Feature article

Mobile hospital robots cure numerous logistic needs

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Abstract
Purpose – The purpose of this paper is to show how mobile robots are addressing a variety of hospital logistic needs.
Design/methodology/approach – The paper includes in-depth interviews with developers of the Aethon hospital mobile robot logistics system.
Findings – Robotics can greatly improve hospital logistic services such as moving food, lab samples, prescriptions and even add a bit of entertainment in the process.
Practical implications – Hospital administrators have new answers to the old challenges of moving items in a timely and cost-effective manner around their facility.
Originality/value – Hospitals are first implementers of mobile robotics to look for answers to their logistic problems. They do not have to break new ground for themselves.

Keywords United States of America, Hospitals, Delivery, Distribution management, Mobile, Robots, Logistics

Paper type Case study

Hospital care includes a great deal more than doctors, nurses, surgery and bed rest. Aethon, a Pittsburgh, Philadelphia company has brought mobile robots to the party to help address other hospital care needs such as getting food and clean linens to the patients in their rooms, delivering prescriptions and medical supplies to the nursing stations in an accurate and timely manner and transporting patient test samples to the laboratory. All of these logistic needs in the past have been difficult to manage in terms of quality and cost control.

The US Bureau of Labor Statistics reports there is an extreme shortage of nurses. Industry studies have shown that nurses spend as much as 30 percent of their time away from patient bedside care chasing down medications, supplies, lab results, all logistics duties.

Aethon has developed its TUG® automatic robotic delivery system answer to these needs. The TUG is a mobile robot that travels autonomously throughout the hospital (Figure 1). It can ride elevators to the desired floor, open automatic doors, avoids obstacles in its path and even announce its arrival and ask people to step aside if they are blocking its path or as it needs to exit an elevator on its correct floor.

TUG system details

Each mobile robot consists of three basic elements:
1 A battery-powered drive and steer unit.
2 A control module with Wi-Fi capability, computerized direction skills, hazard detection abilities, audio "speaking" ability and door-opening and elevator operation skills.
3 Load-carrying modules are custom designed for tasks such as linens delivery or pickup, food service, pharmacy or for lab sample transport. The load modules are detachable so the drive unit and controller can be dispatched on another assignment while modules are loaded or unloaded.

The fleet of TUG robots is under the control of a central computer running the TUGOS software. As an option, the software can include an automatic assess monitoring package which provides a real-time report on status and location of the entire fleet.

The drive unit

A battery-powered steerable drive unit 19 cm high and 51 cm wide. Fits under and supports the front of a variety of available two-wheeled transport carts.

About 24 V rechargeable batteries power two independent motorized drive wheels. The TUG automatically returns to its charging station between runs or when the battery runs low on energy (Figure 2). A charge lasts up to 10 h of normal operation.

The drive unit weighs just 25 kg. Each drive unit is rated to move loads plus TUG up to a total of 227 kg.

The control module

A unit which is attached to the top of the drive unit module. It includes the control computer, a matrix of sensors to detect people and other obstacles, a speaker for audio communication with humans and onboard controls.

The sensor package, called Light Whiskers™ by Aethon, includes sonar, laser and infrared technologies. The sensors allow the TUG to detect any obstacle or person in its path.

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Figure 1 Aethon TUG® automatic robotic delivery system

Note: Robots operate in the same space as visitors and staff, stay close to walls, announce arrival and even take the elevator on their own
Source: © Aethon used with permission

Figure 2 Four meal delivery TUG robots docked at charging stations

Note: Time between meal deliveries used as recharging time to avoid any delays in meal deliveries
Source: © Aethon used with permission

The TUG can autonomously navigate around the obstacle and continue safely on its way. If needed information is relayed to the controller to temporarily take over the TUG's controls.

The onboard control computer has Wi-Fi communications abilities to maintain linkage to the TUGOS system controller. This allows each TUG to communicate with other TUG mobile robots via the central TUGOS software to avoid bottlenecks and coordinate elevator use.

Each TUG controller memorizes the floor plan for the facility by importing CAD drawings of the building. This is used to create an onboard map. An Aethon installation engineer verifies this map before startup of the system. If no CAD drawing exists, the installation engineer can create a map by manually guiding the TUG through the entire facility. RFID tags can be placed around the facility to provide fixed reference points for the TUGs to maintain location accuracy.

The controller can "speak" to humans using recorded messages such as:

- Please step aside, leaving the elevator.
- Food service has been delivered.
- Ready to be dispatched.

Load carts

Aethon has designed a number of application-specific load carts uniquely matched to their logistic assignments. The carts are designed for easy detachment from the drive and control modules. The pharmacy carts have security locking systems which only allow authorized nurses to open and have access to the patient ordered prescriptions. This insures full accountability of patient meds.

