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Design of Wireless Operated (On RFID) Forklift in Warehouse

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Abstract

We describe the development of robotic forklift intended to operate alongside human personnel, handling palletized materials within existing, busy, semi-structured outdoor storage facilities. The robot operates in minimally-prepared, semi structured environments, in which the forklift handles variable palletized cargo using only local sensing, and transports it while interacting with other moving vehicles. The robot operates in close proximity to people, including its human supervisor, other pedestrians who may cross or block its path, and forklift operators who may climb inside the robot and operate it manually. This is made possible by novel interaction mechanisms that facilitate safe, effective operation around people.Using radio frequency identification (RFID) antennas with forklift trucks to identify goods and stock shelves automatically will help to increase efficiency of logistic processes. This paper discusses different approaches to integrate RFID antennas into a forklift truck. The different influences to RFID systems are discussed by consideration of logistic environments. Different antenna concepts are introduced and benchmarked by using simulation and measurement of electric field strength as well as functional tests.

Keywords: *RFID antennas, forklift trucks, warehouse management*

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I. INTRODUCTION

Forklift trucks are used for transport applications when flexibility and high turnover rates are the major requirements. It is more challenging to connect such systems to a warehouse management system than a fixed conveyor system. The Radio Frequency Identification (RFID) concept has been around for decades. The recent reductions of size and cost related to integrated circuits have greatly expanded the range of feasible applications. Today, antenna and sensor technology is a key to successful deployment. The requirements of reader and tag antennas are not unlike those for many communication systems. They are driven by the applications and the regulations. However, the warehouse environments require designs that cannot be easily damaged. Mounting on Forklifts require yet another degree of toughness.

Forklift is totally run on electric motors which are control by a remote operator by means of remote will connected with RFID which fix radio frequency transmit and receives to forklift circuits. With electrical motor it gives the motion to the forklift vehicle like forward, back, left turn, right turn and pallet controlling up down motion. And motions are controlled with remote and which will be transmitting signals to receiver and receiver will convert signals to operation. Its helpful to operator will be situated at only one position and it will operate the forklift from one position and he we monitoring on the neighbor environment due to that he will avoid the accident and operate with vision cameras.

II. DESIGN CONSIDERATIONS

A number of elements of our system's design are dictated by the performance requirements of our task. The forklift must operate outdoors on gravel and packed earth. Thus, we chose to adopt a non-planar terrain representation and a full 6-DOF model of chassis dynamics. We used an IMU to characterize the response of the forklift to acceleration, braking, and turning along paths of varying curvature when unloaded and loaded with various masses. The forklift requires full-surround sensing for obstacle avoidance. We chose to base the forklift's perception on leader sensors, due to their robustness and high refresh rate. We added cameras to provide situational awareness to a (possibly remote) human supervisor, and to support future vision-based object recognition. We developed an automatic multi-sensor calibration method to bring all leader and camera data into a common coordinate frame. The forklift requires an effective command mechanism usable by remote supervisor training.

We chose to develop an interface based on remote commands and stylus gestures made on a handheld tablet computer. Commands include: summoning the forklift to a specified area; picking up a pallet by circling its image on the tablet; and placing a pallet at a location indicated by circling. To enable the system to accomplish complex pallet handling tasks, we currently require the human supervisor to break down complex commands into high-level subtasks. For example, to unload a truck, the supervisor must summon the forklift to the truck, indicate a pallet to pick up, summon the forklift to the pallet's destination, and indicate to the forklift where on the ground the pallet must be placed. This procedure must be repeated for each pallet on that truck.

Our ultimate goal is to reduce the supervisor burden by making the robot capable of carrying out higher-level directives (e.g., completely unloading a truck pursuant to a single directive). We recognize that an early deployment of the robot would not match the capability of an expert human operator. Our mental model for the robot is a "rookie operator," which behaves cautiously and asks for help with difficult maneuvers. Thus, whenever the planner cannot identify a safe action toward the desired goal, the robot can signal that it is "stuck" and request supervisor assistance. When the robot is stuck, the human supervisor can either use the remote interface to abandon the current task, or any nearby human can climb into the robot's cab and guide it through the difficulty via ordinary manned operation. The technical challenges here include designing the drive-by-wire system to seamlessly transition between unmanned and manned operation, and designing the planner to handle mixed-initiative operation. Humans in military warehouse settings expect human forklift operators to stop whenever a warning is shouted.

We have incorporated a continuously-running "shouted warning detector" into the forklift, which pauses operation whenever a shouted stop command is detected, and stays paused until given an explicit go-ahead to continue. Humans have a lifetime of prior experience with one another, and have built up powerful predictive models of how other humans will behave in almost any ordinary situation [2]. We have no such prior models for robots, which in our view is part of the reason why humans are uncomfortable around robots: we do not have a good idea of what they will do next. A significant design priority is thus the development of subsystems to support social acceptance of the robot. We added an "annunciation subsystem" that uses visible and audible cues to announce the near-term intention of the robot to any human bystanders. The robot also uses this system to convey its own internal state, such as the perceived number and location of any bystanders.

