Autonomous Light Beacon Robot

Project Design Review

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Junior Design Team - 18

Zachary Feuerstein

Kevin Hoffman

Xiaolin Zheng

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Project Requirements

1) Robot

- Our team must provide a single, self-contained autonomous robot to act as a participant in the game
    - This robot must not have any information on beacon or obstacle locations before entering
    - This robot must not communicate or receive any input or information from external hardware sources
    - All logical operation used to progress through the field and play the game must be internalized to a controller unit on the robotic platform
    - The robot chassis must have some power source used to drive its components
- Our team robot should be capable of moving through the field in order to play the game effectively
    - Must possess wheels and motors to drive them
    - Should have some logical algorithm within the controller to instruct it on how to move the motors to perform certain movement operations
- The robot must be proportioned so as to fit within the maximum size of two feet long by two feet wide by one foot high
    - The robot must be small enough in size to navigate through the field without being permanently impeded by obstacles
    - The robot should be sufficiently tall in order to communicate with the beacon towers
- The robot must operate safely

    - Must be capable of completing the game without damage to the board or the other team's platform
    - Robot should have internal logic checks to ensure that its operation won't burn out or overstress its components
    - It must not use any Li-Ion or Li-Pol batteries to power its components
    - Motors should remain off at the start of play, until the 2.5' by 2.5' pen is lifted at the game's beginning

2) Beacons

- May be capable of assigning given team color to the robot at the start of the game
    - Robot should have some latent memory elements to store team status and information about the field
- Robot should recognize the status of beacons' possession
    - Robot should possess some light sensing system for detecting different intensities of light
    - Robot may want to recognize the difference between an opponent-captured and uncaptured beacon
- Robot should be capable of locating the beacons' positions relative to itself, and moving to within communicating distance of it
    - All sensors should be elevated to proper heights (decided upon by the design team) in order to maximize the incoming signal power from both the beacon tower lights and IR transmitter
- Robot should be capable of recognizing the presence of an obstacle
    - Must possess some sensory means of detecting the presence of an obstacle
- Robot should navigate obstacles in order to communicate with the beacon towers
    - Should have some logical algorithm for determining what sequence of movements to use to effectively bypass the obstacle
- Robot should be able to communicate with the beacon towers once they are found

- Robot must have some form of IR transmission and receiving hardware
- Robot should be programmed to comply with correct protocols, based off those of the beacon towers, so that the towers will be receptive to its communication
- Robot must claim the beacon to its team by instructing it to change its color to that of its team

3) Gameplay

- Robotic platform should be capable of playing the game for the full three-minute period
    - Our team should implement some way to safely turn off the robot at the end of play
- Must not intentionally interfere with the operation of the beacon towers, the game field, or the opposing team's platform
    - Any unintentional interference caused by components of our robotic platform must be confirmed/discussed with an instructor

Subsystem Requirements

1) Controller Unit

- Must contain all high-level algorithms related to the control and operation of the robot platform's various functions
    - Must take input from the sensor/communication board in order to effectively communicate with the beacon towers
    - Should be capable of storing and manipulating sensor data including, but not limited to, performing basic logical and arithmetic operations on said data
    - Shall be capable of taking feedback from obstacle avoidance sensors and interpreting said feedback in order to control the movement and orientation of the platform
- Must possess some method of analog-to-digital and digital-to-analog conversion of input and output signals in order to interface properly with hardware

- Should be capable of providing fixed reference voltages, and output currents, from which to supply to the sensor/communication board and the motor hardware
    - Should be capable of interfacing with voltage/current amplification circuits if supplied values are insufficient to drive component architecture

2) Sensor/Communication Board

- Must detect the location of beacon towers based on the intensity of radiating light
- Must receive a 38KHz-modulated infrared signal and communicate with the beacon towers via a Universal Asynchronous Receiver/Transmitter (UART) protocol at a baud rate of 300 symbols per second
    - Must transmit the capture signal, provided by the controller, in order to claim the beacon
    - Must transmit within a one-second window between outgoing data packets from the tower in order to perform an effective capture
- Must detect the presence of obstacles on the playing field and provide relevant feedback to the controller based on location

3) Motor Actuation

- Should possess some means of regulating the switching of motor direction in order to prevent damage to the motor hardware
    - Shall receive control signals from the controller, and output relevant actuation signals to the motors
- Shall determine the direction of movement for the platform by accurately interpreting control signals in order to determine the spinning direction of individual motors (e.g. clockwise/counterclockwise)
- Shall provide feedback from the motors' quadrature encoders to the controlling unit as input to movement algorithm

4) Power Management

- Must provide adequate power for all components on the robotic platform to operate safely
- Must provide a minimum of 7V for operation of the controller

    - Must provide enough current to the controller that any controller outputs are not lacking in necessary current to drive signals

- Must continue to provide necessary voltage to controller as potential source degrades to minimum operating standards (ergo, down to 7V operating level)
- Must utilize a voltage regulation system/integrated circuit to provide a fixed 5V rail to sensor/communications board
    - Regulator must be capable of operating effectively to a minimum input voltage of 7V, such that it will not fail before the controller.

Design Calculations

1) Requisite Equations

Ohm's Law V= I*R

Used Ohm's Law to determine Voltage, Current, or Resistance based on measured values.

Calculation of Power P = I*V

Used our knowledge of Current and Voltage of our components to determined the power consumption from each component.

Net Power Draw

Added up all of our individual component's power consumptions in order to find our net power draw.

2) Calculations of Values

**All calculations can be found on the Power Budget chart.