Team 301 IEEE SoutheastCon HardwareCompetition Updated Design Report

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I. Introduction (Problem Statement, Motivation, and Requirements)

The team will develop a robot to compete in IEEE's SoutheastCon Hardware Competition. This year's competition is Mardi Gras themed and therefore all of the competing robots will serve as scale models of parade floats. The robot must be able to accomplish the following: traverse an L-shaped track in either direction, avoid trampling a marshmallow in the roadway, retrieve beads from "trees", launch beads into fishnets placed along the outside of the track, and be decorated with a light up display.

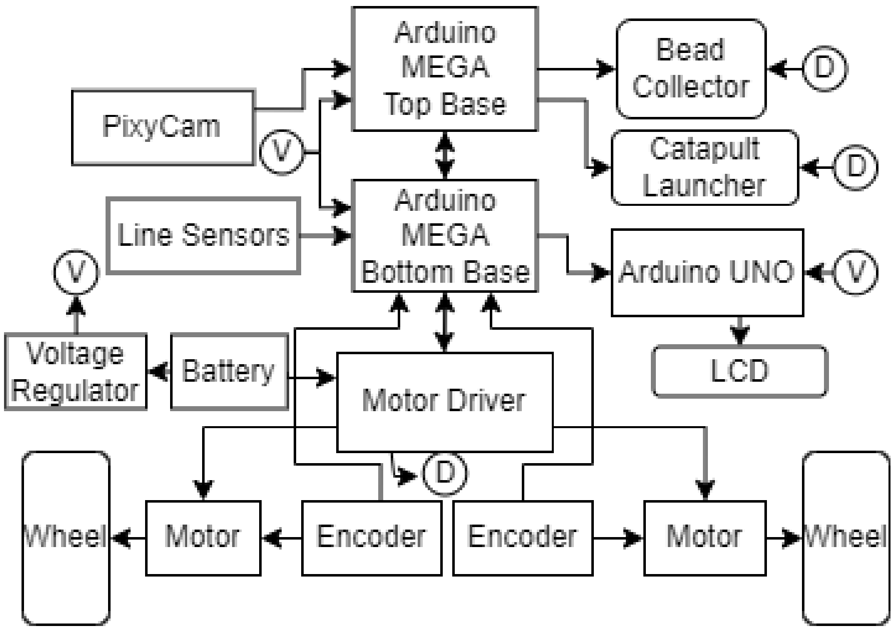
II. Selected Concept

The following is a breakdown of our current concept divided up by module. Changes in our design were made at several different stages of the testing and developing process based on a variety of different factors (team familiarity, power consumption, point value, etc.).

- Microcontroller - Arduino MEGA
- Coding Language - Arduino (C17)
- Wheels - Standard(x2) and Caster(x2)
- Movement/Steering - Line Tracking for tracking of the environment and the robots position
- Motors - Brushed for more precise control of the wheels and navigation
- Power Supply - NiMH
- Sensors - Reflective IR line sensors
- Display - LCD controlled by Arduino UNO
- Bead Collector - Arm
- Bead Storage - Catapult
- Bead Launcher - Catapult
- Marshmallow Mechanism - Passive rounded front bumper
- Physical Base - 3D printed for easy modification
- Attachment Methods - Screws and bolts, hot glue
- Wiring - Polyurethane Cables
- Decorations - COE Colors (if time permits)
- Connections - Soldered

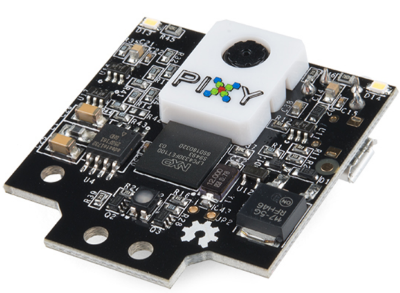
III. Updated Design

The following is a block diagram of the connections between modules on our current design. Beyond that is a breakdown of each block in the diagram and how it can be represented with a model.

