University of Vermont

Computer Organization (CS121)

Homebrew

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Professor: Jim Eddy
Group: Kevin Yeung, Jordan Deso, Connor Burleson

PROJECT GUIDELINES

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Introduction

Homebrew is a company dedicated to designing and implementing advanced robotics for military and commercial use. This current project revolves around the Raspberry Pi, and it's Linux based operating system. The Raspberry Pi 3B+ model will be the core control of operations for our project.

The Raspberry Pi 3B+ is an improvement from previous Pi models. It supports the same operating system however changes to hardware enable greater flexibility and performance from the machine. The main specifications are as follows:

- *Dimensions: 82mm x 56mm x 19.5mm, 50g*
- *SoC: Broadcom BCM2837B0 quad-core A53 (ARMv8) 64-bit @ 1.4GHz*
- *GPU: Broadcom Videocore-IV*
- *RAM: 1GB LPDDR2 SDRAM*
- *Networking: Gigabit Ethernet (via USB channel), 2.4GHz and 5GHz 802.11b/g/n/ac Wi-Fi*
- *Bluetooth: Bluetooth 4.2, Bluetooth Low Energy (BLE)*
- *Storage: Micro-SD*
- *GPIO: 40-pin GPIO header, populated*
- *Ports: HDMI, 3.5mm analogue audio-video jack, 4x USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)*

The improved system on a chip sits on a slimmed down circuitry system. Thanks to the chipmakers, the boosted the chip's now boasts an improvement in performance from 1.2 GHz to 1.4 Ghz. This will allow for greater processing power and faster executions in the machine. The Pi will have two methods of connectivity, an USB Ethernet which allows maximum throughput of around 300Mb/s and a wifi module which supports 2.4GHz and 5GHz wireless LAN. The two hardware will be critical to our ability to communicate with the Pi, and ultimately control it.

There are 18 GPIO pins, which will allow for multiple external devices to be utilized in our machine. Ultimately, the plan is to connect multiple Raspberry Pi's together for the larger project. One Pi will act as the center of operations, with sensors and input/output devices connected to that Pi. A different Pi would be incorporated into the mechanical aspects of the project such as controlling motion. Another Pi could possibly be in control of camera systems and implements machine AI. All seperate Pi's are to communicate with the main Raspberry Pi system, which can be controlled via Ethernet/WiFi/USB from an outside device.

Definitions

Artificial Intelligence (AI): Intelligence created by a machine that demonstrates learning and problem solving
Chassis: base of a motorized vehicle
Servomotor (servos): a rotary actuator that allows control of angular/linear position
Wifi: facility that allows devices to connect to the internet or other devices wirelessly
Bluetooth:an electronic wireless connection of two or more devices

Acronyms/Abbreviations:

GPIO: General Purpose Input Output
AI: Artificial Intelligence
SoC: System on a Chip
GPU: Graphical Processing Unit
RAM: Random Access Memory
HDMI: High Definition Multimedia Interface
USB: Universal Serial Bus
Servos: Servomotor

Figure 1: HDMI Port

Figure 2: Servo Motor

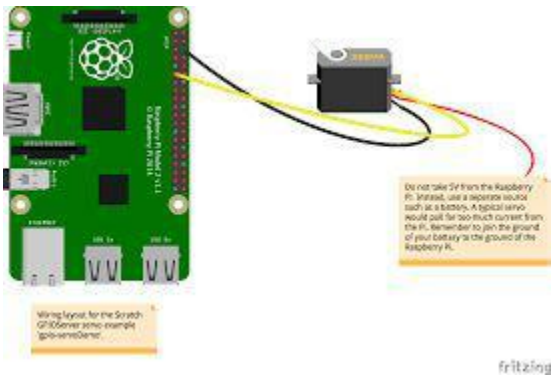


Figure 3: GPIO

Project Detail

The final plan is to use our Raspberry Pi's in a motorized tank which will be capable of:

Motion in any direction on an XY plane (Controlled by Human or AI)

- Sensing obstacles
- Bypassing obstacles
- Remote control (From WiFi/Bluetooth)
- AI should be able to control as well

Motion of the 1 or more turrets in any direction (Controlled by Human or AI)

- 360 degree rotation, ability to look up/down with reason
- Remote control (From WiFi/Bluetooth)
- AI should be able to control as well

Firing 0.4g plastic BBs out of 1 or more turrets (Controlled by Human or AI)

- Fires single shot or automatic
- Remote control (From WiFi/Bluetooth)
- AI should be able to control as well
- Contains magazine/ammo bank
- Returns information on ammunition capacity

Recording/Logging via camera systems (Controlled by Human or AI)

- Camera system could be on the body of the tank with the turret
- Should be able to be controlled by Human or AI
- Will utilize an algorithm for tracking/identifying targets and compensating distance
- Will look for laser

