Sensor system

The sensor system consists of three varieties of sensors: touch, IR light, and reflectance. The touch sensors serve to align the robot with the front wall when firing at targets, and indicate when the robot is at the end of a wall. The IR light detectors are primarily used in acquiring targets, but a 10 kHz sensor has been included as a contingency measure, if other methods of orientation should fail. Five reflectance sensors are used to follow tape, and one is used to detect whether the robot has balls ready to fire. While the signals will be routed to the TINAH board, the sensors will draw their power from two VOLTAGE LiPo batteries.

Each reflectance sensor will be attached to an LM311 comparator and a potentiometer. This will allow the reflectance sensors to output a digital signal (the input voltage compared to the voltage across the potentiometer) reducing the number of analog pins required by six. Four of the sensors will be mounted on the front of the robot—two near the middle, and one at each side. The two near the middle will be used for following tape, and the two on the sides will be used to detect the end of tape near the targets. One sensor will be towed behind the robot, used to sense when the robot is directly in front of tape, allowing us to reverse directly onto tape from firing, as opposed to having to re-acquire tape blindly. The final reflectance sensor is internal, and used to sense when a ball is in the loading mechanism. Our intention is to replace the potentiometers with fixed-value resistors after calibrating them to sense tape/ball, as appropriate.

The IR light detectors are the most complicated sensor. Each requires ten circuits: a detector, DC filter, amplifier, two active filters, a rectifier, and four unity-gain amplifiers. Our intention is to leave each of these as discrete circuits, as opposed to combining several in one. This is to ensure that debugging and tuning are relatively easy. Two of the sensors, mounted facing the front, will detect 1 kHz IR light at a distance of one foot, allowing us to aim at targets. The third will detect 10 kHz light at a variety of distances (achieved using a CIRCUIT, which switches between several amplification values) and will be used as a last-resort method of re-orienting, as well as a method of finding the back wall to collect balls. The two 1 kHz sensors will be mounted DISTANCE apart, to ensure that THING.

The four touch sensors are, at this stage in planning, somewhat in flux. The initial plan is to use digital touch sensors—buttons. One sensor will be mounted on each side of the robot, used to detect when a wall has been reached. The front sensors, while initially planned to be digital switches, might evolve into more complex analog sensors, putting bearings on metal ‘whiskers’ which rotate as the bearings come into contact with the wall, held in the default position using springs. Their rotation will be transformed into a measure of how hard we are pressing into the wall, allowing us to more accurately sense whether or not we are perpendicular to the wall. If it is possibly to use a PID algorithm to stay perpendicular to the wall using digital touch sensors, this will not be necessary, but we see no easy way to test this until our robot is moving: our first goal.

In all cases, cables leading from the sensors and to the TINAH board and batteries will be collected and routed as a single entity, as opposed to a group of individual wires. We intend to use ribbon cable as frequently as is possible, and to have the battery inputs for all our circuits as close to the TINAH board as prudent, to ensure that the cables remain grouped as long as is possible. Our intention is to route the four QRD circuits at the front in conjunction with the touch sensors, simplifying the wiring of the majority of the components located away from the robot’s core. Each tape sensor has three inputs (VCC, ground, and signal) and each touch sensor, two, bringing us to a total of 20 wires required. 24-conductor ribbon cable will be routed from these sensors to a permanently mounted shrouded box header, which will, in turn, be routed to the TINAH board.

The three IR sensors will be routed similarly, using three three-wire insulated cables, tied together and routed to a permanently mounted connector, which in turn leads to the TINAH board. The trailing tape-follower will consist of three cables, also routed as a unit.