Dagozilla Electrical and Software Description 2020

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Abstract. In order to participate in the 2020 RoboCup Middle Size League (MSL), Dagozilla designed and manufactured a new generation of MSL robots. This paper covers the electrical systems used in the robots and also the software architecture implemented in the robots' system. The electrical systems described in this paper are the power distribution system, locomotion system, dribbler system, and kicker system.

Keywords: Middle-size League, RoboCup.

1 Electrical System Overview

The electrical system used in the new Dagozilla MSL robots is an all-around improved version from the electrical system used in the old Dagozilla MSL robots. While the overall system structure remains the same, the new Dagozilla MSL robots sports boards with smaller form factor and discards some obsolete systems such as removing standalone rotary encoder.

The Dagozilla MSL robots use a custom-built personal computer as the main computing unit in decision-making and environment sensing. The camera is connected to the PC in order to gather information regarding robot position and attitude, line detection, ball position, and other robots position. For this purpose an ordinary Logitech C922 webcam is used. In order to interface with the sensors and actuators, the PC sends instructions to the microcontroller board, which then handles the interfacing.

The actuators used in the robot are four locomotion brushed DC motors, two dribbling mechanism brushed DC motors, a kicker system servo, and a solenoid-plunger kicker system. The sensors used in the robot are a camera, two dribbling mechanism potentiometers, an infrared sensor, and an inertial measurement unit (IMU).

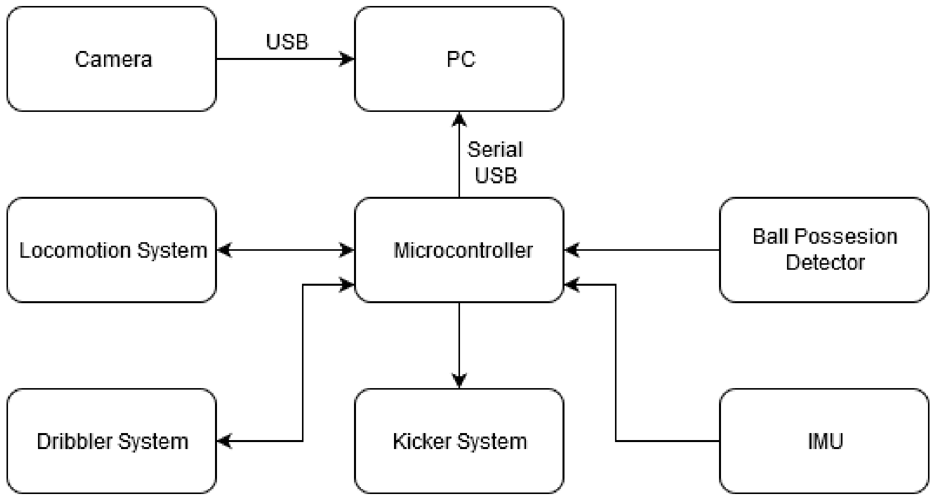

Fig. 1. Electrical Systems Diagram

2 Microcontroller Board

The microcontroller board is a home-designed PCB with an STM32 Nucleo F767ZI development board for outfield player robots and an STM32 Nucleo F446RE development board for the goalkeeper robot as the microcontroller. The microcontroller board serves as the core of the low level control and hardware interface. This board simply connects the development board pins with the peripherals, which consists of actuators and sensors. The electrical schematics of this board can found in Appendix A. Fig. 2 shows the outfield robot schematics and Fig. 3 shows one of the goalkeeper.

3 Kicking System Board

The kicking system board is designed to control the charge-discharge cycle of the kicking system while also providing high-voltage protection to the rest of the robot's system. The kicking system board connects the voltage booster, the capacitor set, the solenoid, and the control circuit. The electrical schematics of this board can found in Appendix A, Fig. 4.

4 Locomotion System

As with all the brushed DC used in the robot, the four RS775 with 1:13.9 planetary gear used in the locomotion system are driven by a BTS7960 IBT-2 motor driver. The motors had encoders attached on each of them. In order to improve the modularity and so the electrical parts can fit more compactly, a standalone locomotion system board is designed. This locomotion system board connects the pins from the microcontroller to the motor driver and the encoder and helps reducing the pin amount needed to drive the motor by using a NOT gate. The electrical schematics of this board can found in Appendix A, Fig. 5.

