RoboSoccer Analysis

Part I: Various kinds and Complexities

Introduction:

RoboSoccer has always been an integral part of the development of Robotics around the globe and as such, has been growing at a variable pace throughout.
Today this field harbors the curiosity of a vast range of people with experience starting from that of a beginner, all the way to that of a professional. As a result, one can find various kinds of robots with the specific goal of entertainment through the means of soccer.

This report shall try to cover all the different types of RoboSoccer Bots of varying complexities and applications along with the different methods of handling and their difficulties.

Manually Handled Bots:

The robots playing soccer whose movements are directly monitored and handled by a person are of the category of manual bots. These bots are majorly differentiated over the method of handling, i.e, either wired or wireless.
Regardless of the method of handling, these bots can also be assistive with the use of an active webcam to help the handler.

Wired Manual Bots:

The most common type of wired manual bots come under the category of manual differential drive bot. These types of robots are controlled using DPDT switches and handled from a distance over long cables.
The motors used are usually high powered dc motors and as such, to activate these motors, high voltage is required which is neither safe nor possible through a handheld controller. To overcome this difficulty, relays are used as intermediary switches which can be activated at a lower voltage and can supply a higher voltage to the motors as required.

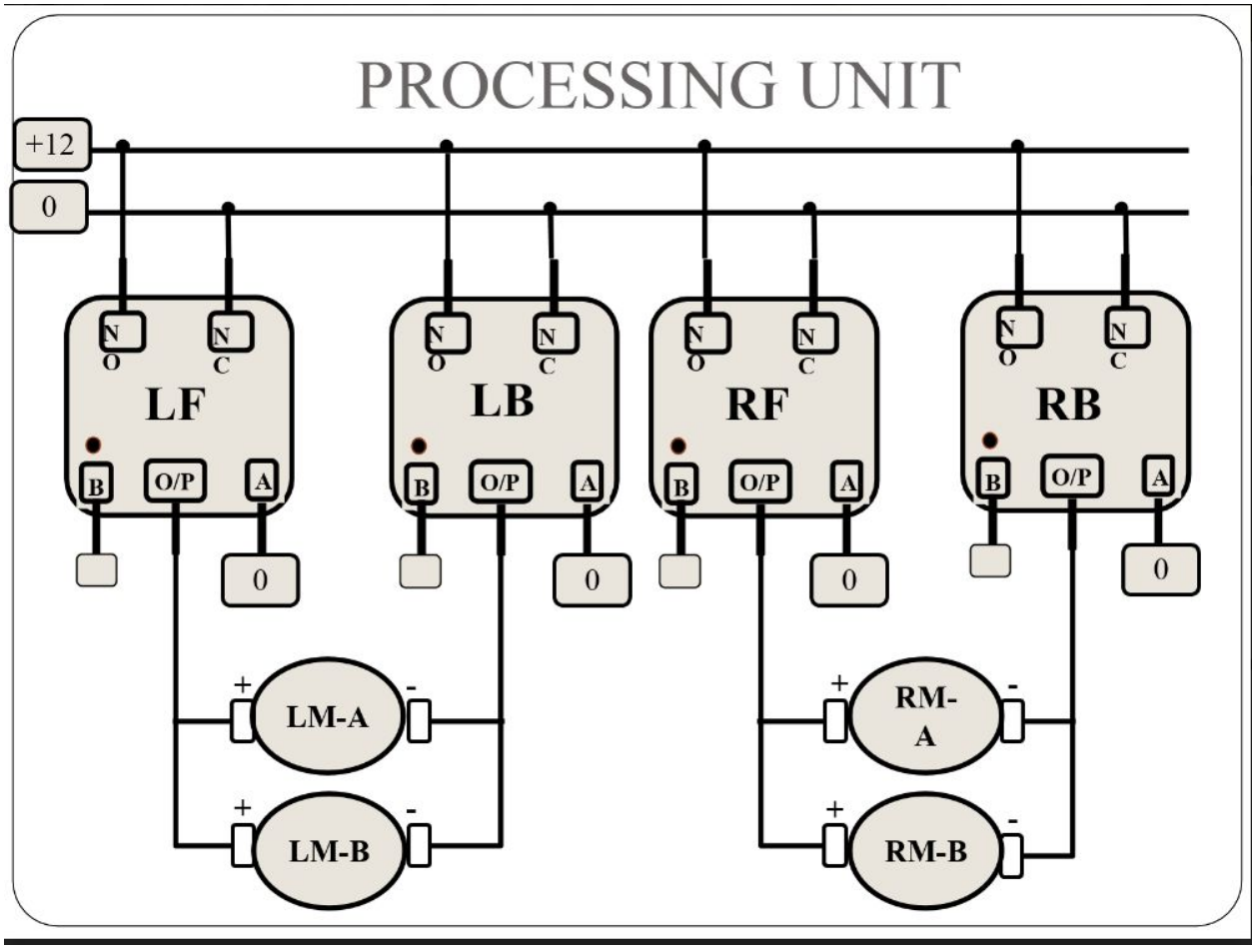


Fig: Simplified circuit for control of motors using Relays

Working:
The above figure shows a simplified circuit for controlling the bot.
The Key is: **L** - Left, **R**- Right, **F**-Forward, **B**-Backwards.
As such for the forward movement, the relay LF and RF should be activated.

Additional Modifications:
To better handle the tackling of opponents as well as capturing of and taking control of the ball, some additional modifications are also used. Usually, some type of contraction is added in the front and additional weight is added to provide better stability albeit bounded by the rules of the tournament.

Difficulties:
The major difficulties faced by these types of bots pertains to the controlling method. These are wired bots and hence not autonomous and the length of the wire, as well as their tangibility, also takes a major role in defining the ease of handling.

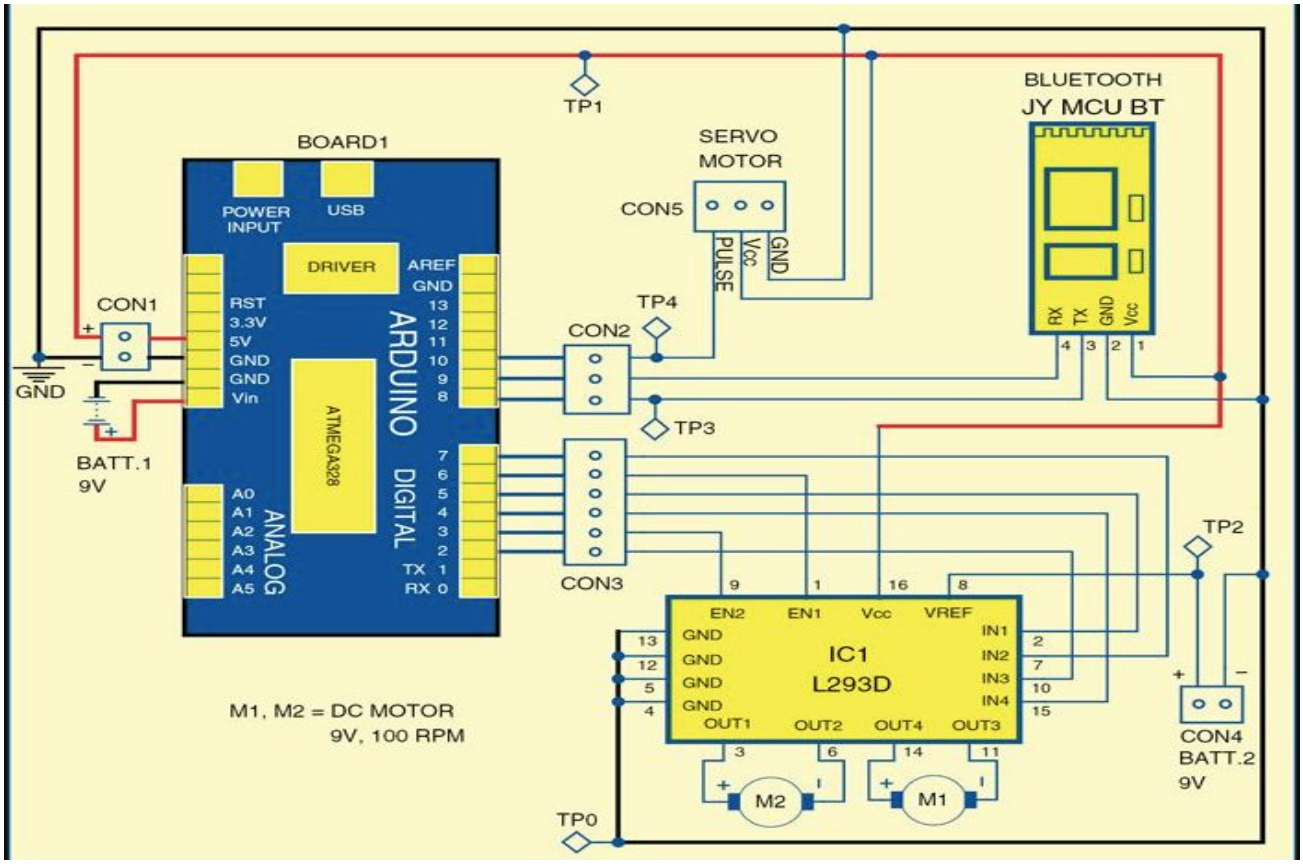
Wireless Manual Bots:

