Auto-Following Cart

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Introduction

Our project was to design and demonstrate a proof-of-concept model of an auto-following shopping cart. This cart is expected to greatly improve a person's shopping experience by permitting closer interaction with items on display, without having to worry about where to park the cart or with the cart being in the way. To achieve this, each cart has a camera and image processing system for it to identify and follow a specific person, even when many other shoppers and their carts are also present. The shopping carts also communicate with one another to share information about what they "see." This greatly expands the capability of any one cart to find its owner.

Product Description

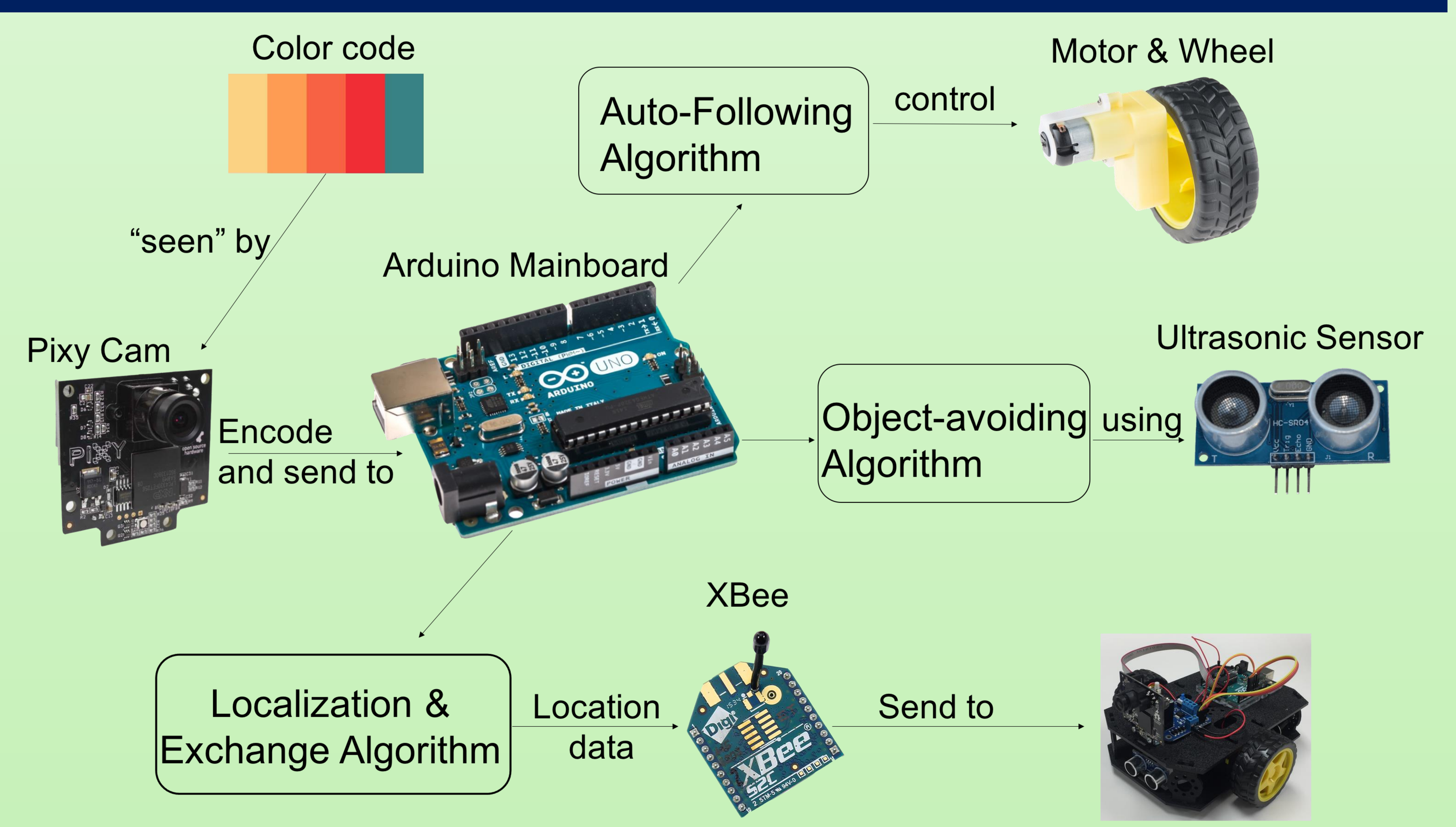
Our carts operate independently, but in cooperation with other carts to help detect and follow customers, by using image processing systems, ultrasonic collision avoidance systems, and a mesh communication network. There are four main functions. Firstly, the cart uses a vision system to follow its owner by keeping the owner's marker in its camera's field of view. Secondly, by detecting stationary tags throughout the store, carts find their locations and directions. Thirdly, carts can autonomously avoid obstacles in their way while following customers. Fourthly, when owner's marker is beyond the camera view, a cart relies on information sent from other carts over a wireless mesh network to find its owner.

Design Choices

To avoid obstacles, we use ultrasonic sensors instead of the visual-based system in consideration of computational expenses and simplified design. This way the vision system is dedicated to detecting and following a specific person, a task that requires many computations. We also have considered other methods to determine a cart's location within the store. For example, one can place Near-Field Communications tags throughout the store; carts passing nearby would read a location code. In consideration of lower cost, however, we chose colored-tag detection by multiple carts that share data over a ZigBee mesh communications network.

Technical Details

Our prototype cart has a motorized base, fast vision sensor, microcontroller board, ultrasonic distance sensors, and radio communications module. The diagram on the right shows how we achieved colored tag-following, obstacle avoidance and inter-cart communications functions. When a colored tag (a temporary sticker on the cart's owner) is seen by the Pixy Cam vision system, tag location and size are sent to an Arduino Mainboard. After analyzing the information, the Arduino controls the cart's motors to follow the tag it is assigned to. The Arduino also receives signal from ultrasonic sensors to sense and avoid obstacles.



The communication between carts is accomplished by a self-organizing ZigBee mesh network. One application of this network is that people change carts while shopping. When a cart owner presses a button on his cart the Arduino executes a localization & exchange algorithm, which informs other carts through the ZigBee mesh network and finds the owner's location.

Acknowledgment

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Results

In this project, we implemented location sensing, auto-following, obstacle avoidance and sharing of information over a radio network. Together these functions accomplished the project goals. Currently, our carts can autonomously follow a specific colored marker by keeping it in its camera's field-of–view. When the marker is not visible, the cart get the markers' information shared by other carts through the mesh network.