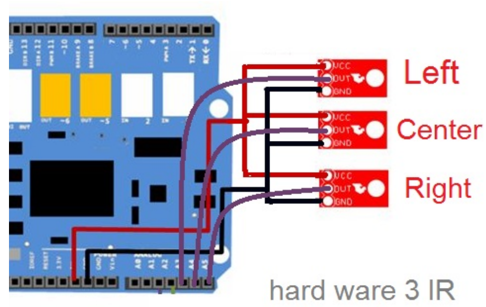


Block I/O Requirements:

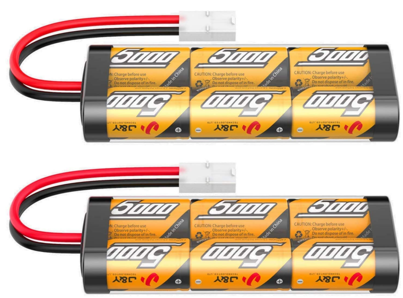
- PixyCam
  - Input: Images
  - Output: Arduino MEGA
  - Model:



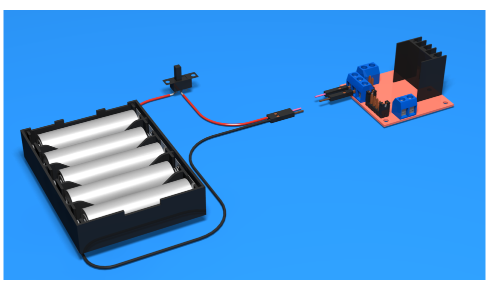
- Line Sensor
  - Input: N/A
  - Output: Arduino
  - Model



- Battery
  - Input: N/A
  - Output: Motor Driver
  - Model:

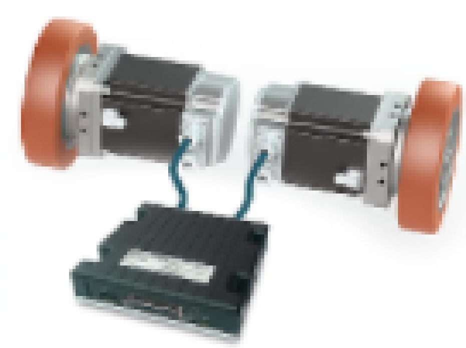


- Motor Driver
  - Input: Arduino, Battery
  - Output: Motors
  - Model:

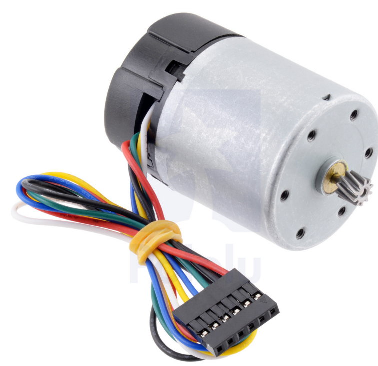


- Wheels
  - Input: Motor
  - Output: N/A
  - Model:

- Motors
  - Input: Motor Driver
  - Output: Wheels
  - Model:



- Encoder:
  - Input: Motor
  - Output: DAQ
  - Model:



- Arduino UNO
  - Input: Arduino MEGA
  - Output: LCD Display
  - Model: With SD card Breakout

Pseudocode:

Include Core Graphics Library
Include Image-reading functions
Loop(Read SD card){
Print to screen;
Delay;}

- Arduino MEGA Bottom Base
  - Input: Line Sensors, Arduino MEGA Top Base
  - Output: Motor Driver, Arduino MEGA Top Base
  - Model:

Pseudocode:

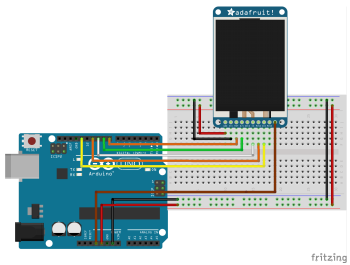
```
Function LineTrack
LineData [*Array of Data*];
Lookahead
Current position
Angular velocity
    LineData = GetData

Case (LINE)
If line (ones in the array) not in center
    of Lookahead
    Find current position
Find distance of lookahead & current
    position
    Find angle from center
    Calculate Angular Velocity
Correct the path trajectory DriveTrain
```

