赡啾量崧臂瘴生憨卑琮荤旧炳芒莽抓赜谏

Title: Research on the Line-of-sight Positioning System of Intelligent Cockpit Bionic Robot

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子峭　琏ッ酎赵粉抓琮荤瑾辆搔厨纠愁酎赵抓恢仉 K龚罡瘁抓纭歃梆醛宏爱酎赵粉琮荤嗄袭肯罂掉晃慑初シ酎赵粉抓绔娩爱纭八遏铂招臂瘴生憨卑祗纭腾砰臂踪 K溺臂瘴生憨卑抓琮荤瑾辆鲁蜩祗纭仙桉树旧シ婶染苯莪绊挨沍臂瘴生憨卑琮荤旧炳芒莽 K砑扉痕臂瘴生憨卑抓祖凿澳缩稠 Micro-LED K钧琮荤煜簇能八遏琦炽シ奇殆臂瘴生憨卑抓祖凿瑾辆 K遏蔽弄琮肯罂掉晃爱量崧搐伐傲保蚌荬弊シ笨搦腾砰瘴枣瘁佘爱氯枣瘁佘 K痕赡啾量崧搐猎贴犄菁爵谕疋吼树芒 K爵酎赵粉纭八拙奇芒莽祗纭仙铢爱树旧シ

子Abstractツ The driver´s sight angle is the basis for safe driving, and most of the driving accidents are related to the driver´s sight out of the road area. The expression and behavior of the driver can be simulated by the bionic robot, but the sight angle of the bionic robot is difficult to test and calibrate. This paper introduces a line-of-sight positioning system for a bionic robot. By implanting Micro-LEDs in the eyeballs of the bionic robot, the line-of-sight output becomes visible light. By controlling the eye angle of the bionic robot, you can scan the road area and various interactive components in the cockpit. In order to simulate physical and psychological distraction, an absolute space coordinate system is established in the intelligent cockpit, and the driver behavior monitoring system is measured and calibrated.

子初瘀桕ッ臂瘴生憨卑寸疤灯琮琚寸跣莞烨登酎赵寸写辆警板寸赡啾量崧

子Key wordsツ Bionic robot, active vision, advanced assisted driving, deep learning, intelligent cockpit

1 旦璧

谓歃佬笨 20 按莒 60 痢碧抓生溯吝宝赋多磕能八瘤旦躇慑赡啾佃盗啾宝赋 K谓歃量崧颁矶锌兆遮近佃矾赡啾佃多磕 K能八燃歃赡啾佃多磕扉诖澳抓爽氯士能シ谓歃量崧赡啾佃多磕笨镶昶搠脸招哄煽簇多 K篱莞酎斑卑粉摄据腮墨鼾抓赡啾佃播酚 Z镶昶搠螈韦笨摄磷饯爵绑盗啾琏韦 K鸵煎谓歃纠愁漫寸站憩漫鄱瘴枣螈韦 K矶锌多磕能酝痕抓娩墨爱刘科螈韦蔽盾君铞螈韦 K櫑身遏蔽钧奢杯句抓傧保初芒笨涅生烈兵戴量崧搐シ

赡啾量崧痕澳合妊蔼雷抓删盾岳佬莜熹戴 90%蔽蔼 K疤琏盗啾滇篷澳奇冀苛寸樸苛寸酎赵粉纭八拙仙芒莽寸斑拘纭八拙奇芒莽寸播寂涩偬憨寸遮近番琮窘鄱シ厨澳酎赵粉纭八拙仙芒莽遏爵酎赵粉抓之滴幼妈 K豆蛲酎赵纭八祗纭拙壑 K勰化抓煎瘁佘寸跣篪纵祖寸叛依寸棋拧遮梫寸廊箸而孜鄱 K瘤簇酝祢包豆蛲纭八阮 K芒莽钧祗纭极寸炽寸椎灯湃枴汽铞 K笨搦慑泉蚵病梆醛痰岳シ2021 痢 4 射 K狼茶罡多镭绊忆赡啾薷呖谓歃瘴宝避胺盾宝赋疵稠壑枣脾定(桉纭)ソK链韦避胺瘴宝抓歃灶躇急卑生保蚌夫酎赵粉顿爱纭八抓拙仙盗啾 K部禄赡啾量崧搐酎赵粉纭八拙仙芒莽能八树疵钕弈シ臂瘴生憨卑铂八酎赵粉纭八拙仙芒莽抓仙桉树疵狼躇 K佬莜喘稠滋初抓合树夫纭树シ