These types of bots try to tackle the difficulties of its predecessor and limit the usage of wire as a medium to control the bot. It still operates the umbrella of manual bots as it is actively controlled by a user but the instructions for movements are provided wirelessly in realtime.

The most common medium for easy wireless transmission is Bluetooth and RF Transmitter. While Bluetooth does require an additional controller to be used for encoding and decoding, usually Arduino and a smartphone as a controller, RF Transmitter can work without one as long as the instruction set for the movements are not too complex.

Bluetooth:

This soccer robot can move forward, reverse, forward-left, forward-right, reverse-left, and reverse-right with the help of an Arduino. The speed of its movement is controlled by the angle of rotation of the phone. The robot also kicks a ball when the phone is shaken.shown below is the circuit of the soccer robot. The circuit is built around an Arduino UNO board, a servo motor Bluetooth module motor driver, and two DC motors.



Functioning of the bot-

As most smartphones contain an accelerometer sensor. A phone with an accelerometer can detect the angle it is being held at. It can also detect rotation and motion gestures such as swinging, shaking, and flicking. The accelerometer can detect whether the phone is upright or sideways, and automatically rotate the graphics on the screen accordingly. Another common use is in controlling games and other applications (such as music players) by moving or shaking the phone. When the phone is rotated in different directions, x,y,z values of accelerometer sensor change. The Phone for this project sends these x,y,z values to the robot via Bluetooth.

The phone sends the sensed data from the accelerometer of the phone to the robot via Bluetooth. Data transmitted by the phone is received by the Bluetooth module on the robot. The received data is fed to a pin of BOARD. The microcontroller on BOARD processes the received data and drives the motors accordingly. The robot also sends back the status.

Difficulty-
The major difficulty in these types of bots is that the power transmission is quite low as is reduces considerably with distance.
The data is also sent through a smartphone and thus poses as an additional requirement.

Autonomous RoboSoccer Bots:

The robots that do not need an active instruction guide for their movement come under the umbrella of Autonomous bots. These bots are given some set of instructions under which they act to complete the task at hand. The majority of these bots use the techniques of image processing to further improve their efficiency.

Raspberry Pi

Robots are thought to understand and interact with the real world through sensors and machine learning processing. Image recognition is one of the popular ways in which robots are thought to understand objects by looking at the real world through a camera just like we do. In this project using **the power of Raspberry Pi to build a Robot that could track the ball and follow it just like the robots that play football.** OpenCV is a very famous and open-source tool that is used for Image processing, but in this project to keep things simple, **the Processing IDE** is used. processing for ARM has also released the GPIO library for processing. will not have to shift between python and processing anymore to work with Raspberry Pi. Two libraries used in these projects are **Hardware I/O `and` GL Video`.`**

Working of bot - Although the intention of the project is to track a ball, they are actually not going to do it. they are just going to identify the ball using its colour. because videos are nothing but continuous frames of pictures. So they take each picture and split it into pixels. Then they compare each pixel colour with the colour of the ball; if a match is found then we can say that we have found the ball. With this information, identifying the position of the ball (pixel colour) on the screen is done. If the position is far left we move the robot to right, if the position is far-right we move the robot to left so that the pixel position always stays at the center of the screen.

Implementation- Connect your Pi to monitor and launch the processing code. video-feed Should be visible on a small window on the screen. Now, bring the ball inside the frame and click on the ball to teach the robot that it should track this particular color. Now move the ball around the screen and you should notice the wheels rotating. If everything is working as expected, release the bot on the ground and start playing with it. **The room should be evenly illuminated** for the best results.