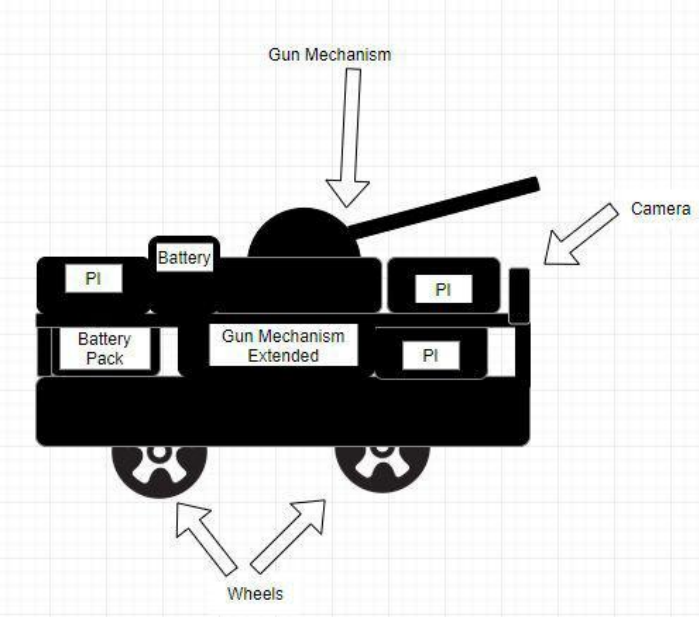
Laser module

- Human controlled or AI
- May have motion or connected to camera or turrent

Sensors

- Obstacle sensors for AI
- Laser/light sensors for AI
- Weight sensor for magazine capacity

Prototype Diagram



Budget

There will be two main sources of expenses for the design process of the tank. Material and labor cost. We will be using online averages for our project positions in order to accurately calculate the actual cost of hiring specialized individuals to build the tank. For costs, Amazon and outside sites will be used to gather supplies, outside the Pi modules which we already have 3 of, at minimum we will likely need sensors, camera systems, and motors.

Material Costs

Below is a table of possible purchases that may be made in order to get our vehicle in working order.

Name	Use	Price
Chassis	Main body of our vehicle	$21.85
Tracks/Wheels	Mounted to the motors	$13.60
Airsoft Gun Parts	Needed to build the turret	$52.61
Power/Battery	Powers Raspberry and gun	$17.99
Motors	Enables movement	$20
Servos	Enables turret movement	$14.99
Camera Module	Allows for remote viewing	$12

Distance/Object Sensor	Prevents AI from hitting walls	$10
Display	Will let user see from POV	$15
Weight Sensor	Will give ammo information	$20
Raspberry Pi 3 B+ Kit	Control computing functions	$105 x 3

Labor Costs

Role	Wage	Expected Hours	Total Expected
Project Manager (Connor)	$20/hr	14	$280
Lead Developer (Kevin)	$19/hr	12	$228
Network Engineer (Jordan)	$18/hr	12	$216
Hardware Guru (Kevin)	$17.25/hr	8	$138
Testing & Quality Assurance (Jordan)	$17.25/hr	9	$155.25

TOTAL EXPECTED BUDGET: $1530.29

Project Plan

Roles:

Venture Capitalist (Jim): Determines profitability of design and product
Project Manager (Connor Burleson): Responsible for the overall planning, design, and progress of the project. Should lead communication to keep team working together to ensure quality of the product.
Lead Developer (Kevin Yeung): Responsible for the technical aspect of project. Keep project manager, as well as other team members, informed of code/device functions.
Network Engineer (Jordan Deso): Responsible for network connectivity of project. Works to keep intentions of software/hardware compatible with network. Also responsible for data connectivity issues as well as data backups.
Hardware Guru (Kevin Yeung): Responsible for knowledge of external hardware being used in addition to the Raspberry Pi. Ability to find cost efficient technology as well as communicating to team members purpose and capabilities of hardware being used.
Testing & Quality Assurance (Jordan Deso): Responsibility is to ensure that the team/company is producing the best possible product that meets specifications as well as being consistently reliable.

