MRSTF 2024 -Research Plan

E.L.A.R.T(Robot Framework)

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Rationale:

As advancements in robotics and computer software continue to progress, we harness the potential of robotics and artificial intelligence to substitute dangerous tasks. Leveraging sophisticated computer hardware and software, we have designed and engineered a tracked robot platform specifically for environmental research. This versatile robot finds invaluable applications in domains such as nuclear disaster assessment and remote environmental studies under the most inhospitable circumstances. Distinguished by the acronym E.L.A.R.T. (Environmental Learning and Research Technology), it goes beyond its physical existence, emerging as an open-source robotic framework easily accessible to the entire scientific community. Its utility extends across a spectrum of institutions and experts seeking instantaneous access to real-time data pertaining to environmental parameters. The targeted user base includes individuals and companies engaged in environmental exploration, industrial endeavors, and territorial mapping. Our robotic framework integrates an innovative algorithm that we have designed known as ETLU (Environment Threat Level Unit). This formula enables us to collect and compile sensor data, returning a final unit that determines the potential risks posed to human health in any given environment. The information gathered is then accessible through a controller that we have designed. This intuitive interface not only allows users to control the robot but also provides them with real time pertinent and insightful data. Equipped with a 10.1-inch display, this interface gives users access to a well-designed user interface, that incorporates a live video feed for better maneuverability. Our software has been licensed under the *"GNU General Public License v2.0"* . This allows users the freedom to use, study, share, and modify our code, further achieving our mission of making a valuable contribution to the scientific community.

Materials:

Components:

- (2) RPi 3
- (1) TN display
- (2) High gain wi-fi adapter
- (2) 10Dbi antenna
- (1) Motor Driver
- (2) 12V dc motor
- (1) Temp sensor
- Mq-2 sensor

Tools:

- Digital calipers
- Soldering Iron
- Solder
- Wire strippers
- Set of pliers
- Set of screwdrivers
- Zip-ties
- Heat shrink.
- 3d Printer

Software Tools:

- Fusion 360
- Visual Studio Code
- PuTTY(ssh)
- Git Hub (version control)

Procedure

Design- process (code, robot build, etc.)

// moved from intro because it makes more sense here

The robot and robot controller both run on raspberry pi 3B+ as their logical processors. This choice was very advantageous because of their relatively low cost to performance ratio.

Engineering Problems

Software: Software optimization to have our framework operate on limited computational hardware was a challenge. Changing the intervals on how often data would update was a great solution to minimizing the network traffic between the controller and the robot. Also having multiple functions running loops on separate threads significantly slowed down the performance of the application. To minimize the workload on the robot side, a secondary microcontroller has been added. This microcontroller will take care of local processes that don’t require a connection to the controller.

Hardware: Many issues came from creating a tracked robot platform that needed to house many different components. 3d printing such complex parts with curves and awkward shapes posed issues in the manufacturing process. Printer calibration was a must to ensure proper dimensional tolerance when fitting components.

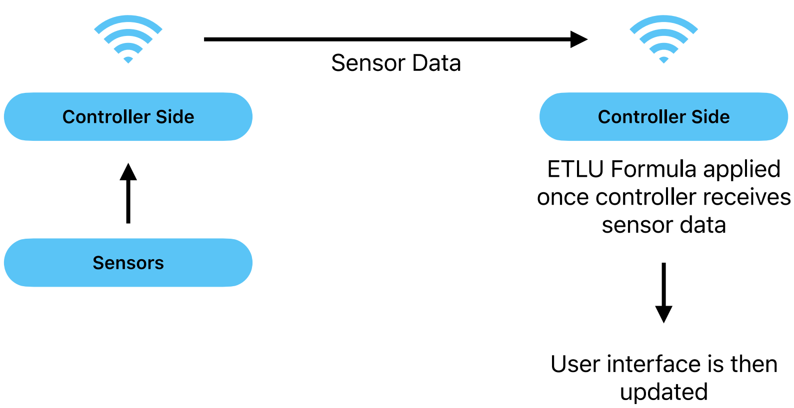
ETLU Formula:

The ETLU (environment thread level unit) is a unit we developed to rate the survivability of an environment-based variables pertaining to that environment. The formula is designed to be expandable allowing other parameters to be included. The formula can be replicated in python (the programming language our framework is built on). The formula works by subtracting the measured value from the minimum threshold and then dividing it by the range between the maximum and minimum values, thereby returning a normalized value. Once this normalized value is obtained, it is fed into another equation that then determines the threat level. The returned values range from 0 to 50, where a rating of zero signifies a completely normal environment, while a rating of fifty indicates conditions completely inhospitable to human life.

$$\eta = \frac{\mathcal{V} - \mathcal{V}\text{min}}{\mathcal{V}\text{max} - \mathcal{V}\text{min}}$$

$\mathcal{V}$ = value
$\mathcal{V}$min = The minimum value
$\mathcal{V}$max = The maximum value

η = The normalized value



$$\Sigma T = (\mathcal{W} \times \eta^1) + (\mathcal{W}^2 \times \eta^2) + (\mathcal{W}^3 \times \eta^3) + (\mathcal{W}^4 \times \eta^4)$$

ΣT = Environmental Threat Unit
$\mathcal{W}$ = (The impact on human health) Ex: (Radiation $\mathcal{W}$) > (Temperature $\mathcal{W}$)

Data Analysis:

Operating Variables

Variable	Max	Min
Temperature	85°C	-40°C

Water Depth		
Radiation	[50,100] Sv or [50000,10000] msv	N/A
Speed		
Distance		

Discussion:

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Needs fixing and vocab elevation

E.L.A.R.T boasts a vast range of features available to safely assess the situation in a given hazardous environment. This technology enables researchers to take a safer approach when assessing hazardous environments and allows them to get the info they desire. For getting more data on E.L.A.R.T we would've gone into a live environment to see how the robot performs, unfortunate we do not have any easily accessible test sites where we live. (write about what we could have done to get results in a live environment, or write about possible upgrades)

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Conclusion:

No good // By exploring several ways to facilitate hazardous scouting missions, we became proficient in many types of skills. Such as 3D modeling, programming in python, and soldering. If we were to change anything about this prototype it would be the material it is built with, and we would change it for something sturdier like carbon fiber. Also, this work can be further expanded upon as we have decided to release the framework publicly and allow other scientists to repurpose. \\

Endorsements:

Professor Joanna D. Haigh Faculty of Natural Sciences (Imperial College of London 2014-2019)

"Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt."

Laura Giroux, Chief Geologist at Nuinsco Resources (2003 – Present)

"Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt. Sample text until I ask for a written endorsement from aunt."

Bibliography: