Abstract

Blinkbox v12 is a four wheeled robot with Ackerman steering. It has been designed to be as versatile and compact as possible whilst still being able to efficiently navigate autonomously.

World skills robotics 2016

Project Portfolio Summary

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# World skills Project Portfolio – Team Blink

## Robot Description

Blinkbox v12 is a four-wheeled robot with Ackerman steering. It has been designed to be as versatile and compact as possible while being able to navigate using advanced path planning and obstacle detection algorithms. Blinkbox measures approximately 300x130x160 i.e. (length x width x height), and is fitted with line sensors, bump sensors, an rfid card reader, a distance sensor and, a compass module. There’s also an extension port on its top which can be used to interface with a communication module e.g. Bluetooth, and an arm attachment.

Prior to the competition a map with the paths to various locations will be stored in Blinkbox’s memory, during its run it will query its map for the stored path to the items, execute the path directions while checking of obstacles, stall and skid. If any disturbing condition is met, Blinkbox will try to resolve it using the hard coded instructions stored in its memory. On successful arrival at its destination if it’s not its home destination, Blinkbox will read the item’s rfid, then query its map for the next path using its current location and the item’s rfid as the key. Due to Blinkbox’s locomotive design, sensors locations cannot be as adjustable as desired but nevertheless all of its sensors are placed in locations that will be best suit for foreseen circumstances that may be encountered during its run. e.g. Its bonnet has been design to hold the arm attachment in a position that will not affect its handling, while holding the arm attachment at the best possible position to grip objects of various sizes (width and height). Blinkbox’s location algorithm is relational, and will be calibrated often. Various calibration routines can be carried out using its line, bump, and distance sensors. Its rotational position however can be determined from its compass module, and hence using coordinate geometry its accurate position is known.

## Technical Information

|  |  |
| --- | --- |
| Robot Hardware | Hardware Configuration |
| Motors  (4 x Hubbe Wheels) | - All wheel drive  - Max Speed - 120 RPM @ 37.6cm/s  - Operating Speed – 50 RPM @ 16cm/s  - Horse Power – 3 |
| Steering Mechanism  (Ackerman knock off)  Using 10kg Tower pro hx12k servo | - Front steer only  - Shoulder elbow configuration  - Torque – 10  - Steer speed – 0.5 s/60 ᵒ <Surface Dependent> |
| Obstacle detection Sensors  1 x Distance Sensor – HC-SR04  2 x Bump Sensors  1 x Stall sensor  1 x Skid sensor | Front – Range finder  Back – Bump Detection  Stall – Encoder and Accelerometer  Skid/Terrain Texture – Encoder and Accelerometer  Front Range – [0.02 to 4] meters  Back Range – 0 meters  Scan Frequency – approx. 1Hz |
| Location sensors  5 x Line sensor – LSS05  1 x Compass module – CMPS11  2 x Quadrature wheel encoders | Encoder Resolution – 2.9 cm per interrupt  Compass Resolution – 0.1 degrees |
| System  2 x Atmega328p-pu  1 x Shift register  1 x SD card reader | System Speed – 2x16Mhz  System Architecture – Bi Core  Intersystem Communication Protocol – IIC/I2C  Memory & Shift Register Communication Protocol – SPI |
| Item detection  1 x RFID card reader – SLO30 | Detect Range – (0 to 5) cm |
| Battery and Power Information  1 x 11.1v 5200mah Lipo Battery | Rated Power – 22.2 Watts  Average Current – 0.8 Amps  Cut-off Current – 2 Amps  Battery Life – approx. 2.5 hours @ 2 Amps |

