Description of the Warthog Robotics 2014 project

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Abstract. This paper presents the RoboCup SSL team WR Magicz developed fromm2@}}muntilmm2@}1 by the Warthog Robotics group from the University of São Paulo at São Carlosw This project merges the best features from older projects developed by the groups GEAR and USPDroidsw Besides thatz it brings a new aluminum mechanical structure with a 3{wheel omnidirectional robust control systemz an efficient kicking devicez a potential fields{based navigation module and a fuzzy strategy systemw The team presents full game capability with accurate and fast responses to strategy and referee commands.

Keywords: RoboCup Small Size Leaguez Roboticsz Embedded Electronicsz Artificial Intelligencew

1 Introduction

At the beginning of 2@}} the groups GEAR and USPDroids merged creating the Warthog Roboticsz a group of the departments of Electrical Engineering of the São Carlos School of Engineering and the Computer Sciences of the Institute of Mathematics and Computer Science of the University of São Paulo at São Carlosw

The group counts with about y@ members students of Computerz Electrical and Mechatronic Engineering and Computer Science and develops robotics technologiesz applying most of them at the robot soccerw This first project of the group brings features from older projects of GEAR and USPDroids and implements them together with some improvements in a new mechanical structurew The next sections present some WR Magic features detailsz including the mechanical structurez electronic devices and computer systemsw

2 Mechanical Structure

Them mechanicalm structurem wasm designedm tom accommodatem them locomotionm systemzm withm itsm fourm Faulhaberm 2132m DCm motorszm gearboxesm ofm Uk}m ratiom andm omnidirectionalm wheelszm capablem ofm providingm am maximumm speedm ofm 1wEm mps5m them kickingm devicezm consistingm ofm twom 22@@m µFm andm 2@@m @Vm capacitorsm andm am customm solenoidm withm am concavem platem attachedm tom itsm axiszm thatm canm kickm upm tom jm mps{m fast5m andm them dribblem devicem thatm countsm withm am specificm shape{rollerm coatedm withm am viscoelasticm materialzm mountedm onm am suspensionm withm shockm absorberm systemm andm linkedm tom am Microredm Am DCm motorm bym am 1k}m gearboxw Them maximumm ballm coveragem whenm dribblingm ism }EWw Them upperm partm housesm them threem electronicm boardsm andm them batteryw Besidesm thatzm itm containsm ductsm form wiringm andm columnsm form coverm attachmentw Them coverm followsm them classicm designm ofm them categorykm am cylinderm withm openingm form them wheelsm andm them kickingm andm dribblem deviceszm resultingm inm am robotm withm }y@m mm heightm andm }j- mm diameterw Allm mechanicalm structurem ism madem ofm aluminumm andm wasm machinedm bym them groupm memberszm offeringm am robustzm yetm lightzm robotw

3 Electronic Devices

Inm orderm tom fulfillm them essentialm requirementsm ofm locomotionzm kickingm andm dribblingzm threem electronicm devicesm werem developedkm MainBoardzm DriverBoardm andm KickBoardw

3.1 MainBoard

Them MainBoardm ism responsiblem form receivingm commandsm fromm them artificialm intelligencezm decodingm themm andm sendingm commandsm withm SPIm tom them requestedm actuatorsm Tmotorszm dribblem devicem andm kickm boardãw Moreoverzm itm measuresm informationm asm batterym andm kickm capacitorsm voltagesm andm sendsm themm backm tom them telemetrym systemw

Am dsPICm 11Fm runningm atm 3@m MIPSm ism usedm asm them mainm controllerkm capturingm them sensorszm controllingm them motorsm speedszm choosingm them radiom frequenciesm andm activatingm them kickingm andm dribblingm devicesw

Them communicationm withm them strategym ism donem bym them transceiverm LAIPACm TRF{2w3Gz am cheapm butm highm reliablem modulem thatm runsm atm 2w3GHzm andm implementsm featuresm asm addressm attributionzm ShockBurstm transmitionm modem andm errorm detectionm viam CRCm [}]w

