Building An Autonomous Radiation Detection Robot

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Aim

- To build an autonomous robot platform to which a Geiger counter can attach to.
- The platform must run the ROS (Robot Operating System) framework in order for SLAM (Simultaneous Localization And Mapping) of the robot to be implemented.

Design Process

The autonomous platform has been built using an iterative design process which was divided into the following contributions:

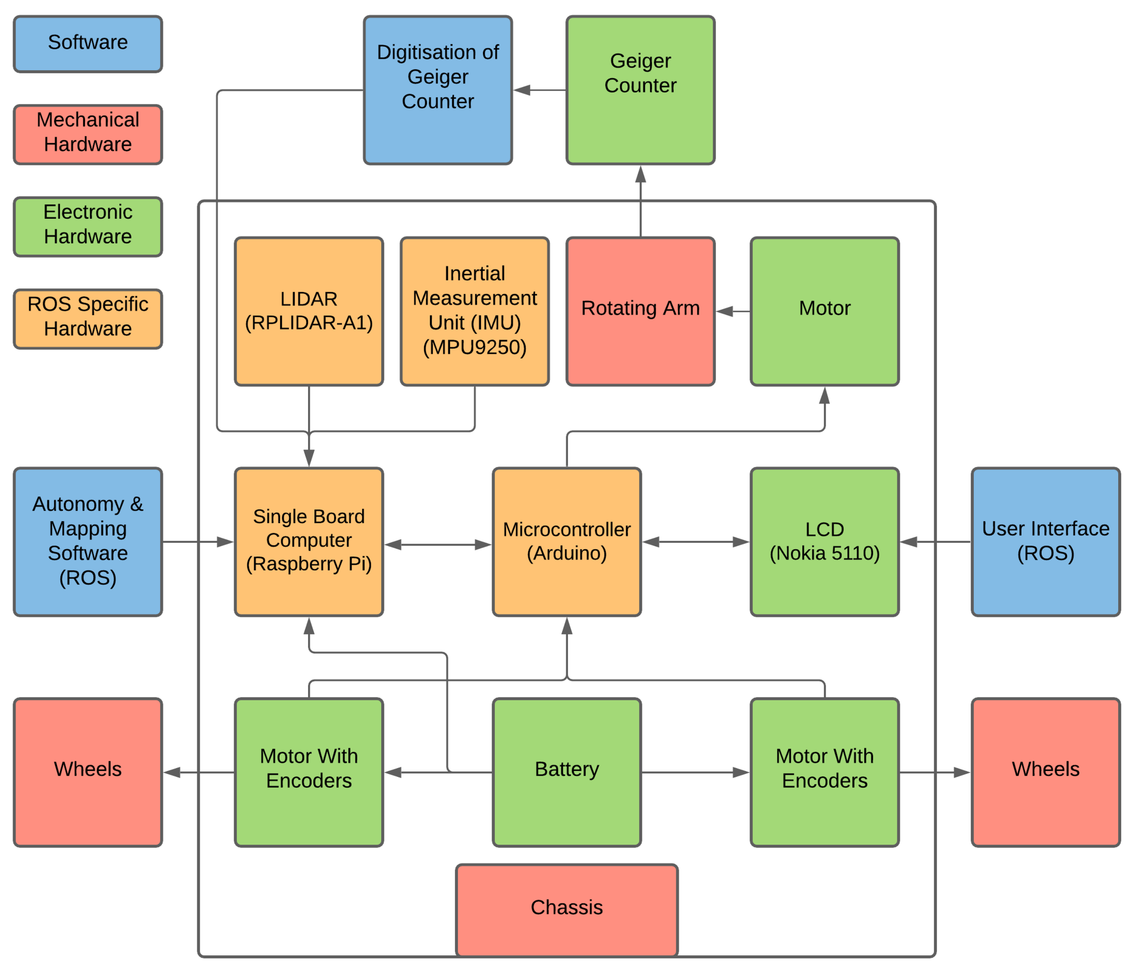
1. Management of 3D printing
2. Selection of ROS specific hardware
3. Hardware implementation and wiring
4. Motor control system tuning
5. ROS programming to enable SLAM

① 3D Printing

- In-house 3D printing has been a vital tool for manufacturing the chassis and contributed to the fast prototyping of design ideas.
- ROS specific hardware like the LIDAR required 3D printed protective cases to mount it to the robot.