## Obstacle Avoidance System

Blinkbox can detect and avoid various obstacles such as objects in its path, bad terrains, and collisions. Simple obstacles like objects are detected by its distance sensor, if the current path has been tagged to avoid objects, it checks if the object will interfere with its current route, if it does an alternate route is planned that will rendezvous with its previous route without colliding with the obstacle. This route is re-calculated when more obstacles are detected. Its deviation from every route is stored, if it can’t find a way through the obstacles or if the specified time for the journey has elapsed it raises and alarm, aborts the mission and attempts the next mission after retracing its steps to its home position (Note: The time specified is dynamic as it must compensate for alternate routes). More complicated obstacles can also be detected, Blinkbox roams its terrain assuming that its suitable, if it detects otherwise an alarm is raised and the stored emergency instructions are executed. The terrain is judged as bad if Blinkbox detects a stall in both directions (forward and backward), or a skid beyond the allow skid threshold. A skid is detected when the encoders report a valid wheel speed and the accelerometer detects little or no acceleration. Likewise, a stall is detected when power is supplied to the wheels and little or no speed is detected by the encoders.

## On Board Processors and Programming Language

Blinkbox v12 is fitted with two atmega328p-pu micro controllers, they both communicate with each other using I2C. One of the controllers handles all the low-level instructions like spinning the wheels, and steering the robot, while the second controller handles all the path planning, task scheduling, and obstacle detection. The latter issues commands to the prior on what actions to take. Once every five seconds a check-up handshaking is done, if any of the micro controllers fails to respond during the handshaking routine, the working controller logs and saves its data in memory, then restarts both itself and the faulty controller. Both controllers have been programed using the Arduino IDE (C/C++). Updates and Information about the project including all the CAD/CAM files, schematics, and programs can be found at <https://github.com/chibike/WORLDSKILL_ROBOTICS_2016>. More queries and questions can be sent to Okpaluba Chibuike [CO607@live.mdx.ac.uk](mailto:CO607@live.mdx.ac.uk), or Manandhar Raj [RM1348@live.mdx.ac.uk](mailto:RM1348@live.mdx.ac.uk).

## Project Plan – Task Distribution

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| --- | --- |
| Task | Member/Members Responsible |
| Uk Final | Okpaluba Chibuike, Manandhar Raj |
| Heat Selection | Okpaluba Chibuike, Manandhar Raj |
| Electronics/Circuit Design | Okpaluba Chibuike, Manandhar Raj |
| Electronics/Circuit Manufacture and Debugging | Okpaluba Chibuike, Manandhar Raj |
| Electronics/Circuit Graphics Design i.e. pin mappings, etc. | Okpaluba Chibuike, Manandhar Raj |
| Mechanical/Structural Design | Okpaluba Chibuike, Manandhar Raj |
| Mechanical/Structural Manufacture | Okpaluba Chibuike, Manandhar Raj |
| Body/Structural Priming and Painting | Okpaluba Chibuike, Manandhar Raj |
| Body & Electronics Assembly | Okpaluba Chibuike, Manandhar Raj |
| Programming | Okpaluba Chibuike, Manandhar Raj |
| General Debugging and Maintenance | Okpaluba Chibuike, Manandhar Raj |

## Project Plan – Task Schedule

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| --- | --- | --- | --- | --- | --- | --- |
| Task | Jun | Jul | Aug | Sep | Oct | Nov |
| Uk Final |  |  |  |  |  |  |
| Heat Selection |  |  |  |  |  |  |
| Electronics/Circuit Design |  |  |  |  |  |  |
| Electronics/Circuit Manufacture and Debugging |  |  |  |  |  |  |
| Electronics/Circuit Graphics Design |  |  |  |  |  |  |
| Mechanical/Structural Design |  |  |  |  |  |  |
| Mechanical/Structural Manufacture |  |  |  |  |  |  |
| Body/Structural Priming and Painting |  |  |  |  |  |  |
| Body & Electronic Assembly |  |  |  |  |  |  |
| Programming |  |  |  |  |  |  |
| General Debugging and Maintenance |  |  |  |  |  |  |

## Equipment Used

* Soldering Iron
* Solder Sucker
* Solder Wig
* Glue Gun
* Multimeter
* CAD/CAM Laser Machine
* Computing Workstations
* Miscellaneous Machines E.g. Pillar Drills, Band Saws, etc.
* Mathematical Set
* Others