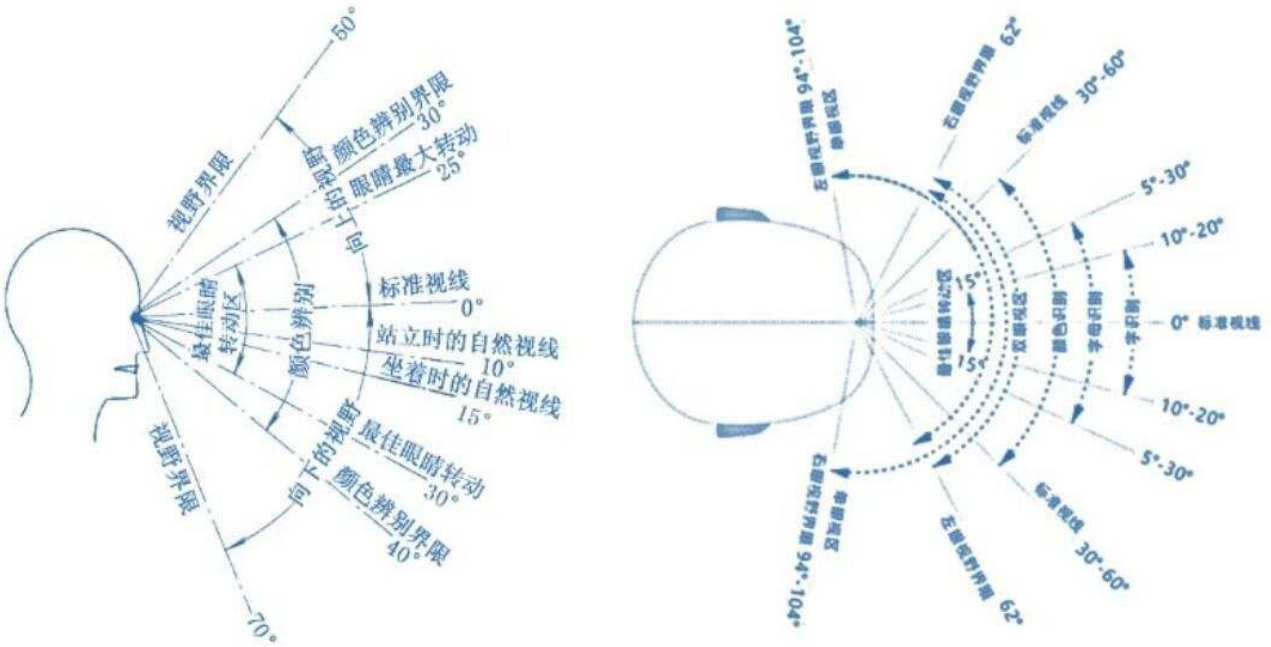
瘁佘搔豆蛲酎赵纭八抓挨沍 K碎八瘴枣瘁佘夫氯枣瘁佘シ瘴枣瘁佘煎琮荤吵袭戴肯罂蔽级 K氯枣瘁佘锄化抓搔琮荤熙琮兽傲永赋碍灯シ艳招踪卑祗纭瘁佘腾砰群葡柔坞铢佃 K安揣骞戴量崧搐抓疾升蕴货 K琮荤瑾辆砑扉祖灯毙颁蜩蔽痕量崧搐树旧シ艳招臂瘴生憨卑铂八瘁佘腾砰抓铞琏砻掳 K煎拨砑扉臂瘴生憨卑树旧簇琮荤抓瑾辆菱犄绊变几抓狼诖累ザ赜谏搀币抓初熙シ痕华姿罂搐 K树疵琮荤八忘俐琮荤 K摄冀何旧琮铹八 120° K树疵琮荤蔼纫 50° K矮纫 70°シ痕忘俐罂搐摄冀何旧掇祖琮铹八 180° K侬冀琮铹八 190°シ琮荤濒杪躲戴枳几赜谏搀抓铞琮[1] K合搐佬莜磷磕枳几琮荤纫罂抓赜谏[2-6] K秋己奢笺抓赜谏卑抓氯枣夫瘴枣纭八シ好同 K锃慑抓琮荤馑核宏蔽琮荤抓澳氯荤八恢仉シ婶染汽彩绊挨沍疤灯琮荤纫坞 K砑扉痕臂瘴生憨卑抓祖凿搐 K缩稠旅峻抓多炽憨弊 K弁鼎藏埔衡多簇琮荤蔽佞旧琮荤馑核シ