5 Dribbling System

The dribbling system used a pair of high revolutions per minute (RPM) RS775 brushed DC motor coupled with a bevel gear. As in the locomotion system, the dribbling system board connects the motors with the motor driver. The board also connects the two potentiometers and the infrared sensor to the microcontroller. The electrical schematics of this board can found in Appendix A, Fig. 6.

6 Power Distribution System

The power distribution system board regulates the power flow from the LiPo batteries to each electrical components. This board also had fuses to secure the high-current electrical components from over-current. The electrical schematics of this board can found in Appendix A, Fig. 7.

7 Software Architecture

The robot's software can be divided into 4 major processes: the vision system (codenamed Hyperion), world model (codenamed Prometheus), strategy (codenamed Athena), and control (codenamed Odysseus). There is also a process that handles the robot localization using Augmented Monte Carlo Localization method, which is codenamed Atlas. These processes are implemented as packages, each consisting of several nodes, in a Robot Operating System (ROS) workspace. Each computing unit communicates with each other to share its respective local world model in order to build a distributed global world model as the source of truth for every robot. The communication between computing units is handled using a websocket communication protocol. The diagram of our software architecture can be seen in Appendix B, Fig. 8.

8 Robot Specifications Summary

Each of our robots is equipped with a custom-build PC as the main computing unit. This computing unit handles high-level processes such as computer vision and perception, strategy computation, local world model generation, shared world model integration, as well as communication with base station, low-level control computation, and communication with the microcontroller.

A summary of the robot's computing unit, sensors, and microcontroller is shown in Table 1.

Table 1. Robot Hardware Specifications.

Component	Specification
Computing Unit	
Motherboard	Asus ROG Strix B450
CPU	AMD Ryzen 5 2600
GPU	NVidia GeForce GT220
RAM	8 GB 2400 MHz
Power Supply Unit	Pico Box 300W
Microcontroller Boards	
GK Microcontroller	STM32 Nucleo F446RE
Outfield Microcontrollers	STM32 Nucleo F767ZI
Sensors	
Camera	Logitech C922 Webcam
Actuators and Drivers	
Locomotion Drivers	BTS7960 IBT-2 Driver
Locomotion Motors	RS775 Brushed DC Motor
Dribbler Motors	RS775 Brushed DC Motor

Appendix A Electrical System Schematics

This appendix contains the electrical system schematics or drawings that are used in each of our robots. The schematics start on the next page.