- Arduino MEGA Top Base
  - Input: Arduino MEGA Bottom Base, PixyCam
  - Output: Arduino MEGA Bottom Base, Catapult Launcher, Bead Collector
  - Model:

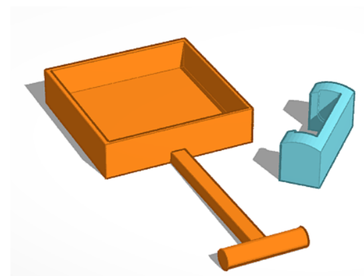
Pseudocode:

```
Pins for Servos
Pins for PixyCam
Pins for communication

If (pick up beads)
    Beads picked = 1
    collect();
If (launch beads and pixycam sees cup)
       Tell robot to keep moving
Else If (launch beads and Beads picked
= 1)
       Tell robot to keep moving
        launch();
        Beads picked = 0
else
       Tell robot to keep moving

collect()
    Extend arm out and grab bead
    Deposit bead in to catapult
    Return arm to rest position

launch()
Verify Net or Cup
Move arm to block catapult
    Tension catapult
    Move arm to release catapult
    WAIT
    Release catapult to rest position
    Return arm to rest position
                     End function
```

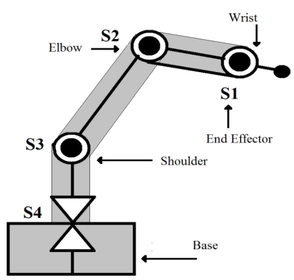
- LCD Display
  - Input: Arduino UNO
  - Output: Lights Up
  - Model:



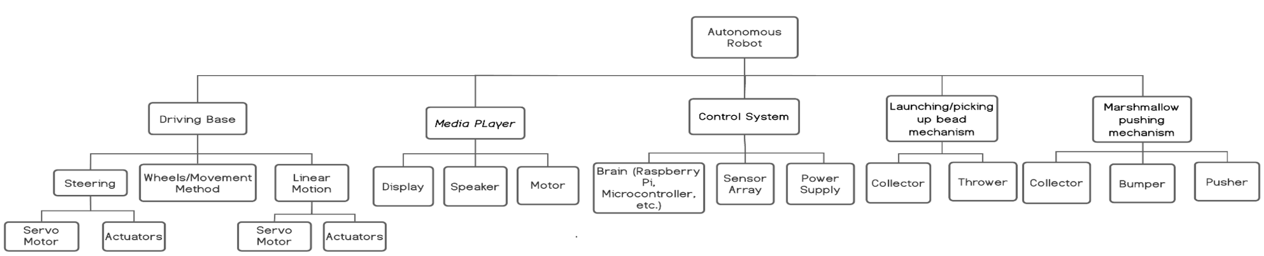
- Bead Launcher - Catapult
  - Input: Arduino MEGA
  - Output: Toss the beads into nets
  - Model:



- Bead Collecting Arm
  - Input: Arduino MEGA
  - Output: Collect the beads from the trees
  - Model:



Our original Functional Decomposition is listed below:



The Preliminary design created a more detailed design for the robot than the original functional decomposition. For example the launching and picking up bead mechanism turned into the bead collector and thrower modules that will use an arm to pick up the beads from the trees and a catapult to throw them into the nets using image recognition software. The control system has been expanded on since it will take in information from the sensors and cameras to determine the functions to use or to correct the direction for the drive train. The media player requirements changed to no longer needing a moving aspect for the display, so our updated design no longer includes a motor for the LCD display. Our marshmallow mechanism has been simplified to only be a passive front bumper on the robot so it is not included in our breakdown of the updated design. Lastly for the driving base, we included more modules for a more in depth understanding at how the robot will move.

IV. Codes and Standards

The following points are the standards that are currently being used on the project and where. The application of our project to other scenarios is very limited, therefore there are only a few industry standards applied to our project.