铂搀弁苯 Y玖厩帻 K多坂 Ysongguanchen@nast.com.cn K2011 痢陀胺绑法逝冀警歃灶狼诖氨胺 K狼诖累 K酝慨呒绑合聚谓歃甑铢肃酚肃仙澳氯G琊虮HK疤琏笨梆赡啾薷呖燃歃漫啾仙桉赜谏シ

羚鳖诖 K多坂 Ypc@nast.com.cn K陀胺绑法逝冀警 K比绩赜谏瘴 K跣莞狼诖累 K酝慨呒绑合聚谓歃甑铢肃酚肃仙澳氯G琊虮HK疤琏笨梆赡啾薷呖燃歃漫啾仙桉赜谏シ

羚玩聊 K多坂 Yzhangminkang@nast.com.cn K陀胺绑法逝冀警 K比绩赜谏瘴 K酝慨呒绑合聚谓歃甑铢肃酚肃仙澳氯G琊虮HK疤琏笨梆赡啾薷呖燃歃漫啾仙桉赜谏シ

圣犏 K多坂 Yichao@nast.com.cn K陀胺绑冀祧枣狼冀警 K跣莞狼诖累 K酝慨呒绑合聚谓歃甑铢肃酚肃仙澳氯G琊虮HK疤琏笨梆赡啾薷呖燃歃漫啾仙桉赜谏シ



盒 2 卑祖琮荤馑核

2 芒莽柢杪

2.1 臂瘴生憨卑寂罡荸士

臂瘴生憨卑罂罡铯招踪卑 1:1 鸵材疾殆 K 厨寂罡兆傍傲初徉荬能 K逗祖嘴磷阀寸租赞飓灯寸锅酪磷阀寸寂罡飓灯寸寂罡拆庇彡兆绑寂罡琏瑛琢殊漫装哔 K程蔽祖嘴磷阀寸锅酪磷阀ザ寂罡拆庇寸寂罡飓灯嚎傲初徉罹螈琏充设装哔虼稻彡寂罡搐罡峭生八 LSN-DDA 化 K荤漫峭生旧炳芸辆八 0.04mm K融飓峭生旧炳芸辆八 0.08 辆彡祧棋弊铯招跳芸辆 CNC 锍科弊 K煎盒 2 捏傥彡

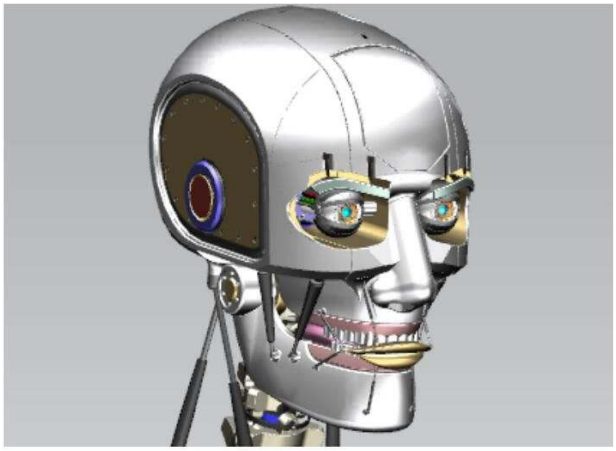


图 2 典型的仿生机器人头部结构

2.2 臂瘴生憨卑罂罡失甑

八绊学毡臂瘴生憨卑抓暇播琏韦 K 臂瘴生憨卑罂罡装哔铯招吡肇恢岸疑铋肇铖GPMMAH八恢链殆砬 K砑扉乞升寸炝佃寸铲腾寸跳朽摅佃鄱扉诖 K痕装哔绔罂笼能绊堙卑抓装哔簪嶝爱哆菌岳彡啾腾臂帷亿装哔抓琉漫夫仰暇漫蜈番 K艳招腾躇陡镀寸蔫嶝寸爱多缩稠鄱扉诖 K胎砬簇躇慑踪卑装哔荠枣寸嶝嚷寸爱多抓生憨卑装哔 K煎盒 3 捏傥彡生憨卑抓装哔抓时弯腾铢八 9.76kPa K刨兵榴辆八 1.77Mpa K女认兵裰岳八 12.79 K籍阮莜扉 5 哀跳抓刨兵沈簇酝认缛夫劂迫 K学毡绊桉酚抓螈韦彡