Linen service carts have trays to keep ready-to-use linens neatly stacked. Bins are provided for return of soiled linens. The carts when detached from the drive and control module become storage units for clean linens on the patient floor.

Food service carts keep meals ready to serve and safe from contamination. When the cart arrives on the floor and announces its arrival, staff detach from the drive/control unit, meal trays can then be distributed to patients. Special-needs trays are clearly marked for the correct patient room. After meals have been served, the cart can be filled with the dirty dishes and trays, and with the push of button returned to the kitchen.

Operation of automatic door and elevators

Each TUG can communicate with a module attached to doors or elevators. The unit enables the TUG to signal for an elevator to come to the current TUG floor. The TUG can also transmit instructions to the elevator as to the floor it wishes to go to. Typically the TUG system is set up to employ service elevators and not the normal visitor and staff elevators which reduces conflicts with visitors and staff (although, when necessary, the TUG can share common elevators.

The elevator control modules are incorporated into the elevator system at the time the TUG system is installed and integrated into the hospital facility. The interface allows the TUG to monitor various signals from the elevator controller, including current elevator cabin location, direction of travel, arrival to desired floor and when the doors open.

Details of basic TUG dispatch

Once the system is installed in the facility and the floor plan has been loaded into the master controller, the system is ready to operate. TUGs are dispatched from the loading areas such as the pharmacy, central supply, kitchen or laundry. The sender keys in the destination for the load using the facility map on the monitor screen.

TUG deliveries can be scheduled to occur at specific times as well as be executed on-demand. When the TUG arrives at the destination it announces its arrival. Once staff has completed the unloading, they press a button on the TUG to signal it to return to its home base or continue its deliveries to other nurse stations. If staff on a nursing floor needs an empty TUG to return soiled linens to the laundry, as an example, they telephone the laundry and request the dispatch of an empty TUG.

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Hospital applications

A number of hospitals have installed the Aethon TUG system. Some have implemented a total hospital logistic solution while others have applied the TUG to a specific logistic need such as food service, linens or pharmaceutical. Below are descriptions of a selection of applications in operation now.

Children's Hospital Boston, Boston, Massachusetts

Children's Hospital is a 395-bed pediatric care facility. A fleet of six "Choo! Choo! Train" looking TUG robots not only deliver meals to the children patients but also provide an entertaining change of scenery for them (Figure 3). The TUG units carry meals from a basement kitchen to all patient floors of the facility. The idea for the train-styled TUG was generated by a child undergoing treatment for leukemia in San Francisco who expressed the desire to have his medications delivered by a robot. The Make-a-Wish Foundation chapter in San Francisco connected the patient with Aethon.

Make-a-Wish Foundation is a charity that tries to provide a "wish" for seriously ill children. The Make-a-Wish connection even resulted in the young patient actually being involved with design of the train engine-like façade for the TUG. Aethon now offers the train-styled TUG as a standard option and donates $1,000 to the Make-a-Wish Foundation for each train TUG it sells.

Figure 3 TUG "wearing" a steam engine "overcoat" to liven the lives of young patients at children's hospitals while delivering their meals

Source: © Aethon used with permission

Now the pediatric and adolescent patients at the hospital founded 1869 are treated to the trains passing their rooms at meal times. Shawn Goldrick, Director of Patient Support Services for Children's Hospital Boston says "Our food service professionals are now able to remain on the floors supporting patients' food service needs, allowing nurses to spend more time providing hands-on patient care. We love the fact that we are able to accomplish something so functional while bringing smiles to patient faces."

University of Maryland Medical Center (UMMC), Baltimore, Maryland

To address concerns about slow drug delivery as well as inventory losses, UMMC implemented an initial three TUG-based pharmaceutical delivery system (Figure 4). The 757-bed teaching hospital provides acute care for more than 32,000 inpatients and 300,000 outpatients annually.

Nurses in the trauma unit felt that the previous manual pharmacy delivery cycle time of 74 min (on average) from order until arrival at the nursing station was too long and should be able to be greatly improved. The Aethon TUG system in just its first year of operation reduced average delivery times to 30 min.

Other bonus benefits were that nurses saved more than 6,000 h in tracking down medications. There were also reductions in drugs being misdirected or lost in transit. Nurse satisfaction with pharmacy service improved by 23 percent (Figure 5).

The system has been so successful that UMMC has added additional TUG robots and implemented an all-electronic "chain-of-custody" system called MedEx. This is a fully automated tracking system which provides real-time location and status information on all medications in the hospital. This increases medication security and compliance with government regulations while reducing paperwork and increase staff availability for other care tasks.