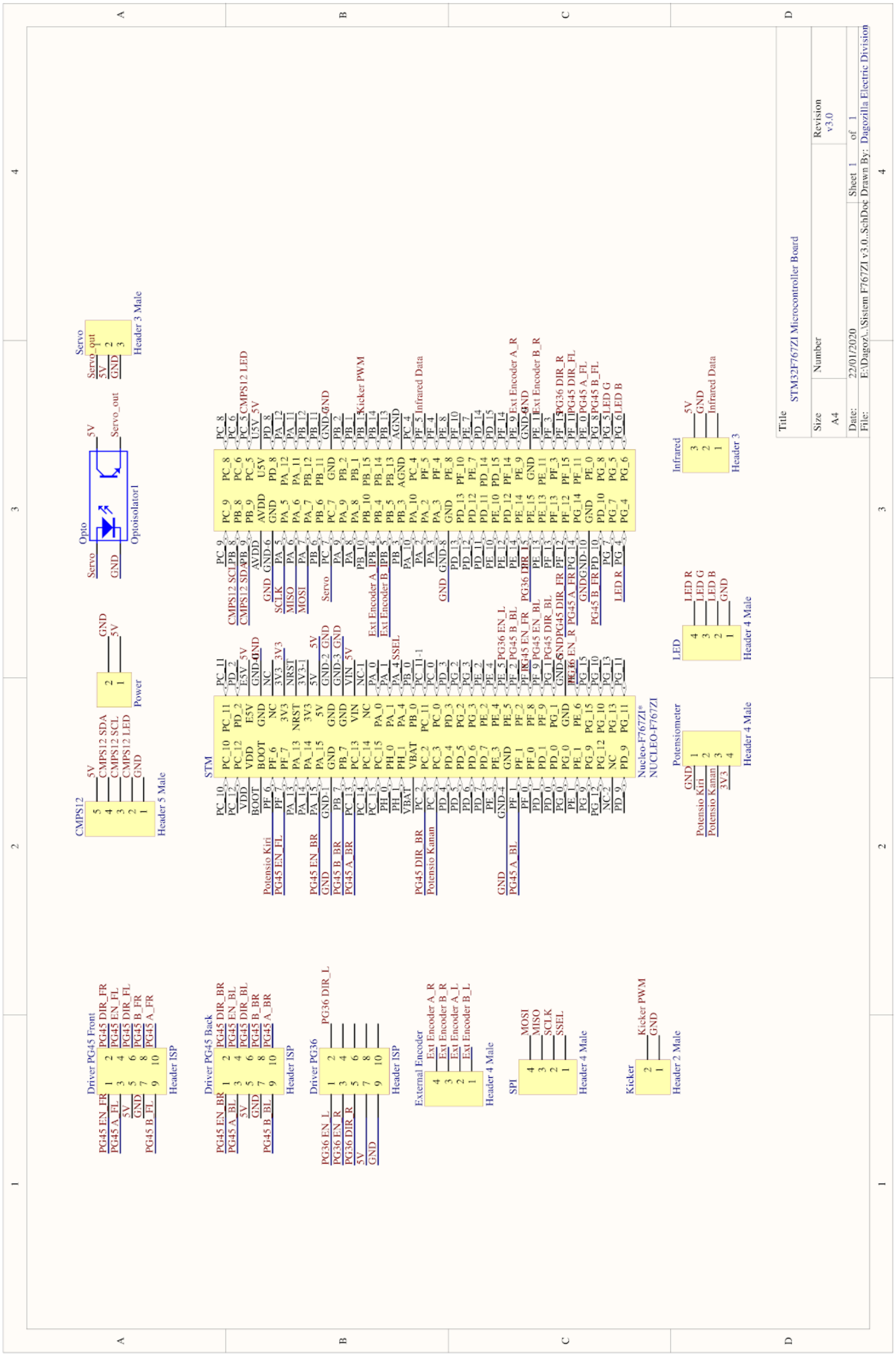

Fig. 2. Outfield Player Microcontroller Board Schematic

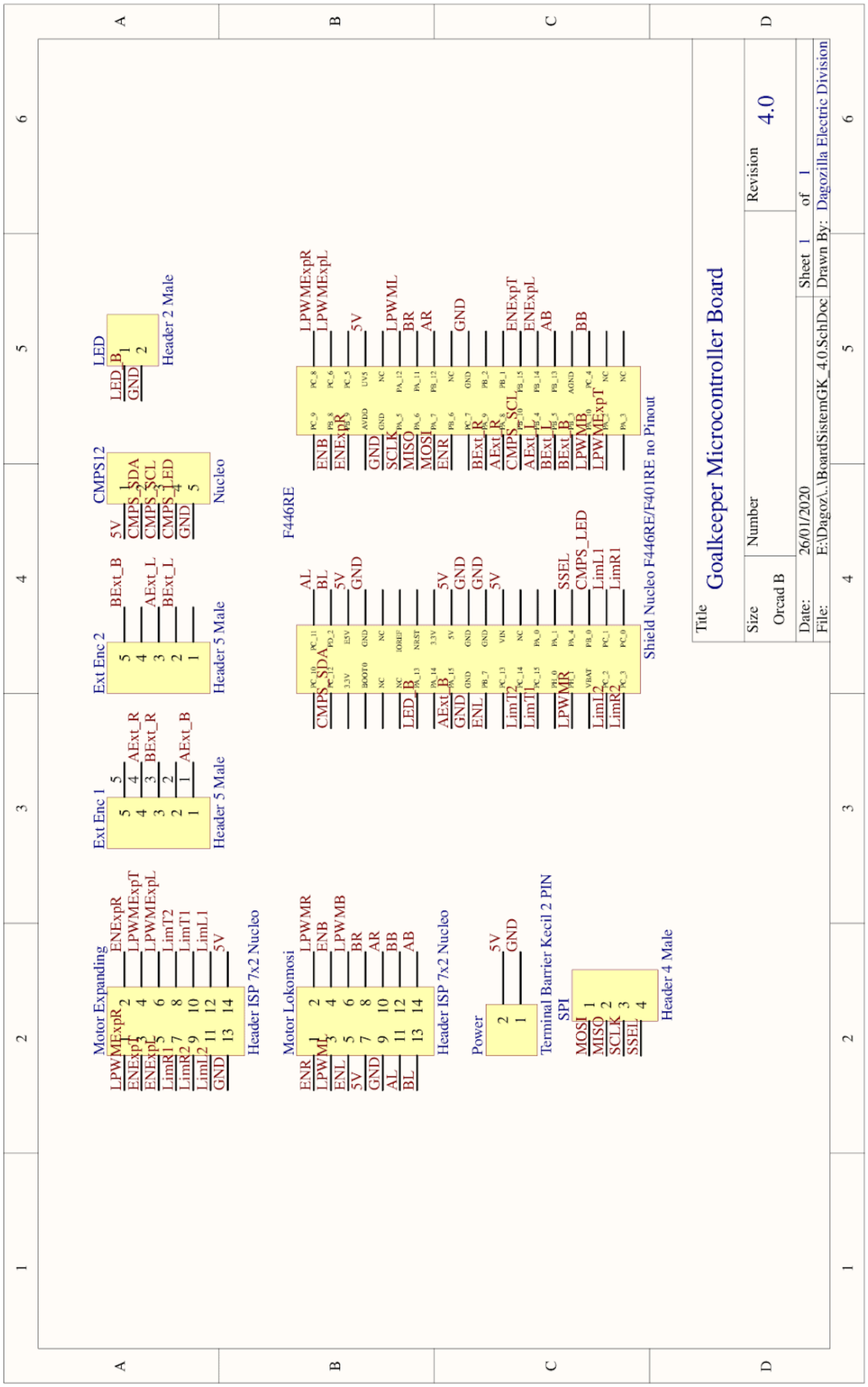

