet of floor space and just the walking and driving time required could be substantial," explained Dr Lee. In the past few years, the use of robotic arms in conjunction with RFID tags has sped up the item pickup and drop-off process in major ways. However, robotic arms take up much space and are useable only in huge warehouses with sufficient passage spaces built-in between shelves.

#### Smart warehouse logistics

Dr Lee's team thus developed a radically different system with a subversive idea. "Instead of man-to-goods, we opted for a goods-to-man approach. That is to say, instead of sending the workers to the shelves to pick up or drop off an item, we send the shelves to the workers so that they just need to stay at one spot without wasting time on travelling within the warehouse," she said. The system uses automated guided vehicles (or AGV in short), which are smart robots controlled by a central system. They are thin enough to go under a shelf and strong enough to lift the whole shelf and carry it to a workstation. Lights on the movable shelves will indicate which items need to be removed and the same information will be shown on a screen. There is no picking list and workers no longer need to walk or drive around to find

the shelf, or to verify the item with their eyes, minimizing the chance of human errors.

"One key advantage of our system is less space requirement. Land is an expensive asset and passages are considered as an idle space that doesn't generate income for a warehouse. When necessary, the system may minimize passages for the highest stocking capacity," added Dr Lee. The intelligent AGVs are designed to rotate on the spot, so that no extra space is required for making turns. The system can even maximize the use of floor space by leaving only absolutely necessary passages between shelves. To retrieve a shelf that is not readily reachable on an aisle, the central system will work out the easiest route. Then two or more AGVs work together to move shelves that get in the way, before retrieving that particular shelf. The system also optimizes AGV paths, so that they don't crash into each other or cause any congestion in the aisles. Even the re-slotting is optimized to minimize retrieval time.

In December 2018, Industrial IoT-based Smart Robotic Warehouse Management System won a gold medal and an outstanding Automation Award at the Asia International Innovative Invention Award. In April 2019, this project also won the silver medal at the 47th International Exhibition of Inventions of Geneva.