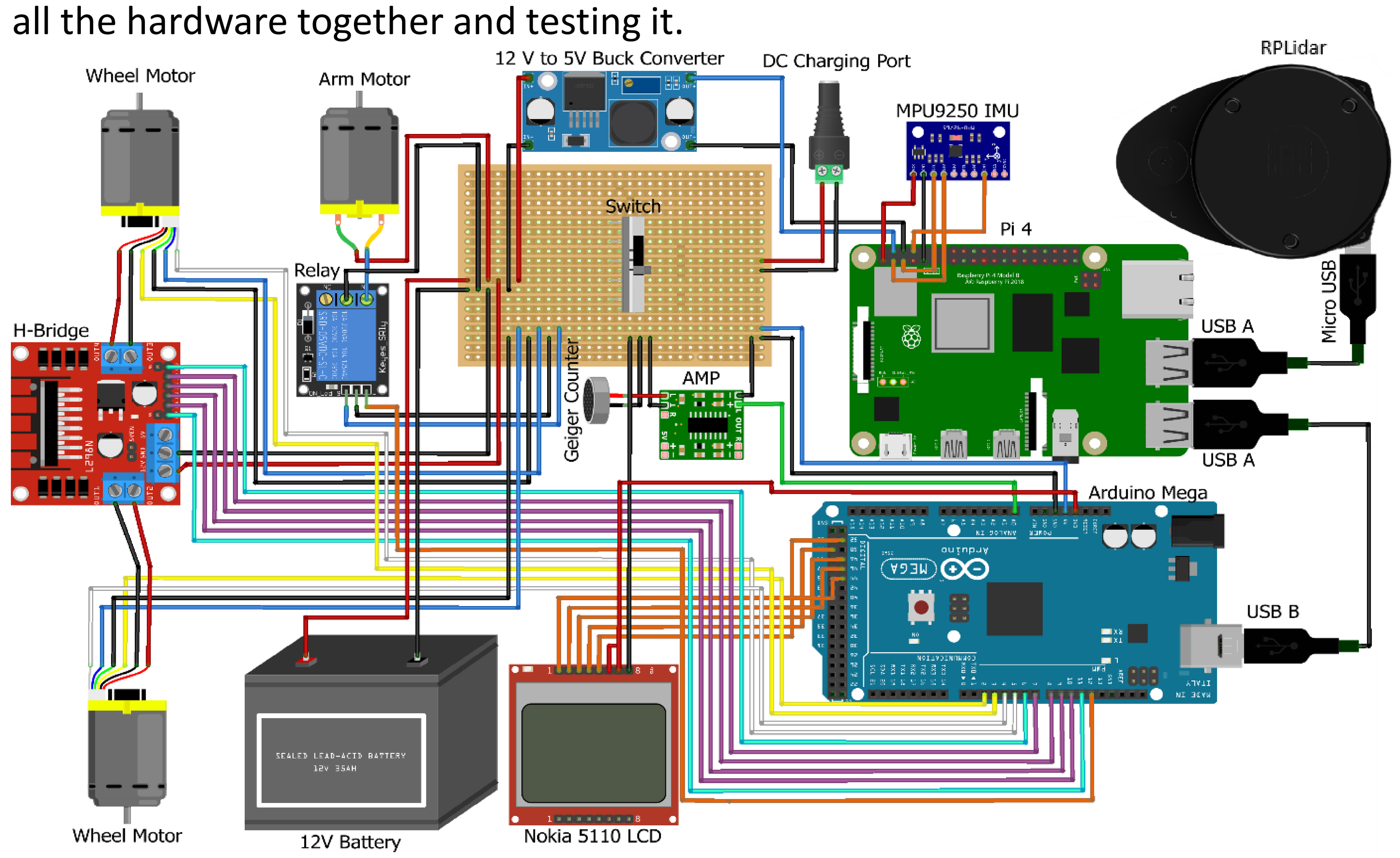
② ROS Hardware

- ROS specific hardware was selected to enable autonomous movement in a laboratory.
- This hardware bridges the gap between the SLAM algorithm and motor control.



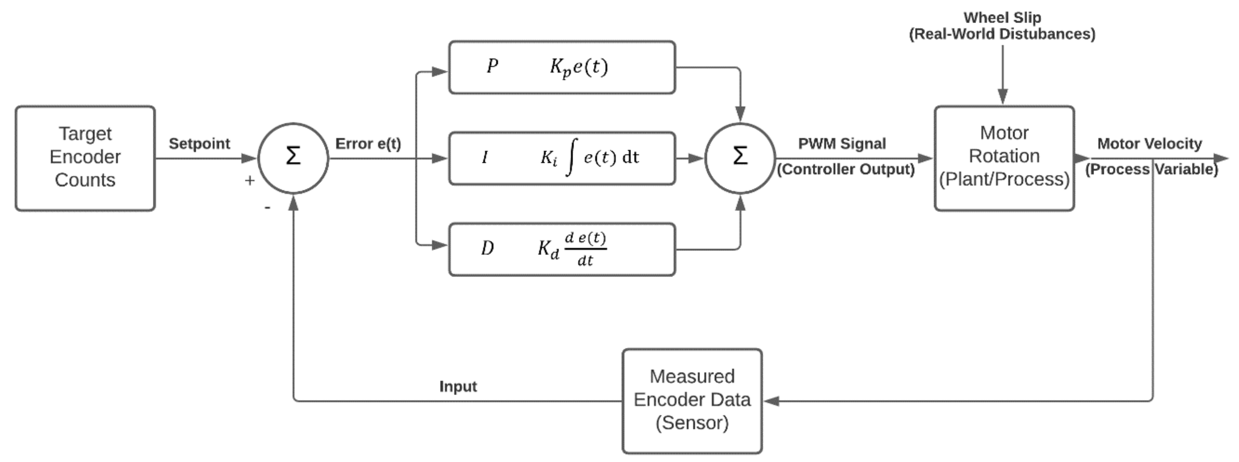
③ Hardware Implementation

- The block diagram was then converted into a circuit diagram, using Fritzing, to check that all the hardware was compatible.
- As the robot platform has custom Geiger counter parts, much time was spent wiring all the hardware together and testing it.