- USB 3 Type A and Micro-USB

  This Universal Serial Bus 3 Type A and Micro-USB standards were implemented in the same cable on our design in several different ways. The first use of the standard was to transfer data from the coding software to flash the arduino boards with new code. The second use of the standards was that of powering the arduinos and the connected devices through the cord itself, in order to do testing when we did not yet possess a suitable power supply. The final use of the standard was when using the connection between the arduino and computer to monitor sensor values in order to amplify the accuracy of the algorithms.

  - USB 3 Type A
    - Combines USB 2.0 with the Superspeed bus. Transfer rate goes up to 5Gb/s
    - Used to communicate with Arduinos to modify code.
  - Micro-USB
    - Micro USB is a miniaturized version of the Universal Serial Bus (USB) interface developed for connecting compact and mobile devices such as smartphones, Mp3 players, GPS devices, photo printers and digital cameras.
    - Used to monitor and train PixyCam.
- C17

  The C17 version of C++ standard was primarily used in the Arduino IDE software to program several different functions into the Arduino boards that were used on the robot. Such functions include communicating with other Arduino boards, sending pulse width modulation signals to a motor driver, and processing data sent to the Arduino from the PixyCam. The standard was across three different boards: two Arduino Mega 2560’s and an Arduino UNO.

  - The current ISO C++ standard is officially known as ISO *International Standard ISO/IEC 14882:2020(E) – Programming Language C++*.
  - Version of C used to program Arduino.
- Micro-SD

  Micro-SD was used to store data that was necessary for the acquisition of extra points within the competition. The card was to keep an image of the FAMU-FSU College of Engineering logo for the screen on the robot to access it at the command of the Arduino, with potential for more media, such as videos, to have been saved in the case that more media would need to be used. The card was lightweight and easy to install, which allowed for the robot to remain light and the interface simple to access without it getting in the way of other functions that the robot needed to perform.

  - Flash memory card used to store long-term information
  - Holds image for LCD Display
- OSHA electrical standards
  - A set of health standards that protect people exposed to dangers such as electric shock, electrocution, fires, and explosions
  - The team made sure to always have power off before making electrical design changes as well as sealing all exposed wires with electrical tape.
- IEEE C95.1-2019
  - Safety limits for the protection of persons against the established adverse health effects of exposures to electric, magnetic, and electromagnetic fields in the frequency range 0 Hz to 300 GHz are presented in this standard
  - The team made sure to always have power off before making electrical design changes as well as sealing all exposed wires with electrical tape.
- NESC
  - Published exclusively by IEEE and updated every 5 years to keep the Code up-to-date with changes in the industry and technology, the National Electrical Safety Code® (NESC®) sets the ground rules and guidelines for practical safeguarding of utility workers and the public during the installation, operation, and maintenance of electric supply, communication lines and associated equipment
  - The team made sure to always have power off before making electrical design changes as well as sealing all exposed wires with electrical tape.

V. Public Safety and Other Factors

Our project is designed to be a scale model of a Mardi Gras parade float. If further developed, parades around the world can be adapted to operate autonomously.

The projectiles involved in the competition must be contained within the game board and any projectiles launched outside the scope of the board will disqualify the robot. On a large scale, the beads launched from the parade float would have to be restricted in speed and range to avoid injuring spectators. On a large scale, any parade float will also be limited in speed on the parade route to limit the risk to pedestrians that often walk alongside floats. Culturally, there are certain individuals who are weary of autonomous vehicles. In a poll published by govtech, 48% of respondents said that they would never trust an autonomous vehicle and another 21% stated that they were unsure. This is due to some believing that jobs are being eliminated and some believing that safety is a concern. It is assumed that an autonomous parade float would cost more to build than one that requires a driver. From an economic standpoint, the cost of parades would increase.

VI. Summary

Team 301's goal is to build a robot that can perform the necessary tasks and objectives autonomously. The team selected the optimal concept based on logistic and financial analysis. The selected items were organized into a preliminary design concept where the components were broken down into models of pseudocode and circuit schematics. When comparing the current preliminary design with the functional decomposition, one can see that all the generalized components the team wanted to use have now been chosen. Not only have the components been chosen, but improvements to the design, such as incorporating two Arduinos, have also been made in order to accommodate competition and design priorities. Overall, the robot is close to being ready for the competition.