III. ANTENNA TECHNOLOGIES FOR FORKLIFT TRUCK RFID SYSTEMS

3.1 Positions for Integration of RFID Antennas

Integration of RFID antenna on a forklift truck is restricted mainly by the limitation of places on forklift truck´s front side. The antenna must radiate in direction of the goods. To identify goods in several lifting heights, antennas must be moved with forks simultaneously. Two different positions for integration of antenna elements must be considered: An antenna can be integrated into the forks carrier or into the forks. Two different types of forks carriers, named type A and B can be distinguished according to [1]. Only a slim slot between forks carrier and ground allows antenna integration if the mounting position in the forks carrier is preferred. Moreover, due to mechanical abrasion of forks this space will be reduced. If the RFID antenna shall be integrated into the forks carrier, this effect must be considered over time. Additionally, if the RFID antenna is mounted on the forks carrier, it will easily be destroyed during operation. Otherwise, if the antenna is integrated into the forks, it must be considered that forks have to be changed if thickness is reduced to 90 percent of a new fork.

3.2 Patch Antenna for Integration into Forks Carrier

A patch antenna with integrated reader unit was designed for integration into the forks carrier by deister electronic. The front plate can be changed easily in case of destruction due to an accident. In practical application, the reader can be damaged by objects on the ground. The RFID reader unit and power supply is integrated into the unit. Connection to forklift truck terminal PC is established by a four-line wire on the lift pole. For mechanical protection the wire was put into an empty tube of the hydraulic system. In figure 1 an additional sensor is shown which is used to detect a goods carrier on the fork to control the RFID system

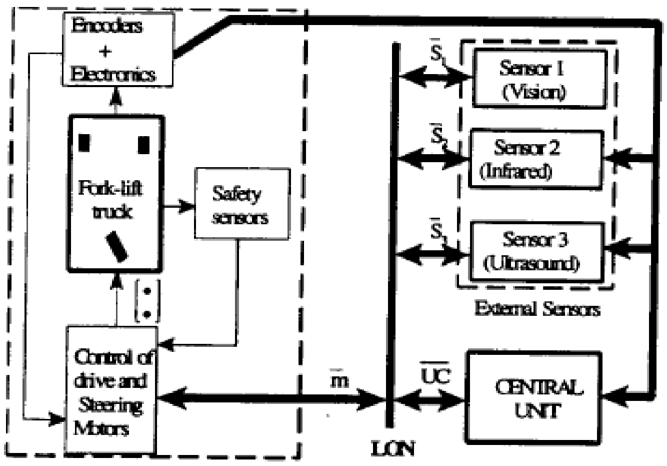

Fig 1. System architecture

IV. ENVIRONMENTAL CONDITIONS

4.1 Path Losses

The path losses in an open area are called free space attenuation. Path losses describes how field power of an electromagnetic wave decreases on the propagation path between transmitter and receiver depending on environment properties. This effects have been investigated for RFID systems by Nikitin and Rao [2].

4.2 Transponder Detuning

Resonance frequency of an RFID transponder changes when particular materials are approached. Detuning of RFID transponder decreases the system performance [5]. If there are different objects in an RFID system, all equipped with RFID transponders, they all may have different resonance frequencies, even if the same type of transponder is used, due to this effect. Reception range of an RFID system decreases if resonance frequency of the RFID transponder and working frequency of the RFID reader differ. In [3] a concept is shown to produce transponders with different resonance frequencies by using different positions to place the RFID chip on the antenna. Experiments show a strong deviation of the resonance frequency when placing RFID transponders on different objects [4][5].

4.3 Interference Effects

Overlap of waves with the same frequency is denoted as interference and cause local minima and maxima of the signal amplitude. This effect is caused by the superposition principle [4], waves do not have mutual influence. For a specific location, the signal strength can be determined by addition of the single amplitudes. The frequency of the resulting signal is the same as of the single waves [7]. Interference effects are a challenge when investigating RFID systems since they can cause local amplification or attenuation of the signal, but they can also amplify the noise level [4] which makes it more complicated to detect the signal. Interference effects are supported by additional sources of electromagnetic waves, i.e. other RFID readers [4] and reflections. The area where transponders can communicate with an RFID reader becomes smaller if more transponders are in the field, because communicating RFID transponders are also a source of electromagnetic waves [7] causing additional interferences. Reflections of UHF signals can occur on metallic surfaces [6]. Since RFID systems are implemented in areas with many metallic objects, such as production areas, logistic centers and warehouses, these effects must be investigated well.

V. CONCLUSION

This paper reports on an approach for integrating low cost, power efficient sensors, probabilistic localization, and stochastic learning in a wireless sensor network-based system applied to warehouse management. Avoiding accidental cases and save human life due to use of driverless forklift. The RFID reader is affected by the environmental conditions and geometry of the forklift trucks. This paper analyzed the antenna models used in the RFID reader and had found the antenna model that is least affected. In the future work the bow-tie antenna model is to be replaced with a circular patch antenna and further compared with the previous results.

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