Group 04 Bing Bong

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**Test and Evaluation Master Plan**

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| Requirement | Test Method | Evaluation Method | Threshold | Objective |
| 1 | Demonstration | Within 5 seconds of being turned on Bing Bong moves without user input to follow a person. | 5 seconds | Once Bing Bong enters an area for autonomous motion, Bing Bong moves without guidance from a user. |
| 1.1 | Demonstration | Bing Bong continues to move with a load of 0.5kg or less. | 2 seconds | If a payload weighing 0.5kg or less is loaded into Bing Bong, Bing Bong must move while carrying the payload. |
| 1.1.1 | Inspection | The storage compartment is attached to Bing Bong and does not fall off when Bing Bong moves. | Entire time. | Bing Bong must include a storage compartment for an optional payload.when Bing Bong moves. |
| 1.2 | Demonstration | Bing Bong follows a person and detects when the garbage it is carrying weighs 0.5kg. | 5 seconds | Bing Bong must follow a person until the garbage can has been filled when that is Bing Bong’s designated task. |
| 1.2.1 | Demonstration | When garbage weighs more than 0.5kg, Bing Bong then attempts to locate the can in the house. | 5 minutes | Heads to the garbage can when garbage on Bing Bong weighs more than 0.5kg. |
| 1.2.2 | Demonstration | Can detect a person as a person. | 5 seconds | Bing Bong must identify a person. |
| 1.5 | Demonstration | Bing Bong must recognize a person when the person is in front of Bing Bong. | 10 seconds | Bing Bong must recognize when a person is nearby. |
| 1.6 | Demonstration | Bing Bong must not run into still objects and move around them. | 30 seconds. | Bing Bong must avoid obstacles. |
| 2 | Demonstration | Bing Bong must be able to be controlled by an app on the user's phone. | 60 seconds. | Bing Bong must have wireless capabilities. |
| 3 | Test | Bing Bong must be able to take commands from the app. | 60 seconds. | Bing Bong must communicate with the Trash App. |
| 3.2 | Demonstration | Bing Bong must turn off when prompted by the user. | 15 seconds. | The Trash App must tell Bing Bong to turn off when prompted by the user. |
| 3.3 | Demonstration | The user will prompt Bing Bong to take out the trash. Then Bing Bong will take out the trash. | 10 seconds | The Trash App must tell Bing Bong to take out the trash when prompted by the user. |
| 3.4 | Demonstration | The user will prompt Bing Bong to follow the person in front of it. Then Bing Bong will follow the person in front of it. | 10 seconds. | The Trash App must tell Bing Bong to follow the person in front of it when prompted by the user. |

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| Constraint | Test Method | Evaluation Method | Threshold | Objective |
| 1 | Measurement | Height, depth, and width will be measured with a tape measure | 45cm x 45cm x 60cm | Must not be larger than 45cm x 45cm x 60cm |
| 2 | Measurement | Weight will be measured with a scale while empty | 20 kg | Must not be heavier than 20 kg |
| 3 | Inspection | The batteries Ah rating can be inspected | 10 Ah | Must not exceed 10 Ah |
| 4 | Inspection | Bing Bing will be inspected to make sure it complies with all points listed in ANSI.RIA R15.08-1-2020 | ANSI/RIA R15.08-1-2020 American National Standard for Industrial Mobile Robots | Bing Bong shall comply with ANSI/RIA R15.08-1-2020 American National Standard for Industrial Mobile Robots |
| 5 | Inspection | Bing Bong will be inspected to make sure it complex with all points in IEE 802.11 | IEEE 802.11 | Bing Bong shall comply with IEEE 802.11 |
| 6 | Inspection | Before purchase, every part can be confirmed to be from a WSU approved vendor | WSU approved vendors | Parts must only come from WSU approved vendors |
| 7 | Inspection | The bill of materials list can be inspected | $300 | Total cost must not exceed $300 |
| 8 | Demonstration | The speed can be measured while Bing Bong is moving at max speed | 50 cm/s | Speed must not exceed 50 cm/s |
| 9 | Inspection | The sensors can be seen on Bing Bong | 2 sensors | Must have 2 sensors or more |
| 10 | Inspection | The actuators can be seen on Bing Bong | 3 actuators | Must have 3 actuators or more |