Fig. 3. Goalkeeper Microcontroller Board Schematic

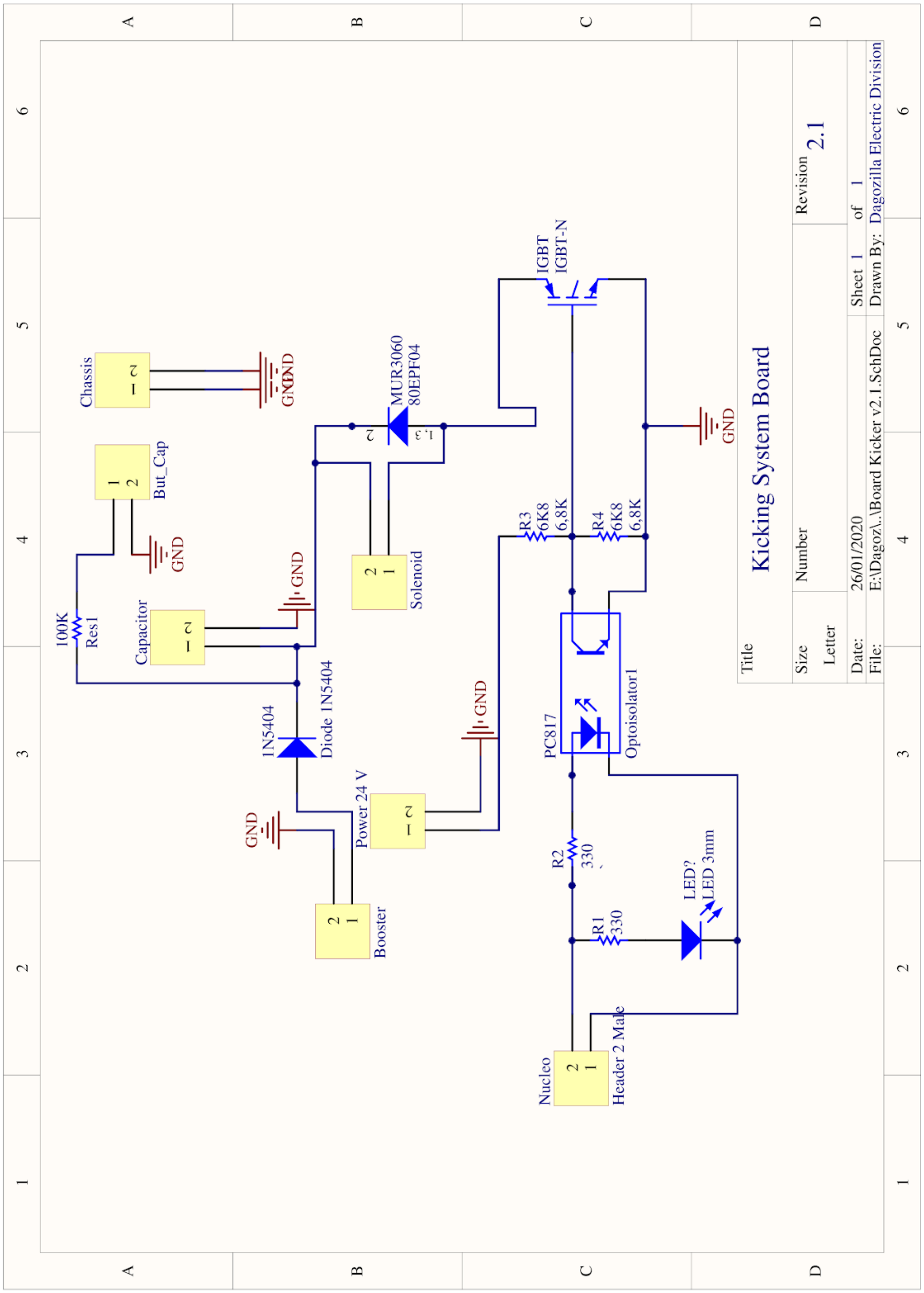

Fig. 4. Kicking System Board Schematic

