Final Project Proposal

Year: 2024 Semester: Spring Team: 05 Project: Dodgebot

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Team Members (#1 is Team Leader):

Member 1: Yusuf Jarada Email: yjarada@purdue.edu

Member 2: Maximillian Drach Email: mdrach@purdue.edu

Member 3: Carlos Cotera Email: ccoteraj@purdue.edu

Member 4: Ayman Motoda Email: aelnamr@purdue.edu

**1.0 Project Description:**

/\* TODO(b/0001): I just pasted some whatever text we should all expand on this design \*/

**Hardware Components:**

**Robot Body:**

* Design a simple and compact robot body that can move on an axle.
* Ensure that the design allows for easy bunching and dodging movements.

**Axle and Motor System:**

* Choose motors that can control the movement of the robot along the axle.
* Integrate an axle system that allows the robot to rotate and dodge punches.

**Camera System:**

* Select a camera with sufficient resolution and frame rate for real-time detection.
* Mount the camera in a way that provides a good field of view for detecting punches.

**Color Detection System:**

* Use sensors or image processing techniques to identify brightly colored gloves.
* Implement a system that can accurately distinguish the gloves from the background.

**Microcontroller or Single-Board Computer:**

* Choose a microcontroller or single-board computer (like Raspberry Pi or Arduino) to process camera input and control motors.
* Ensure it has the necessary processing power and interfaces for camera and motor control.

**Software Components:**

**Image Processing Algorithm:**

* Develop an image processing algorithm to analyze the camera feed.
* Identify and track the position of the brightly colored gloves in real-time.

**Control Algorithm:**

* Create a control algorithm that takes input from the image processing module.
* Implement a dodging strategy based on the detected glove positions.

**Motor Control:**

* Write code to control the motors based on the output from the control algorithm.
* Ensure the robot can move quickly and accurately to dodge punches.

**Integration and Testing:**

* Integrate the hardware and software components.
* Test the prototype in controlled environments to ensure accurate glove detection and effective dodging.

**Refinement:**

* Refine the algorithms and adjust parameters based on testing results.
* Fine-tune the robot's movements for better dodging performance.

**Safety Measures:**

* Implement safety features, such as emergency stop mechanisms, to ensure the safety of users and the robot itself.

**Documentation:**

* Document the design, code, and testing procedures for future reference or improvement.

Keep in mind that this is a high-level overview, and the specific details will depend on the components you choose and the complexity of your design. Additionally, safety should be a top priority, especially when working on a robot that interacts with physical objects.

**2.0 & 2.1 & 2.2 & 2.1.1 Team Member Expertise and Team Roles and Responsibilities:**

Team Member: Carlos Cotera – Software Lead

* Responsible for design and implementation of source code. Undertakes functional prototyping efforts early in the semester to mitigate risk in the later stages of the design process.

2.1.2 Team Member: Maximilian Drach – Systems Lead

* Responsible for high level functional overview of the system, including the theory of operation, block diagram, and component selection. Ensures components and systems on project work together coherently.

2.1.3 Team Member: Ayman Motoda – Hardware Lead

* Responsible for design of printed circuit board electrical schematics and layouts, often in charge of circuit board construction and packaging assembly

2.1.4 Team Member: Yusuf Jarada – Team Lead

* Maintains communication among team members, ensures team is progressing and assists fellow team members in addressing significant issues.

3.0 Homework Assignment Responsibilities

*Design Component Report*

**A3-Software Overview: Carlos Cotera**

**A4-Electrical Overview: Ayman Motada**

**A6-Mechanical Overview: Yusuf Jarada**

**A8-Software Formalization: Maximilian Drach**

*Professional Component Report*

**A9-Legal Analysis: Maximilian Drach**

**A10-Reliability and Safety Analysis: Yusuf Jarada**

**A11-Ethical/Environmental Analysis: Carlos Cotera**

**A12-User Manual: Ayman Motada**

4.0 Estimated Budget

1. Motors = $1,000
   1. The total is of a 3x quantity of 40Nm Hub Motors
2. Board, Micros = $210
   1. Requires a Jetson ($150) + STM32 ($30)
   2. Board + Components ($30)
3. ESC + Power Supply = $200
   1. DC-DC Converter & Inverter for Motor ($150)
   2. Components for supplying subcircuits at 5V, 3.3V ($50)
4. Mechanical Components = $100
   1. Ball and Socket Joint ($20)
   2. Shaft ($10)
   3. Belts ($50)
   4. Screws, Nuts, ETC. ($20)