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| Standard | Test Method | Evaluation Method | Threshold | Objective |
| 1 | inspection | The C++ code conforms to the ANSI/ISO C++11 standard | ANSI/ISO C++11 or newer | Any C++ code used in bingbong should conform to the ANSI/ISO C++11 standard |
| 2 | inspection | The python code conforms to PEP 8 – Style Guide | PEP 8 – Style Guide | Any python code used in bingBong must conform to the PEP 8 – Style Guide |
| 3 | inspection | Purchased motors should conform to IEC 60034-2-1 | IEC 60034-2-1 | Any motor that’s used in bingBong must conform to IEC 60034-2-1 |
| 4.1 | inspection | Bing Boing will be inspected to ensure that it conforms to the Raspberry Pi 5 Networking IEEE 802.3af-2003 PoE standard. | IEEE 802.3af-2003 PoE standard | Bing Bong must conform to the Raspberry Pi 5 Networking IEEE 802.3af-2003 PoE standard. |
| 4.2 | inspection | Bing Boing will be inspected to ensure that it conforms to the IEC 62680-1-3 standard. | IEC 62680-1-3 standard. | Bing Bong’s USB-C connection must conform to the IEC 62680-1-3 standard. |
| 4.3 | inspection | Bing Boing will be inspected to ensure that it conforms to the Raspberry Pi 5 Arm Cortex-A76 64-bit CPU IEC 61508-2:2010 and IEC 61508-1:2010 standards. | Raspberry Pi 5 Arm Cortex-A76 64-bit CPU IEC 61508-2:2010 and IEC 61508-1:2010 standards | Bing Bong must conform to the Raspberry Pi 5 Arm Cortex-A76 64-bit CPU IEC 61508-2:2010 and IEC 61508-1:2010 standards. |
| 5 | Inspection | Check the batteries used in BingBong to make sure they comply to the ANSI/NEMA C18 for battery safety | ANSI/NEMA C18 | BingBong must conform to the ANSI/NEMA C18 for safety for primary, secondary, and lithium batteries. |
| 6 | Inspection | Bing Boing will be inspected to ensure that it conforms to the ISO 376 - Load Cell Calibration Standard for the weight sensor | ISO 376 - Load Cell Calibration Standard for the weight sensor | Bing Bong must conform to the ISO 376 - Load Cell Calibration Standard for the weight sensor. |

**Summary Tables of Test Results**

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| Requirement | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1 | 2/19 | Team Projects Lab | Passed | ino file included in repo | 2/19 |
| 1.1 | 2/19 | Team Projects Lab | Passed | ino file included in repo | 2/19 |
| 1.1.1 | 3/19 | Team Projects Lab | Passed | Attached and tested on this date | 3/19 |
| 1.2 | 4/5 | Team Projects Lab | Passed | py and ino files included in repo | 4/5 |
| 1.2.1 | OBE | OBE | OBE | OBE | OBE |
| 1.2.2 | 2/15 | Team Projects Lab | Passed | Model included in repo | 2/15 |
| 1.5 | 2/15 | Team Projects Lab | Passed | Model included in repo | 2/15 |
| 1.6 | 2/23 | Team Projects Lab | Passed | ino file included in repo | 2/23 |
| 2 | 3/13 | Team Projects Lab | Passed | java file included in repo | 3/13 |
| 3 | 3/13 | Team Projects Lab | Passed | py file included in repo | 3/13 |
| 3.2 | 4/14 | Team Projects Lab | Passed | java file included in repo | 4/14 |
| 3.3 | 4/14 | Team Projects Lab | Passed | java file included in repo | 4/14 |
| 3.4 | 4/14 | Team Projects Lab | Passed | java file included in repo | 4/14 |

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| Constraint | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1 | 4/11 | Russ Fishbowl | Passed | Converted cm to inches | 4/11 |
| 2 | 4/11 | Russ Fishbowl | Passed | Converted kg to lbs | 4/11 |
| 3 | 4/6 | Team Projects Lab | Passed | SunFounder PiPower | 4/6 |
| 4 | OBE | OBE | OBE | Costs $225 which is over our budget | OBE |
| 5 | 3/19 | Team Projects Lab | Passed | Raspberry Pi 5 modem conforms | 3/19 |
| 6 | 4/5 | Erica’s House | Passed | Inspection was performed before each part was purchased. | 4/5 |
| 7 | 4/8 | Rus Fishbowl | Passed | Most up to date bill of materials in as built design spec | 4/8 |
| 8 | 2/14 | Erica’s House | Passed | Speed measured from video. Each square in video in 9.5 inch | 2/14 |
| 9 | 4/9 | Erica’s House | Passed | Picture included in slides | 4/9 |
| 10 | 2/11 | Erica’s House | Passed | Picture in discord | 2/11 |

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| --- | --- | --- | --- | --- | --- |
| Standard | Test Date | Test and Evaluation Location | Result | Notes | Date Passed (Accepted) |
| 1 | 4/5 | Team Projects Lab | Passed | Used Arduino IDE | Passed |
| 2 | 4/5 | Team Projects Lab | Passed | py files included in repo | Passed |
| 3 | 2/6 | Team Projects Lab | Passed | Amazon order history | Passed |
| 4.1 | 3/19 | Team Projects Lab | Passed | Raspberry Pi 5 modem conforms | Passed |
| 4.2 | OBE | OBE | OBE | Standard for USB C cost $425 which is over budget | OBE |
| 4.3 | 3/19 | Team Projects Lab | Passed | Raspberry Pi 5 CPU confroms | Passed |
| 5 | 4/6 | Team Projects Lab | Passed | SunFounder PiPower | Passed |
| 6 | 2/22 | Team Projects Lab | Passed | Amazon order history | Passed |

Summary

BingBong performed very well in test results for requirements, constraints, and standards. Only one test requirement was OBE and was not able to be implemented in the time frame for the project. Only one constraint requirment was OBE because the standard cost over budget. Only one standard requirment was OBE because the standard cost over budget. The two standards that were over budget were for industrial mobile robots and USB C. Many of the tests are included in sub folders of the github repo. The repo is <https://github.com/eric-foy/BingBong> and is public for you to check.