Current Status of Art

Project Title: Deliveroid
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Introduction:

There exists a need in the workplace for a seamless and effortless exchange of physical documents between co-workers or departments. Currently, to have such an exchange, people have to tediously take time out of their busy day and walk to the office of the person they wish to deliver the documents to. If the documents need to be signed, the person then has to wait on the individual to read through and sign the document, then finally get to return to their office. This arises a need for a delivery robot, or what Spaceship Tech likes to call a Deliveroid. The autonomous robot is able pick up items at a source and deliver it to the intended destination. To successfully create the Deliveroid, it is necessary to research the principles used today in other technologies to achieve autonomy. For the robot to be autonomous, it must the following competences: self-localization, path-planning and lastly, map-building and map interpretation. Simple methodologies used today guide the robot along a predetermined path from a starting point to a destination. A designer is able to implement such a robot by using IR sensors and making it follow a dark line on a lighter colored surface. However, simply guiding a robot from a starting point to a destination means that the robot in effect, it not fully autonomous as it is only able to follow along the predetermined path either going forward or in reverse. This is why many designers are seeking to use light detection and ranging sensing (lidar) in order for the robot to create a 3D map of it's surroundings. To exploit this sensing technology, however, on-board storage media would be necessary as well as several other sensors. With the need for many sensors comes the need for more processing power which.. Robots such as Starship Technologies' robot uses satellite positioning and mapping to navigate the outside world. French-made delivery robot PostBot is able to assist on foot mailmen by following behind the mailman, lifting a total load of 330 pounds. From the evaluation of these technologies and products currently on the market, Spaceship Technologies will be able to decisively conclude what principles and methods best suit the Deliveriod.

Section 1:

The main engineering principles/concepts used in the design of the Deliveroid is a concept that has gotten a significant amount of recent traction - robot autonomy. In the simplest sense, robot autonomy means that the robot should be able to perform its intended function without the need for external control or influence. Depending on the function of the robot, making it completely autonomous can be a never-ending challenge. In the case of our Deliveroid, its autonomous aspect lies in the fact that the delivery robot needs to be able to autonomously travel between departments in the workplace in order to transfer documents and other items between co-workers and/or departments. A fully autonomous Deliveroid would need to be able to gain and store information about its environment, move without human intervention, cause no harm to humans, property or itself. Some technologies that aid sensing the environment includes electromagnetic spectrum sensors, sound sensors, temperature sensors, distance sensors, altitude

sensors and simple cameras. For example, distance sensors may aid autonomy by allowing the bot to "sense" an obstacle or person and avoid collision.

There have been many advances in the search of a solution that will allow for full autonomy. Starship Technologies have found a way to use Satellite positioning to create an autonomous food delivery robot. The robot is able to use its positioning system to find out what roads it should take to get to its destination and where each intersection is with great accuracy. Indoors, an engineer can make use of sonar sensing to sense objects and enable the robot to follow a specific path along a wall. Many commonly used technologies for getting robots to go to a specified destination simple guides the robot to the goal destination. This can be accomplished by putting an inductive loop or magnets in the ground underneath the robot and have it follow the path. Another method may be drawing a dark line on a lighter colored floor. This would create a contrast between the dark line and the floor. Using an array of IR sensors, the robot is able to calculate the reflectance of the surface underneath and thus try its best follow where there is a lower reflectance.

These technologies, however, do not create a fully autonomous robot. This is why many designers are seeking to use light detection and ranging sensing (lidar) in order for the robot to create a 3D map of its surroundings. By using such a technology, the robot would be able to gather details about its surroundings and store them on a storage medium for later use. The robot would be able to learn about new environments and thus self-localize itself in that environment and be able to self-calculate paths to a certain destination. Another technology available today is called ROS (Robot Operating System). ROS provides device drivers, visualizers and libraries that can better enable a robot to function as intended. ROS also provides a navigation technology that collects data from odometry and sensor streams and outputs commands that tell the robot what to do and in what direction. The navigation stack can also be configured for the particular shape of the robot which enables it to perform at a higher level.

Section 2:

There are many solutions out in the real world being deployed by companies to do delivery service. Within the last 5 years robotic delivery service has become more of a prominent feature with new products being released on an almost monthly basis. One such product is a robot built by Effidence SAS, a French based company, called PostBOT. Post bot is being tested in a german city and is supposed to help with carrying mail items for deliveries by carrying up to three hundred and thirty pounds and it moves and gets its sense of direction by tracking the movements of the legs of the deliveryman automatically following behind. It can also work in all weather conditions and can navigate obstacles by using computer vision software to identify object and move around them. It has four wheels and it is rectangular in shape with a height of about 5 feet.

Another robot named Gita built by Piaggio an italian company is a personal delivery device that looks similar to an exercise ball in shape can carry up to forty pounds and moves at a maximum speed of twenty two mph. It lasts for eight hours and has a unique design of two wheels over the entire body which allows for zero turning radius. It was designed to be a maneuverable as possible in highly condensed cities and can go any place that is wheelchair accessible. It has

multiple cameras embedded around its body and a storage bay with a finger print locking mechanism. It was designed to make carrying around heavy everyday items easier.

China has also deployed another delivery robot earlier this year made by Jingdong. It can carry 5 packages at once and travels up to twelve mph and can climb a twenty five degree incline as well. It is a four wheeled robot that costs almost one hundred thousand dollars to manufacture. When delivering it sends a text notification at its destination to the recipient and is uses face recognition technology or a pin code in order to access contents.

Deployed in dc is a food delivery robot developed by Starship technologies in London. A 2 feet tall robot deliver meals and groceries short distances around the city. The robots navigate by using cameras and gps technology and builds internal maps of the city through exploring new areas so that it can compute faster was to get to its destination the next time around. It can identify stop signs and can tell when a car is passing and can wait till the path is clear to cross without getting crushed. The robot comprises of six wheels with a compartment that has a code lock to open.

Section 3:

One aspect most current delivery and carrying robots have in common is the presence of a camera(s) in the architecture. This is, of course, a vital component in the machine's ability to interact with the outside world. In the case of technologies similar to our proposed Deliveroid, such as Starship Technologies' delivery robot, or Piaggio's personal robot, Gita, the built in cameras serve the purposes of identifying traffic signals and mapping out the local area for later use, respectively. Though these tasks are quite useful for the functionality of the robots mentioned above, finding and having optimal high definition cameras, able to produce the sharpest and most accurate picture, for these tasks can probably be quite costly. Despite this possibly high cost it is necessary in order to have the robots function as intended. Our Deliveroid is a machine intended for indoor use, in an office setting specifically, and could possibly circumvent this cost.

As previously mentioned, the strength of a camera is its ability to accurately identify the real world with a drawback of cost. We previously mentioned several other technologies that can be used to identify the environment of our Deliveroid. The IR distance sensor for example which is widely used in many daily technologies we use, particularly in public bathroom toilets, sinks and dryers, is several times cheaper than a micro-camera. However, the drawback of the sensor is that it is primarily for close-mid range use. Luckily, this drawback is circumvented by our intention of using the Deliveroid as an indoor office delivery robot. This same argument of circumventing cost with purpose is somewhat applicable to the approach of implementing a sonar sound sensor and not so much with a radio frequency strip detection due to installation costs.

Knowing the strengths and weaknesses of components in the current status of the delivery robot market, we believe that it would be best if our product, the Deliveroid, stick to low cost, sufficiently useful architecture that is able to be both affordable yet efficient in its office

setting. This can be accomplished through the use of affordable parts and very competent programming.