Safety Measurements and Quality Issues in Botball

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***Abstract*—Abstract - This publication reviews various safety issues, encountered with technical parts of the current Botball kit and parts of previously used controllers and measurements, which should be taken, to reduce hazards for users. Also - a less serious problem - are quality issues, which can be quite challenging while building and testing a bot. Disadvantages for outside-US teams are also shown up and ideas for solutions provided.**

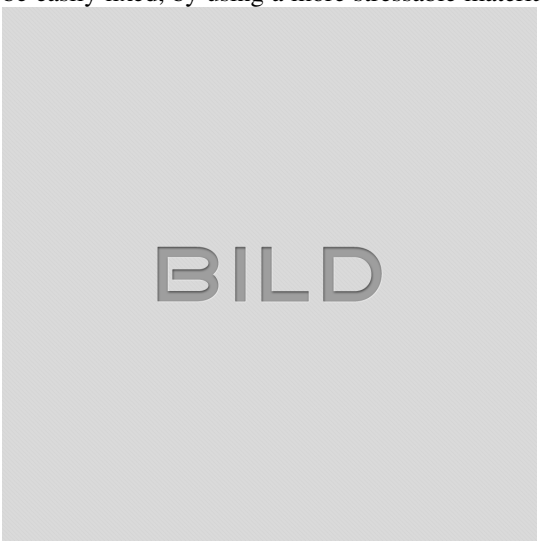
I. Introduction

In this season there were many problems and quality issues, which were encountered by teams working at our school. Because there are teams, working with other equipment than the parts, provided in the current kit, parts previously used in Botball are also reviewed. These controllers and parts are also used in other challenges than botball (like KIPR/PRIA Open, Junior Botball Challenge) and in the latter one, it's used by young students. If this equipment is provided explicit for younger persons, it is an important aspect, that these parts are safe to keep them from dangers, which can occur, when misusing the equipment or in normal operation.

II. Quality Issues

At first there are the quality issues, that came up very often. Mostly, servos are breaking down with only light loads put on them. Also they are not very accurate, if you moved them between to phases of activation, like shown in the chart below. On various ports big servos aren't working at all, but mini servos are working. This fact were tested on various setups, like activating all servos and only enabling the specific port, with and without weight on the servo horns. Other problems which occurred to other teams at our school are servos which are spinning continuously or can't be stopped from spinning by disabling the port.

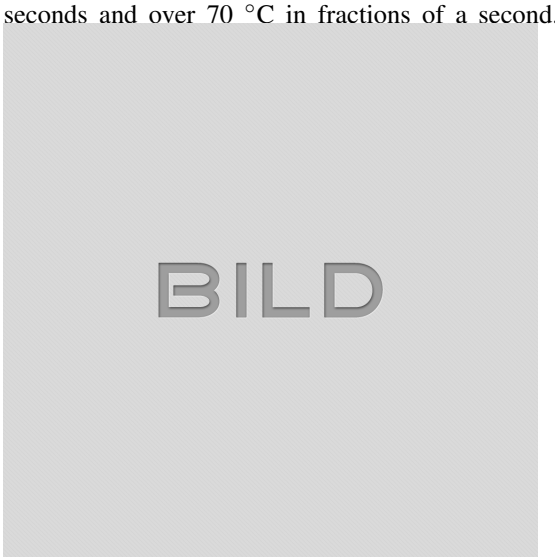
Also many new servos broke, because of parts of the gears inside broke off. Mainly this happens if you put larger weights on the servos (like heavy actuators/grabbers), so this part can't be seen as an quality issue indeed, although this problem could be easily fixed, by using a more stressable material.



III. Safety Hazards

Botball thrills many younger students to work on robots using parts or the whole Botball kit. To ensure they can work safely on their robots, there are some safety issues, which should be fixed. We've found many problems with controllers, batteries and a few other parts, which could lead to skin burns or other serious injuries.

The KIPR Link for example, has a non-functioning HDMI port, that is used as a heatsink and is accessible from the outside. This controller isn't contained in the current Botball kit anymore, but is used mainly by younger students to get in touch with this competition, at KIPR/PRIA Open and the Botball Junior Challenge, so if they are getting delivered by KIPR further, they should remove this port. Skin burns can happen between 45 °C and 51 °C within minutes, between 51 °C and 70 °C within few seconds and over 70 °C in fractions of a second.



As you can see, if you put the processor from the KIPR Link under load, it can quite heat its external parts up. Especially this specific port is located on a spot, where you would likely grab the controller with your hand/fingers.

As mentioned before, there are issues with batteries, which can be very dangerous. Two batteries started burning while operating the wallaby with it - both times the load balancer dongles were between the controller and the battery. One time, one of our batteries blew up, because it overcharged over night. This incident could have easily started a fire at our school.

The chargers used for the KIPR Link are only available with the NEMA-1 (Standard American) plugs. If these chargers are used in Europe, users have to plug an adapter between the charger and the power outlet. With many of these converters users are able to accidentally touch the bare metal contacts when pulling out the plug and are at risk to get a shock, which can be life-threatening at 230 volts AC. Also these chargers haven't got a built in circuit to discharge the internal capacitors when it's pulled out of the power outlet. If someone gets his bare skin in contact with the two contacts, he will get a shock, which isn't really dangerous, but quite painful and can lead into damage of the charger, if the shocked person drops the charger.

IV. Parts which are not available in Europe

To build a game table one have to buy plastic tubes in inch measurements and get some sort of plastic plates, which form the floor of the game table, that are banned from the European Union, because the dust which arises when the plates are broken are poisonous, and are only available from the United States. These plates are very difficult to ship because they measure 4' times 4'. Often the pvc pipes are also only available in large dimensions, which doesn't fit on standard pallets. Because of these measurements, shipping costs are reaching

huge amounts of money, so it is difficult for many European teams to build tables, which are identical to the ones used at ECER and GCER. If you buy only parts, available in your home country, you only can get parts in metric measurements, so the game tables are showing inaccuracies and for the teams a lot of stress on site, because they have to adjust their code to work properly on the used table and that is a big disadvantage for teams out of Europe. Well, this problem can't be easily fixed, because there can't be to types of game tables provided. For example if two teams play against each other at GCER and one is from Europe, the other one from the US, what type of table should be used? Maybe there are ?hybrid? solutions to manage this problem, like using metric tables at ECER and imperial tables at GCER and at US-regionals.

V. Conclusion

All of the shown facts above may not happen when using a quite expensive robot kit to develop your robots and certainly not in parts and kits, which are intended to get younger students get known to robot programming. A more or less big part of these problems can be avoided and/or fixed by yourself if you have advanced skills in electronics, low-level programming and engineering. But you can't require all students in the Botball competition to have this skills. KIPR should take action in some cases, like use batteries with internal load balancers and safety mechanisms, to shut them of or rather cut the internal power connection in case of it being charged or used wrong.This may destroy the battery, but keeps it from exploding or causing a fire. Maybe, in future controllers, they could use open source platforms (like the Raspberry or Banana Pi), so you can replace them more easily, when not living in the USA. If you are from Europe and one of your wallabies have an internal problem and you can't repair it, you have to send it to KIPR and it takes weeks until the package comes back.