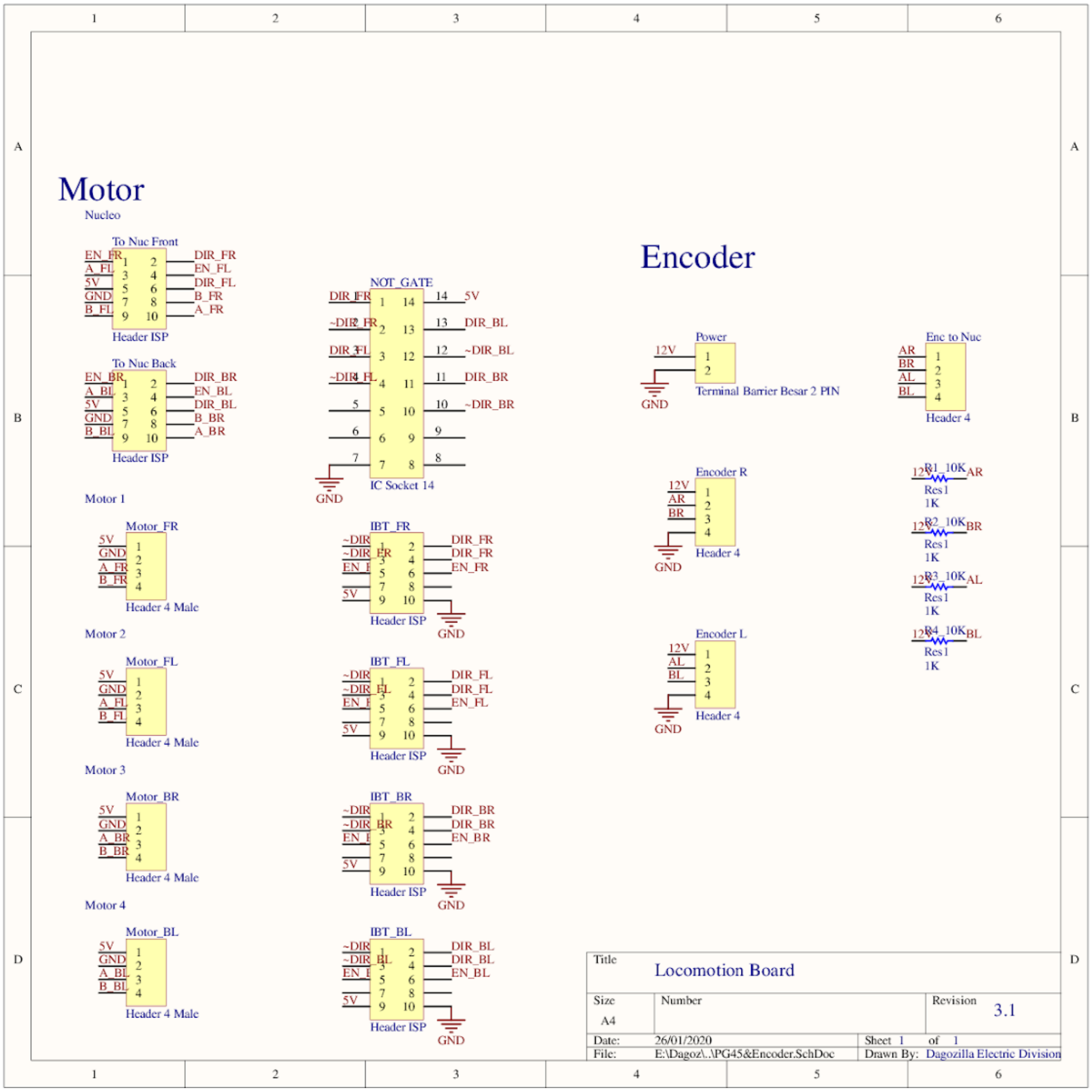

Fig. 5. Locomotion System Board Schematic

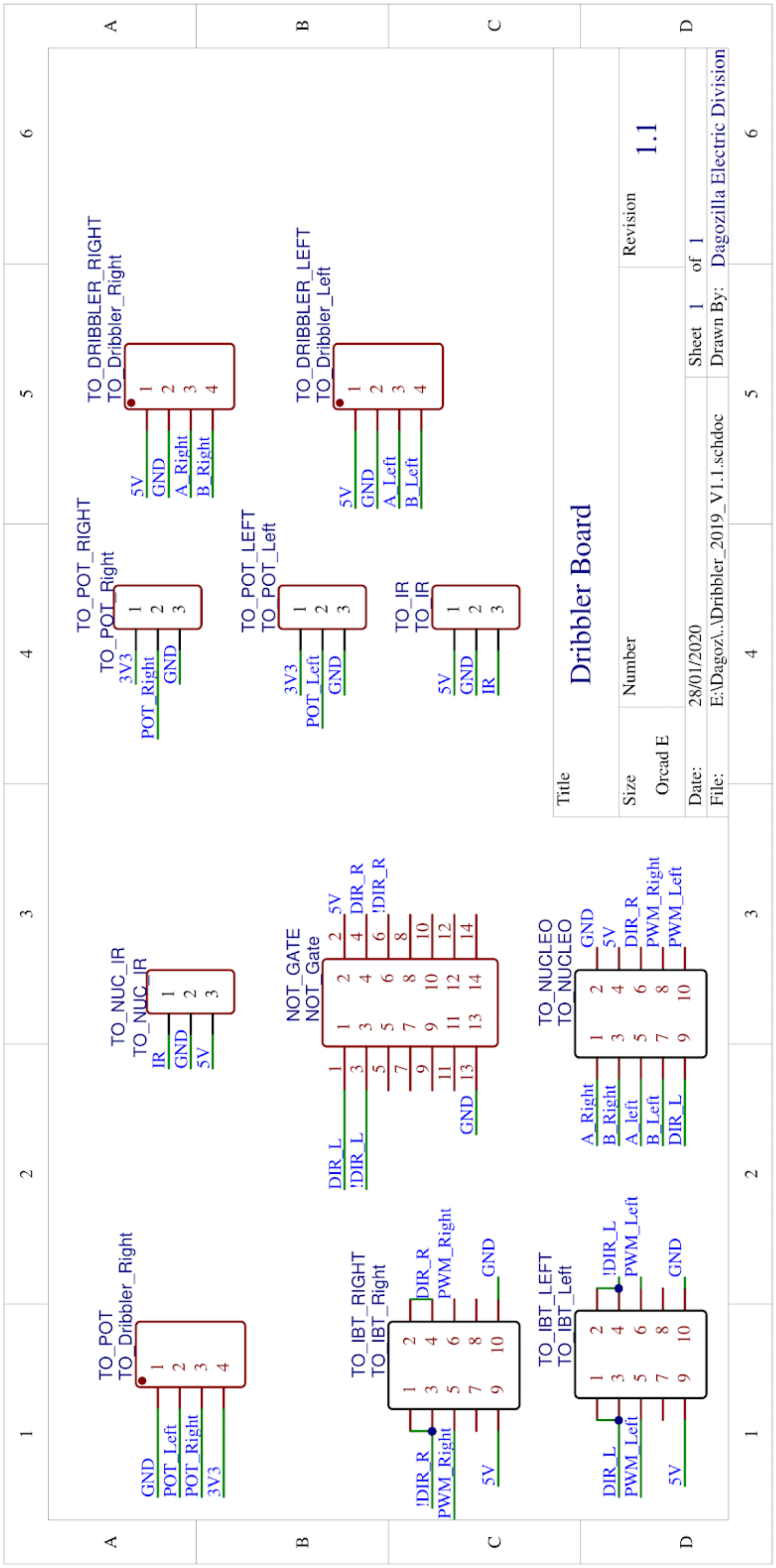