④ Control System

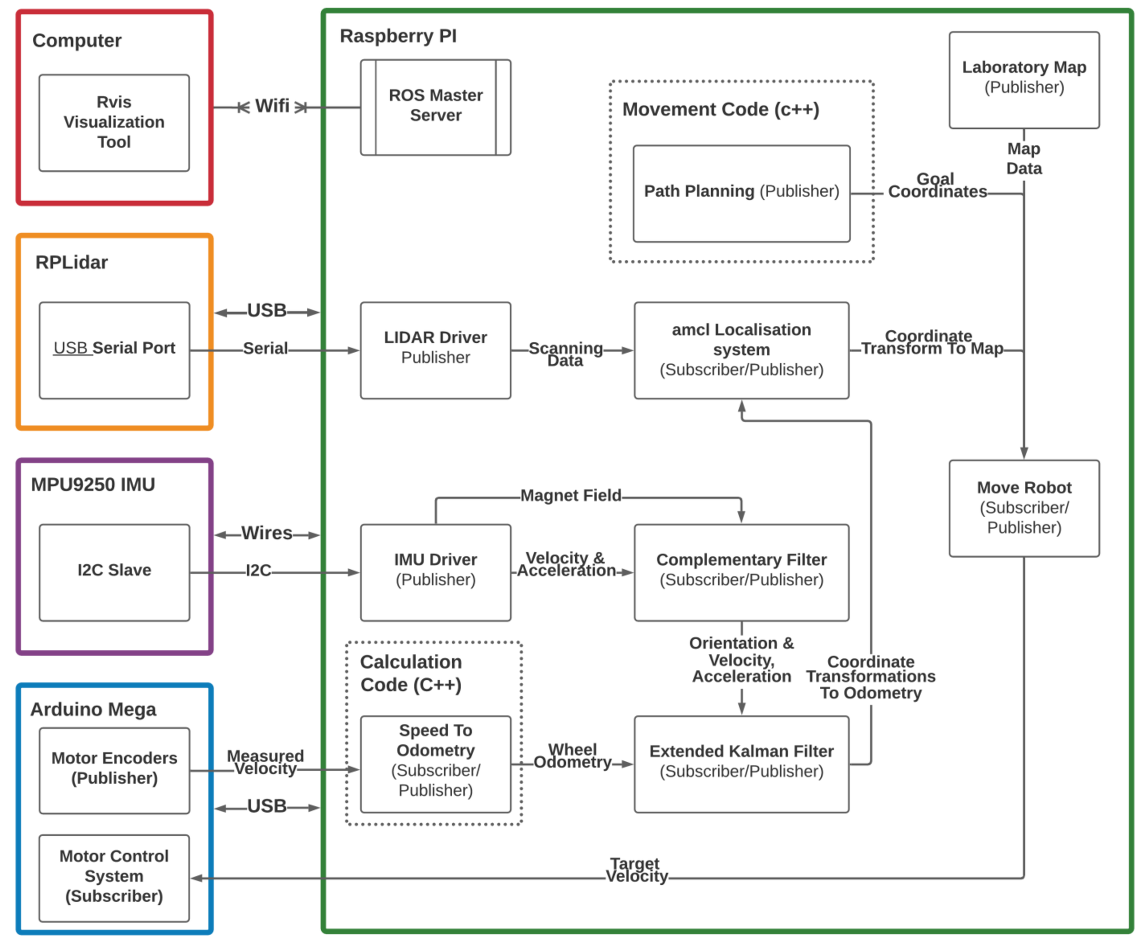
- A closed-loop PID control system manages the motor velocities.
- It interprets the encoder data to calculate the motor velocities.
- Then adjusts the power output to the motors until their velocities reach the target speed.



- The system was tuned to produce accurate movement data, which is used for localisation of the robot.
- Classical tuning methods did not produce an accurate system output.
- Simulink was used to design a physical PID autotuning program, which enabled a fast system response time.

⑤ Software Architecture

- The control system code was implemented onto the Arduino, which handled low-level control.
- The ROS framework server was run on a Raspberry Pi to facilitate communication between devices and enabled high-level autonomous control of the robot.



Conclusion

- A physical PID autotuning program has been developed.
- A partially autonomous robot platform capable of SLAM and detecting radiation in a laboratory has been built.
- The robot can map a room and then follow a complete coverage path around it whilst also avoiding obstacles.
- Further tuning and testing is required in a lab environment to confirm the robot's functionality over longer scanning times.
- The ROS framework increases the potential for future autonomous developments.

Future Developments

1. Finish implementing an online user interface and have scans run upon start-up.
2. Add the PID control system to the Geiger arm in order to manipulate its position.
3. Upgrade the existing platform with more accurate sensors to enable autonomous exploration in a laboratory environment.