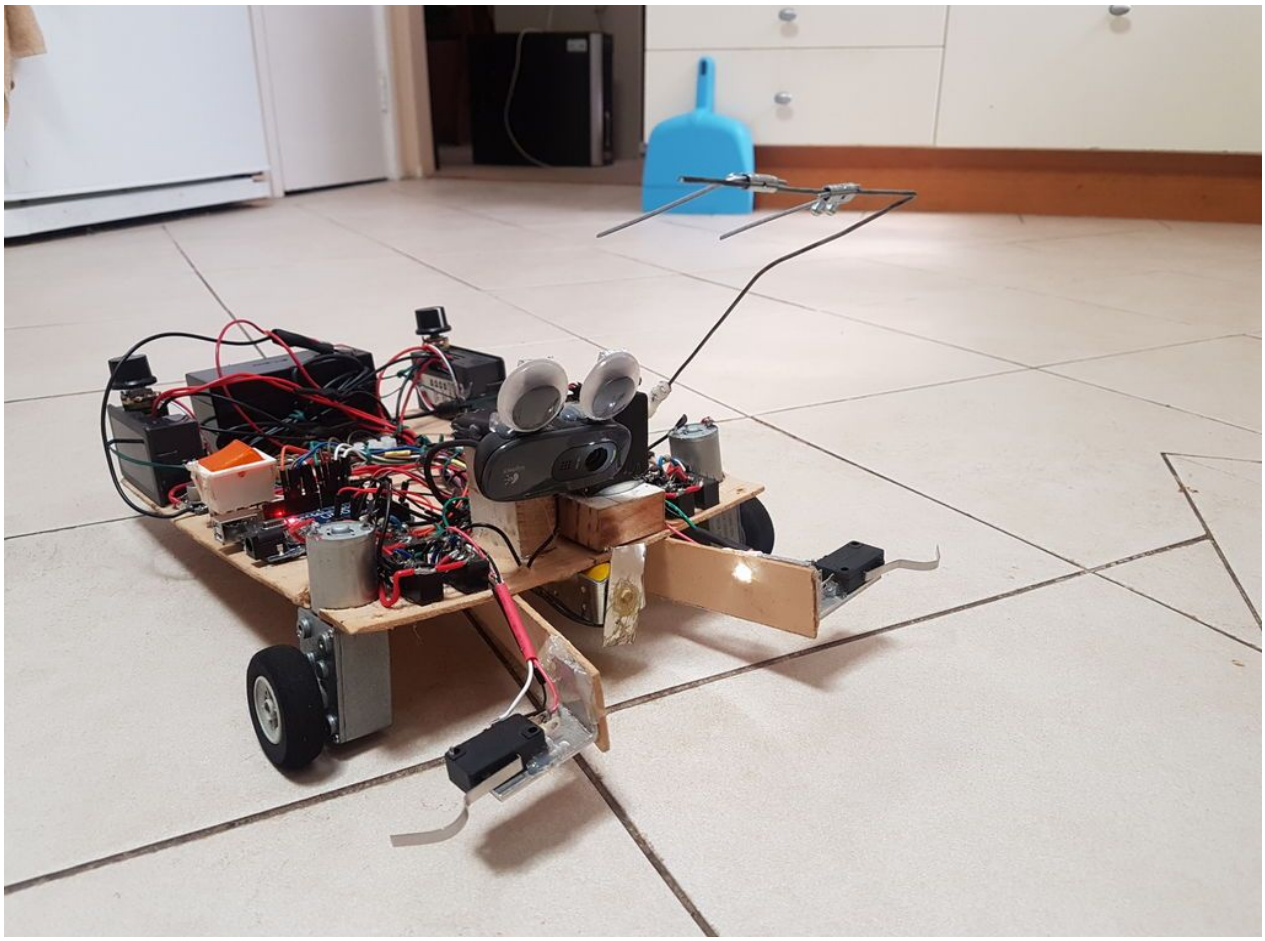
Difficulties-

- Difficulty in recognition of the object if the object is not of contrasting color with the background.
- Using only Raspberry Pi for controlling the movements as well as processing slows down the bot a lot as the bot requires continuous input and output to the motors for proper chasing and capturing of the ball.