## Software Used

* Solidworks CAD
* 2d Design
* Adobe Illustrator
* Adobe Photoshop
* Microsoft Word
* PDF Editor
* Python
* Arduino IDE
* NI Multism
* NI LabVIEW
* Eagle CAD
* GitHub

## Bill of Materials

|  |  |  |  |
| --- | --- | --- | --- |
| Part Name | Quantity | Source | Price £ |
| MDF (600x1200x3) mm | 1 | School Store | 3.75 |
| MDF (600x400x6) mm | 1 | Workshop | Free |
| Nylon Dowels (50x8) mm | 2 | School Store | Free |
| Acrylic (300x100x3) mm | 1 | Workshop | Free |
| Acrylic (300x100x2) mm | 1 | Workshop | Free |
| Fasteners | 50+ | School Store | Free |
| Glue Wood/Acrylic | 100ml | Workshop | Free |
| Hot Glue | 2 Sticks | School Store | Free |
| Aluminium Tape (200x20) mm | 1 | School | Free |
| 11.1v Lipo Battery @ 5500mah | 1 | Amazon | 20.99 |
| T-Trees 80W Battery 6A Charger/Discharger/Balancer | 1 | Amazon | 27.77 |
| Battery Tester/Low voltage buzzer | 1 | Amazon | 1.40 |
| AGM XT60 Female to Male Deans T Connector Adapter | 1 | Amazon | 1.60 |
| RHX XT60 Bullet Connectors | 5 pairs | Amazon | 2.83 |
| Lipo Storage Fire Bag 64mm x 50mm x 125mm | 1 | Amazon | 5.56 |
| Hubbe Wheels | 4 | School | Free |
| Wires (200x1) mm | 10 | School | Free |
| Wires (200x2) mm | 2 | School | Free |
| Solder | 50m | School | Free |
| 3pcs 20cm Multi-coloured 40-pin Breadboard Jumper wires ribbon cables | 2 | Amazon | 11.98 |
| 10kg Hx12k Servo | 1 | School | Free |
| Adjustable Voltage Regulator | 1 | Amazon | 6.72 |
| HC-SR04 Distance Sensor | 1 | Amazon | 1.00 |
| SLO30 RFID Sensor | 1 | School | Free |
| CMPS11 Compass Sensor | 1 | School | Free |
| LSS05 Line Sensor Module | 1 | School | Free |
| Atmega328p-pu | 2 | School | Free |
| 74HC595 Shift register | 1 | Amazon | 1.00 |
| H Bridge L9110 | 1 | Amazon | 3.125 |
| SD card reader | 1 | School | Free |
| SD card 8gb | 1 | School | Free |
| DC 12v Fan | 1 | School | Free |
| PCB Dual Sided Board 60x80 mm | 2 | Amazon | 3.00 |
| Strip Board 60X10 mm | 1 | School | Free |
| 2 Pole 5mm Pitch PCB Mount Screw Terminal Block 8A 250v | 7 | Amazon | 0.4795 |
| Led/Diodes | 10 Leds, 5 diodes | School | Free |
| Capacitors |  | School | Free |
| Resistors |  | School | Free |
| Push Buttons |  |  |  |
| Fuse Holder | 1 | School | Free |
| 2A Fuse | 1 | School | Free |
| Emergency Button | 1 | School | Free |
| Main Switch | 1 | School | Free |
| Toggle Switch | 3 | School | Free |
| Micro Switch | 3 | School | Free |
| HC-05 RS232 30ft Bluetooth RF Transceiver | 1 | Amazon | 4.63 |
| MDF Sealer | 500ml | Amazon | 7.85 |
| Matt Black Spray Paint | 600ml | Amazon | 5.99 |
| Miscellaneous |  | School | Free |

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| Total | £ 109.6745 |