Figure 4 Typical medication delivery TUG

Notes: When combined with the MedEx program, safely delivers medications in secure locked drawers; the system includes biometrics and software to create a complete chain-of-custody for every medication; saves hospitals by reducing the number of medications lost or misdirected in a manual distribution system as well as expediting round-the-clock deliveries
Source: © Aethon used with permission

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Figure 5 TUGs at a nursing station increase nurse satisfaction by allowing them to focus on patient care rather than searching for or retrieving equipment and supplies

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El Camino Hospital® Silicon Valley, California

When planning their new 42,000 m^2, 300-bed facility, the hospital management realized that distances between departments would result in greatly increased time and costs for delivery of food, pharmacy, linens and other necessary supplies. With the help of the hospital's Center for Technological Innovation, they decided to install the Aethon TUG system.

They now have 19 TUGs deployed for a variety of logistic tasks. Two TUGs transport lab samples from the patient floors to the laboratory. Two units safely and securely deliver medications from the pharmacy to the nurse stations. Five food service TUGs deliver meals in a timely manner to patients. Four units remove trash while four other units deliver fresh linens and retrieve soiled items (Figure 6). Two other units handle other materials.

Ken Graham, Chief Executive Officer for El Camino Hospital, says "Aethon's TUG robots have allowed us to automate over 80 percent of all deliveries – from medications and lab samples to linens and waste management – saving us more than $650,000 USD a year in wages and benefits, not to mention workers compensation claims."

Figure 6 Typical linen delivery TUG with its 227 kg load capacity, the robot effortlessly delivers clean linen and returns soiled linens to the laundry

Source: © Aethon used with permission

University of Pittsburgh Medical Center – St Margaret Hospital, Pittsburgh, Philadelphia

St Margaret Hospital is a 185-bed community and teaching operation. Before the TUG system was installed, St Margaret's central supply unit made an average of 60 hand deliveries per day to seven nursing units. Deliveries included medical equipment and supplies. Supply technicians spent 9 h/day making deliveries.

Judy Hession, central supply manager, said "It was difficult to keep up, especially on evenings and night shifts, when staffing is at a minimum. There were complaints from nursing about slow deliveries. My staff was discouraged."

Aethon installed a three TUG delivery system which has resulted in an average round-trip delivery process of just 8.8 min while safely navigating halls, visitors and staff (Figure 7). The hospital estimates they have a return on their investment of 185 percent.

Alle-Kiski Medical Center, Natrona Heights, Philadelphia

The hospital selected three TUG robots to handle lab results and supply delivery to the emergency department (Figure 7). The 250-bed hospital with a staff of 300 doctors and 1,100 employees found that turnaround time for lab results decreased from 24 min to just 7 min. Staff was able to treat many more patients without adding personnel. Lab result time can be very critical when treating patients in the emergency department.

Providence Hospital, Washington, District of Columbia

Providence Hospital operates a 382-bed medical facility and a 240-bed nursing and rehabilitation center. Concerned with improving asset management and tracking, Providence Hospital leadership implemented a TUG logistics system. TUG robots handle transport of supplies, meals, medications as well as lab specimens.

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Figure 7 Typical TUG robots used for logistic support for laboratories, pharmacies and even blood banks

Notes: The TUG eliminates the need for personnel standing by to make deliveries; TUG robots are available around the clock to make as-needed deliveries while saving considerable expense for staff

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Previously, nurses, pharmacists and lab technicians were spending valuable time acting as runner to fetch and deliver needed items rather than staying focused on patient care. Now the TUG system is available 24 h a day and is always on duty and never calls in sick or takes a vacation. Staff is no longer diverted to logistic needs.

The pharmacy department was able to eliminate the position of runner. Now the TUG makes as many as 40 medication deliveries per day. Nurses no longer have to rush to the lab, taking time away from patient care.

In the food service area the TUG robot system was delivering meals and in just two months after implementation, was already saving 100 min per day. The TUG robot also fetches late trays.

Central Dupage Hospital, near Chicago, Illinois

Central Dupage Hospital (CDH) operates a 313-bed facility. CDH, like many hospital, implemented a room service model for patient meals. Patients order from a menu just the food they want. Hospitals have found that such an amenity improves the patient experience and reduces the amount of wasted food while providing better quality and variety.

While the room service model had many benefits, the hospital found that there were problems of timeliness and labor cost. Their food service vendor turned to the Aethon TUG system. Recently the TUG system for food delivery makes more than 24,000 trips and travels over 4,800 km/year. The average time between order and delivery to the patient is only 32 min, well below the hospital goal of no more than 45 min between ordering and delivery.

The TUG system has been such a success that CDH is planning an expansion for a new 202-room addition and is relying on TUG to provide a cost-effective food service solution. The new addition will be more than twice as far from the kitchen as before. Planning indicates that the TUG system will continue to be able to deliver food in less than the 45-minute hospital goal.

For more information on the Aethon TUG hospital mobile robots or to see video of the units in operation, please visit: www.aethon.com.

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