5.0 Project Specific Design Requirements (PSDR)

Definitions:

* Punch - Strong enough force applied by a bare hand to create mild contusion on an average 21-year-old healthy male.
* Environment (Area) – The effective area in space, which the dodging system was design to monitor.
* System – The electrical makeup of the robot which involve the specified components.
* A Motor Drive System (MDS) that should have the ability to rotate the discs that are attached to the shaft of the motor quickly.
  + Should have enough torque to rotate the disc 180 degrees in 50ms or less from the time of receiving the ESC signal command.
* A Supplemental Power System (SPS) that should have the ability to provide power at the various voltages of the onboard components. The provided power supply will be at 12V to the entire logic system.
  + The SPS should have the ability to take this 12V supply and convert it to 5V that the Jetson, ESC logic inputs, and motor encoders.
  + The SPS should also have the ability to take the 12V supply and convert it to 3.3V that the STM32 microcontroller uses.
  + The SPS should be able to handle the wide range of current demands (2A-7A) of the logic system and its various attached peripherals.
* A High Voltage Delivery System (HVDS) that should have the ability to provide power to the supply line of the ESCs
  + Should have the ability to provide high demands of current quickly.
* An Environment Tracking Algorithm (ETA) that can track a punch in continuous time and space. This algorithm should have an ability to utilize the information streams monitoring the environment and accurately track the real-world locations of a punch and the Dodgebot.
  + Proper calibration of the camera is accurate enough to map a pixel’s location to around a 2cm portion of the real-world coordinate location.
  + The Color Tracking Algorithm can identify a punch and Dodgebot 99.38% (4-sigma) of the time if they are with-in the monitoring environment area.
  + The Color Tracking Algorithm should have the ability to analyze the current camera frame before another frame is sent to computer. (~1/250 second)
* A Punch Avoidance Algorithm (PAA) that can approximate the ideal locations for the Dodgebot to achieve its stated purpose of not getting hit by a punch.
  + The PAA should have the ability to predict the path of punch coordinates by anticipating the trajectory of the incoming punch.
  + The PAA should have the ability to create a set of ideal coordinates that are not in trajectory of the incoming punch, thus effectively dodging a punch.
  + The PAA should have the ability to create at least 1 ideal Dodgebot coordinate before the next set of real-world locations are inputted from the Tracking Algorithm. (~1/250 second)
* A Torque Instruction Algorithm (TIA) that can translate the real-world coordinates and ideal coordinates to applied torque values each motor must produce to move the Dodgebot to its new ideal location.
  + The TIA should be modular to every possible set of coordinates down to the accuracy of the ETA system. (~2cm)
  + The TIA should be able to calculate the approximate amount of torque each motor has to apply to place the Dodgebot at its ideal coordinates down to the accuracy of the ETA system.
  + The TIA should have the ability to convert the ideal amount of torque into a PWM signal to be sent to an ESC.
  + The TIA should have the ability to input the position of the motors from the encoder of the motor.
* A Communication Instruction Algorithm (CIA) that can translate all the instructions from the TIA into a standard communication protocols (SPI, MIPI, etc).

1. An ability to track a punch and robot in the environment space.
2. An ability to create a set of coordinates that place the robots outside a punch trajectory path.
3. An ability to translate a set of coordinates into motor specific torque values to control the proper robot path.
4. Computer Vision input validation and testing for:
   1. Minimum latency
   2. Correct punch angle prediction
5. Testing dodging logic for:
   1. Mapping punch inputs to correct dodge choices consistently.
6. Design Hardware for embedding components:
   1. Cameras
   2. Sensors
   3. Boards

6.0 Sources Cited: