WORLD SKILLS ROBOTICS 2016

Project Portfolio

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.

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1 World skills Project Portfolio – Team Blink

1.1 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.

1.2 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 ° <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

1.3 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.

1.4 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, or Manandhar Raj RM1348@live.mdx.ac.uk.

1.5 Project Plan – Task Distribution

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

1.6 Project Plan – Task Schedule

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	★	★	★	★	★	★

1.7 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

1.8 Software Used

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

1.9 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

Total	**£ 109.6745**