3.2 DriverBoard

Them DriverBoardm receivesm commandsm fromm them MainBoardm andm activatesm them motorswm Them controlm systemm mustm assurem them properm functioningm ofm them Faulhaberm 2132m DCm motorszm thereforem itm countsm withm y}2m linesm perm revolutionm Faulhaberm IE{2m encodersm tom measurem theirm realm speedszm thatm actm asm them feedbackm ofm am classicm PIDm controllerw Them drivingmismdonenbymthemICmL2-Enmanm H{bridgenthatmamplifiesmthemsignalsmthatmwillmbemsentm tomthemmotors{zmactivatedmbymPulsemWidthmModulationmTPWMãzformthatmismanmeasymtom implementmsolutionmandzmaccordingmtom[2]zmensuresmthatm‘themglobalmefficiencymofmthem systemzmevenmwhenmtakingmthemlossesmduemtomharmonicsmintomaccountzmismmuchmlargerm thanmthemonemprovidedmbymlinearmamplifiers”w

3.3 KickBoard

ThemKickBoardmcontrolsmthemkickingmdevicezmchargingmtwom22@@mFmcapacitorsmtom2@@m Vmandmdischargingmthemmimmamcustommsolenoidmwhenmrequestedw Themchargingmmodulem followsmthemboostmtopologymwithmamdigitalmcontrolmsystemw Amprinciplemofmthemboostm convertermismthemswitchingzmimmothermwordszmtheremmustmbemvoltagepcurrentmpulsesmatmthem transistormgatezmasmdescribedmimm[1]zm[3]mandm[y]zmhencemamPWMmsignalmismgeneratedmbymam PICm)EFmcircuitw

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4 Computer Systems

ThemWRmMagicmProjectmsoftwaremismbasedmonmtwomsub{projectsmdevelopedmbymthemgroupkm themGEARSystemmlibrarymandmthemstrategymapplicationw

4.1 GEARSystem

ThemGEARSystemmismamdistributedmsystemmlibrarymthatmprovidesmcommunicationmamongm allmsystemmmodulesw Itmwasmbuiltmovermn CORBAzmamclassicmstandardmformthismkindmofm applicationzmandmallowsmthemexecutionmofmthemAImapplicationmimmonemmachinemandmthem telemetrymsystemmimmanothermonezmformexamplew

ThemlibrarymarchitecturemismmminimalistzmwithmfourmbasicmelementskmServerzmSensorzm ControllermandmActuatorw Themsensorsmcanmcreatemteamszmplayersmandmballsmandmsetmtheirm informationmTpositionzmorientationzmvelocityzmwwwãw Controllersmmaymreadmthesem informationmandmsendmcommandsmtomthemactuatorsmTmovezmkickzmdribblezmwwwãw Actuatorsm readzmdecodemthesemcommandsmandmexecutemthemw

4.2 Strategy and Artificial Intelligence

The strategy is responsible for setting behaviors to the players and planning pathsw Some behaviors were definedk defendz interceptz pass and kickw Defend is performed only by the goalkeeper and consists in standing still in front of the goalz protecting itw Intercept shall prevent the ball from going towards the goalw The passing behavior consists in conducting the ball towards the opponent areaz preferentially towards a team mate that is close to the areaw Finallyz kick behavior pulls the ball to the goalw The attribution is flexiblek during the gamez the coach can choose the best set of behaviors for the game situation using a fuzzy control logicw

The path planning uses the orientated potential fields techniquew This technique uses solutions of the elliptic partial differential equations contour value problem to create the potential fieldsw The Dirichlet contour condition was used [U]z where the goals have potential @ and obstaclesz }w This technique represents an evolution to the old USPDroids strategy system [j]z because it allows the definition of behaviors at the generated trajectoriesw This is possible due to the definition of a influence vector to the potential field [U]w

The utilization of this kind of equations also solves another conventional potential fields problemk the existence of local minimumsw

5 Conclusion and Future Work

The presented project brings a whole set of improvementsz taking the group to a highly competitive levelw The developed hardware is robustz reliable and provides an excellent platform to the strategy systemsw The implemented navigation algorithms allow the robot to move fast and softly in the fieldz permitting the execution of all desired strategiesw

Until mid{2@}3m the computer systems shall be tested harder and some new features may be available either on navigation and strategies or on integration systemsz improving the ability of the teamw

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References

}w Techz Lwz Watermanz HighmFrequencym2w3GmWirelessmTransceiverzmTRFm2w3GmTransceiver DatamSheetzmT2@@jã
2w Oliveiraz VwAwz Aguiarz MwLwz Vargasz JwBwz Sistemas de Controlek Aulas de Laboratórioz EESC{USPz T2@@yã

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jw SmithzmGwDwzmNumericalmSolutionsmofmPartialmDifferentialmEquationsk mFinitemDifferencem MethodszmOxfordmUniversityzmT}--2ã

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