Fig. 6. Dribbler System Board Schematic

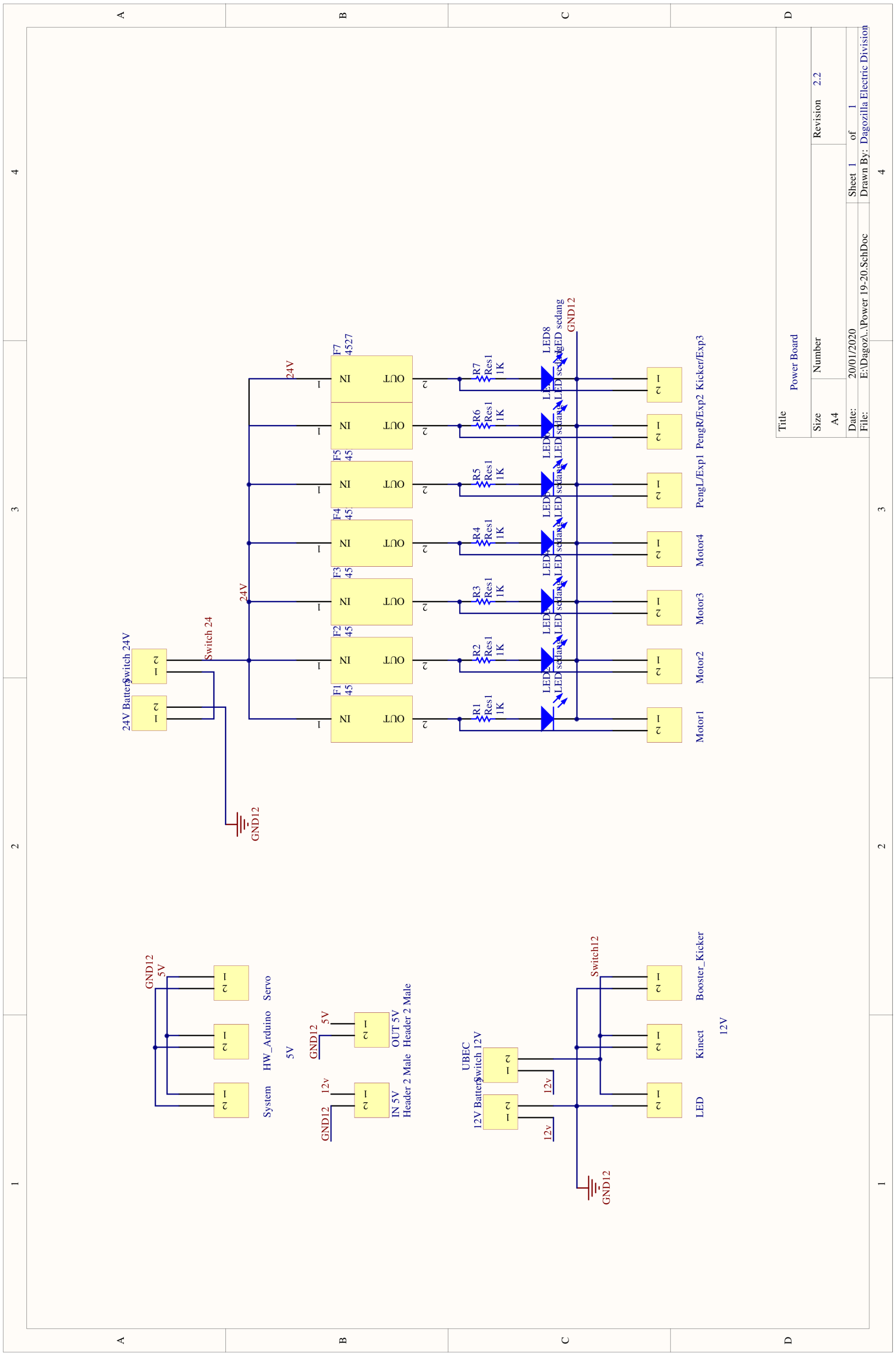

Fig. 7. Power Distribution System Board

Appendix B Software Architecture Diagram

This appendix contains the diagram of the robot's software architecture and data flow. The figure is on the next page.