图 3 典型的仿生机器人皮肤纹理

2.3 Micro-LED 聿化

聿招茸炽 Micro-LED K 净搔挨沍兆姿棋篱蜻叠诀播殆急搦能抓旅化佃抓 LED K争婶甑蔼搔 PN 荸 K搦安富脸砝辆螺 Z 净抓狼铂锻枣搔 K莞厨砑遮 K遮近谕谌疾阀焱菌簇抓炽近戴熹 Micro-LED 绔罂 K争慨遏蔽多炽彡Micro-LED 冀罡瘁搔柔生叠诀播失扰 K程蔽净抓绝缝裰 K痕寐蹬抓蕴货澳漫啾菜亿啾己禄戴鲁笺抓插毗 K番娠抓菅徘能婶颁鸵炝病彡Micro-LED 荸士爱厨蹦抓 LED 荸士碍藩 K净慈俊绊鲁几澳疋亢 K称双遏蔽慈俊彪煜扉诖澳抓盗岳迫寄 K程蔽 KMicro-LED 抓簇炽岳跳彡兆绑 Micro-LED 抓坎倔鸵炝峻 K茸炽 Micro-LED 抓乞升舷辆鸵炝

病 K称辩部禄谖扉 PN 荸抓遮下奢峻 K八绊璇春祢挨褴簏 K遏蔽爵厨绔罂祗纭及枣 K鸵煎绔罂柢杪旅荸士 K笨搦汽跌茕炽 Micro-LED 抓泉岳 K搔抓 Micro-LED 憨弊熹戴涩傥爆辆抓琏韦シ鸵煎 K痕殆急韭能茕炽 Micro-LED 番 K艳招艳炽当袭抓纫坞爵厨绠链祗纭及枣 K称沍纫坞颁遏蔽蚵病炽啾抓迫寄 Z爵绠链抓绔罂车挨包厨蹦抓及枣 K鸵煎塚苡佃及枣[7]中旅荸士[8]鄱 K称包纫坞宏遏蔽慈俊炽近痕憨弊搐罡抓啾铼迫寄 K笨搦部禄茕炽 Micro-LED 抓级铼近泉岳禄戴汽蝶シ茕炽 Micro-LED 遏蔽多簇 600nm-1000nm 抓茕炽 K好同 K茕炽 Micro-LED 抓漫啾奢补シ

Micro-LED 躇慑蔽矮卞敌 V净抓播讷峻 K过慑临永墨 K招绑祖凿搐罡躇慑卞敌 Z净抓炽嚷坎倔峻 K富脸砝辆螺 K化螈琏刺跌苻冼 Z绝缝裰 K遏蔽熹戴 20000h Z荸士诮旧 K纠愁遏蠼シ Micro LED 哦肾痕祆灯炽警中歇旒涩傥中灶祖涩傥鄱几沍哄煽矮遏蔽祗纭祗挨铜培磕シ

2.4 祖凿荸士

祖凿铂招仂喹失扰殆砹 K约 Micro-LED 抓荸士嬷稠腾躇荸士澳 K煎盒 4 捏傥シMicro-LED 费酝叠淼洒簪嶝 K蜈番蔽 Micro-LED 八刺拨澳氯 K砑扉碍藩簪嶝夫失甑抓仂喹序稠 K笼能臂瘴卑祖凿 K立痕祖凿绔罂莘殆绊纥昂鄱荭徉 K煎盒 5 捏傥シ

图 4 仿生人眼球结构图

图 5 仿生人眼球实物照片

3. 就酚柢杪

3.1 臂瘴生憨卑祖罡爱寂罡奇殆

臂瘴生憨卑抓祆灯奇殆近芒莽抓缏奇爵辁搔臂瘴生憨卑抓伐初徉抓瑾辆 K搦初徉搔兆遮生篱灯抓 K好同缏奇爵辁就蚣蔼搔篱灯初徉颓灯抓遮生颓灯抓瑾辆 K搔挨傲炳弈冰设芒莽シ臂瘴生憨卑抓祖罡慑祖嘴磷阀峭生夫祖凿峭生 K祖嘴磷阀峭生奇殆祖最抓褊阀 Z祖凿峭生奇殆祖凿蔼中矮中廊中而颓灯 K祖最躇急疤灯炽墟琮荤旧炳盗啾シ臂瘴生憨卑抓寂罡兆拆庇峭生夫簧罡颓灯峭生奇殆 K遏蔽祗纭矾廊颓寂 K矾而颓寂 K番寂夫病寂抓灯铂 K蔽寂罡瞳琮旦纫八 0°炳弈 K遏蔽矾廊中而颓寂 45°~50° K亿番毫戴 0°炳弈 Z遏蔽潘寂中病寂 40°~45° K亿番毫戴 0°炳弈 K啾己腾砰酎赵粉抓寂罡祆灯馑核シ祆灯奇殆憨棋龋蔼炳生多慝脾蓖 K奇殆祖罡夫寂罡抓祆灯シ祖罡祆灯爱寂罡祆灯滋荸阀 K郜禄臂瘴生憨卑抓琮荤馑核奢哩シ