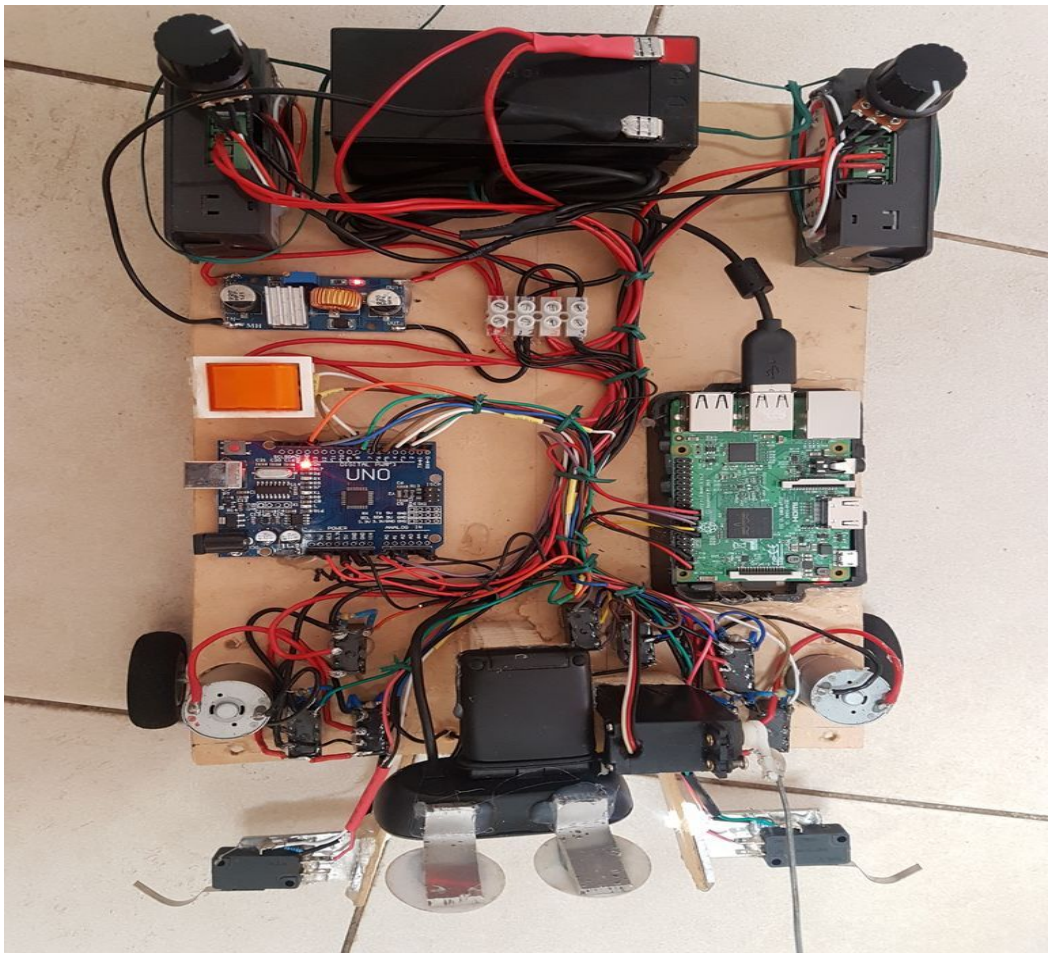
Raspberry Pi + Arduino

Functioning:
The concept for this project is to create an autonomous soccer-playing robot (as it requires no human controller input). The robot searches for a ball using the rpi camera. The color(different from the environment) should be specified so that the bot can identify the ball among the surrounding. It tries to center and move to the ball itself, capturing it via an LDR enabled trapping arm. This robot then searches for the goal, the goal can be set using a different color and kicks towards the goal (via a solenoid).

A raspberry pi running an OpenCv python program takes in information from the RPi camera and acts as the brains of the robot. An Arduino is used to control the DC motors, kicking solenoid, and trapping servo.



Implementation: The python code runs OpenCV to transform a normal RPI camera image into a black and white image highlighting the location of a certain color. If the ball is not visible the robot rotates in either direction until it finds it again. The area and x position of this transformed image is calculated and used to determine how close the robot is to the ball. If it is too far away then the robot moves towards or rotates to try and center the ball.
When the ball gets close enough it casts a shadow on the LDR, which is implemented using an LED, which in turn causes the trapping arm to come down controlled by the Arduino. This sends a signal back to the raspberry pi which transitions the robot into goal finding mode, which is just to locate another color.
The robot then moves with the ball until the goal color is a certain size and centered, then the raspberry pi sends a signal to the Arduino that the soccer bot should kick. The Arduino then raises the catching arm, actuates the 5V relay which causes the solenoid to fire, kicking the ball to the goal. The loop then continues indefinitely.



Difficulties :

- A robot cannot snatch the ball once it is captured by another robot.
- If there is an object of the same color as ball or goal then the robot might not be able to differentiate between the object and ball (or goal).