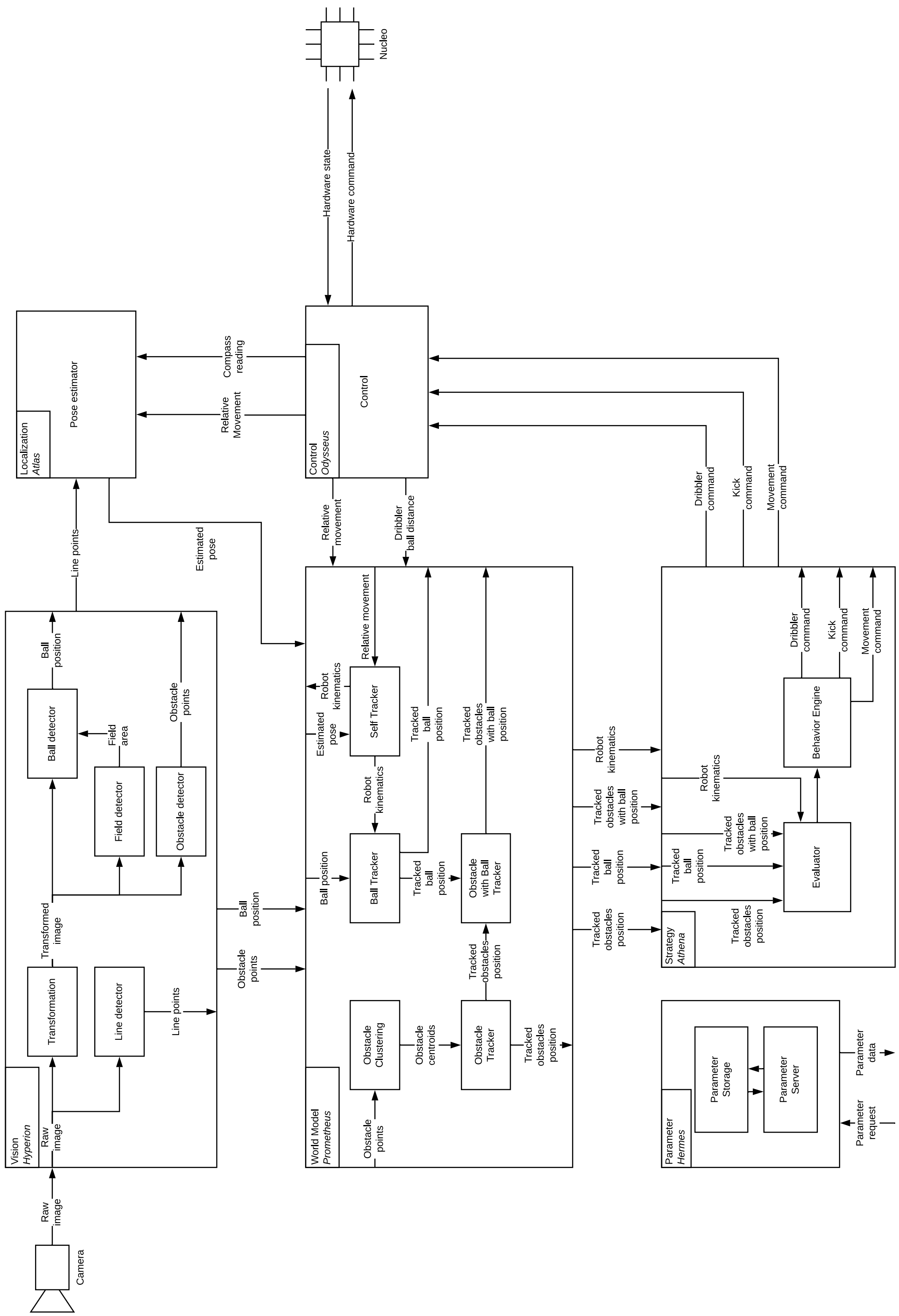

Fig. 8. Dagozilla Software Architecture Diagram