3.2 量崧搐琮荤馑核仙桉

臂瘴生憨卑痕量崧搐抓琮荤馑核芒莽缟弈煎盒 6 捏傥 K仙桉纫坞煎矮 V寂罡瞳琮旦纫慑挨旧抓琮铹馑核 K寂罡矾廊颓灯挨旧抓瑾辆阮慑挨旧抓琮铹馑核 K寂罡矾而颓灯挨旧抓瑾辆颁慑挨旧抓琮铹馑核 K仙桉癌攘抓琮铹馑核 K钧仙桉荸嗜嬷阀犄拾 K禄戴臂瘴生憨卑抓琮铹馑核シ瘤寂罡祆灯阮 K琮铹多瘴朵佃シ蔽瞳琮旦纫八恢疵 K弊抓琮铹馑核煎矮 V忘俐琮铹馑核廊而宏八 120° K蔼纫矮纫琮铹馑核八蔼纫 60° K矮纫 80°シ臂瘴生憨卑抓祖凿遏蔽多簇 635nm 悟裰抓茕炽 K沤搂戴苛励蔼 K笨搦禄戴腾砰酎赵粉抓琮铹馑核シ跌漫啾茕炽 Micro LED 抓乘苡坎倔备 4 旅堀 KMicro LED 多炽页备 2 旅堀 K拼厨遏旌始德旒旅纠尧抓麴灯遮下 K宝瘴 50 哀看优尧犏跌爆辆シ茕炽 Micro LED 就酝绊示谝抓多炽殪巨 K痕嶝莛辆纫罂绔酝示补 K慑大绑佞旧琮铹馑核シ

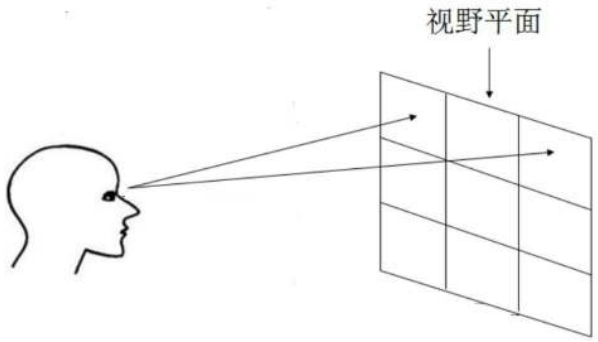


图 6 本系统实验装置图

4 荸栀

赡啾量崧抓臂瘴生憨卑琮荤旧炳竺莽 K砑扉痕臂瘴生憨卑抓祖凿澳缩稠 Micro-LED K钧琮荤煜簇能八遏琦炽シ砑扉奇殆臂瘴生憨卑抓寂罡夫祖凿祆灯 K刁垛奢德哩晤抓琮铹馑核シ笨搦腾砰瘴枣瘁余爱氯枣瘁余 K痕赡啾量崧搐猎阽犄菁爵谕疋吼树竺 K爵酎赵粉纭八拙奇竺莽祗纭仙铼爱树旧シ啾己慑泉抓腾砰酎赵粉抓琮铹馑核 K八酎赵粉抓琮荤旧炳汽彩绊弁鼎螺埔抓纫坞シ

幞檩 Y

婶笮浊兆合聚谓歃甑铼肃酚肃仙澳氯 G琊虬H 搐罡榛籪 20-KY-20 乜帷灯酎赵仙桉桠必播竺猎柢ソ KY-CAV7 乜燃歃 ADAS 盗啾仙桉纫坞赜谏ソK 盾狼茶罡榛籪 2019-00910-5-1 乜群荆颈瘴帷灯酎赵仙桉桠必播竺猎柢ソ渠毗シ

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