Timeline:

March 11 - March 20: Project planning/organization
- All team members create design, goals, and expected budget

March 21 - April 2: Driving Capabilities of Vehicle
- Lead developer and project manager will work to make vehicle drivable
    - By remote control via laptop

March 31 - April 12: Shooting Capabilities of Vehicle
- Lead developer and project manager develop shooting system
    - Also by remote control via laptop

March 25 - April 12: Integrate Camera into Vehicle
- Network engineer will work ongoing to install camera system that will be effective for driving and shooting to assist remote control feature

April 10 - April 20: Integrate AI Sensors
- Lead developer and network engineer work to develop AI sensors

April 18 - April 25: Testing & Quality Assurance
- Jordan will ensure product meets quality and reliability standards

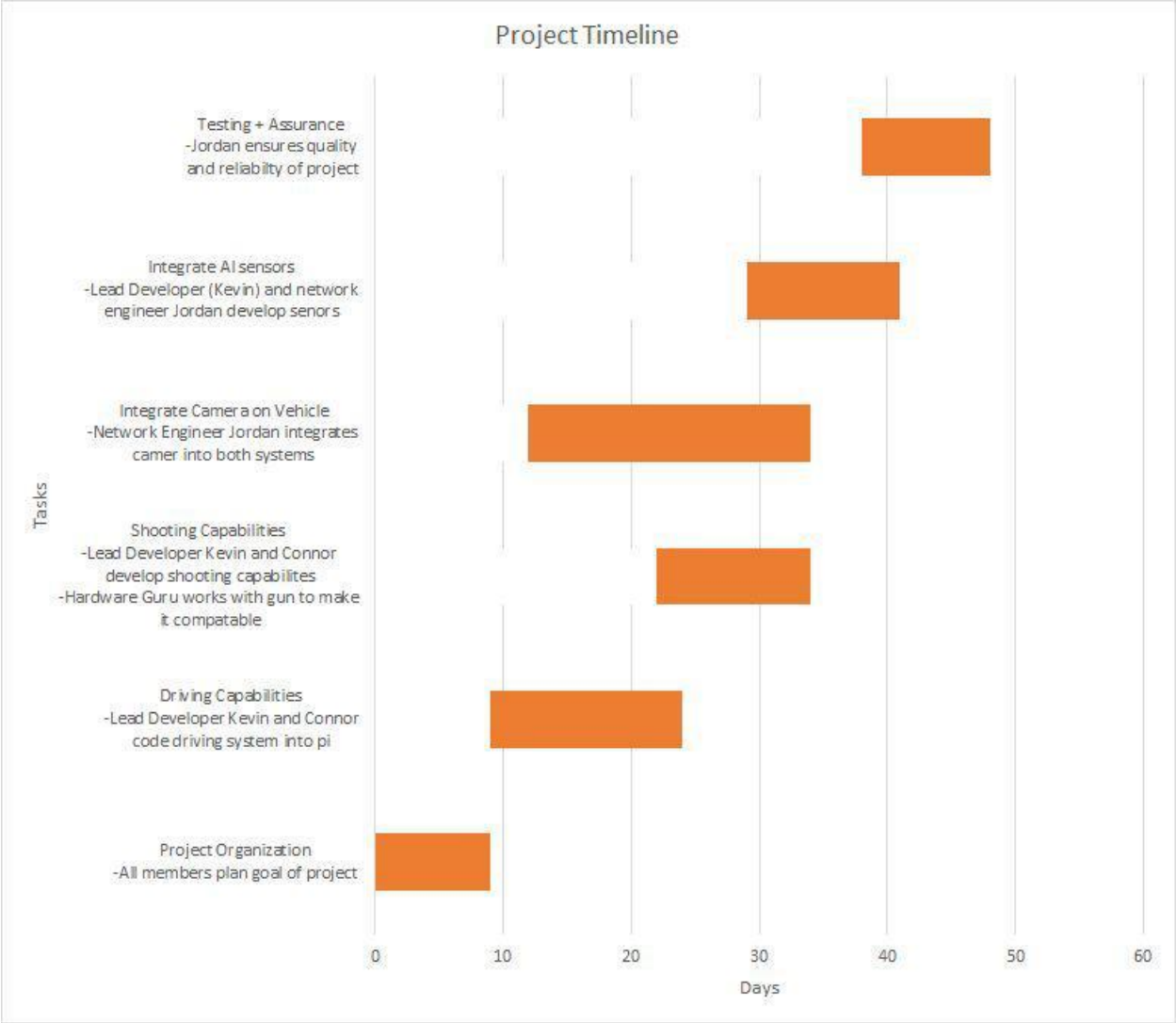


Figure 4: Timeline for prototype

Target Market

The target market for our product will mainly be focused on providing military industries with safe, yet effective methods of locating and getting rid of possible threats which can halt or slow down their discrete operations. The artificial intelligence foundation of our product will allow military organizations to observe possible danger areas from a safe distance, monitoring the view of the tank while being notified of threats in the area as they become present.

While the tank is in operation, such organizations will have direct control of all movement, weapon use, and camera control, alongside the AI capabilities in constant run time. With that said, if the tank is proceeding into an area which is deemed unsafe to target, users can manually direct the tank out of the area.

In conclusion, Homebrew's AI tank provides an adequate balance of user and AI movement for organizations which value being in direct control of current operations, while also benefiting from the ability to observe the tank remotely from safe distances.

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