Proposal

Salt-Dispensing Robot
For Ice Reduction and Prevention

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Introduction and Motivation

Our project proposes an alternative to manual salt spreading. Winter season weather brings the problem of ice formation on the ground. Reducing traction, ice formation becomes a hazardous condition for many scenarios such as walking on foot or driving in a vehicle. To remedy the danger, people often spread salt manually on their property. Salt effectively lowers the freezing point of water or ice by a few degrees, reducing the probability of ice formation.

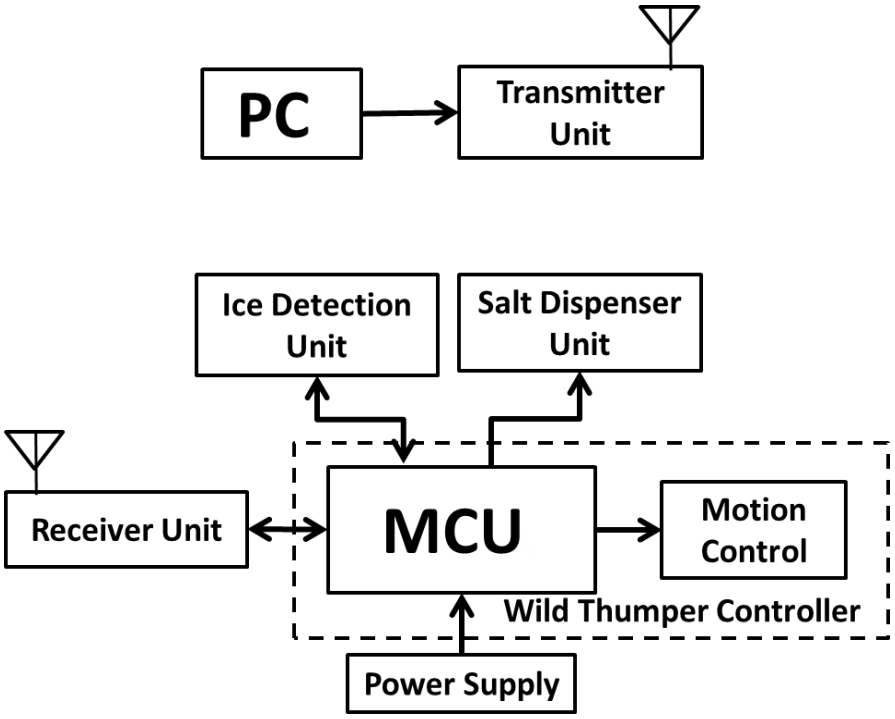
To avoid exposure to freezing weather and injuries caused by slipping and falling on the ice, a robot substitute is to be constructed and take care of the salt dispersion instead of a person. With the salt dispensing robot, not only is the problem of ice formation solved, the manual labor under extreme condition is also reduced.

Although our knowledge and hardware experience on robotics is not sufficient, the excitement of the project will drive us to delve into engineering topics we have never explored, and our existing skills will help us along the way.

Benefits:

- Remove the danger of slipping and falling on ice
- Remove exposure to cold weather by staying inside and controlling the robot
- Potentially expedite the ice dispersion when compared to manual dispersion

Design Block Diagram



Block Descriptions

- **PC**

  PC is a simple Windows-based setup which users will interface with. PC generates control signals that direct the motions of the remote robotic unit. An XBee module connected to the PC via an XBee USB Explorer enables the data transmission. The XBee module communicate to another XBee module located on the ground vehicle. The interface between the PC and USB Explorer is, like the name suggests, USB.

- **Transmitter Unit**

  The transmitter unit consists of an Xbee (Xbee 1mW Chip Antenna Series 1) connected and an Xbee Explorer USB. Receiving control signals from the PC, transmitter unit then processes and transmits the signals to a receiving unit. The rest of the setup is on the remote ground vehicle. The transmitter will interface with the receiver via ZigBee Wireless protocol. The transmitter is will be housed on a USB Explorer.

- **Receiver Unit**

  To form a wireless communication link, a receiver unit is utilized. Similar to the transmitter unit, an XBee (Xbee 1mW Chip Antenna Series 1) is used to receive and process control signals. The processed signals are subsequently sent to the MCU (micro controller) unit. The Receiver should be interfacing the transmitter via ZigBee Wireless protocol; the receiver will also be connected to RX/TX pins on the microcontroller.

- **Wild Thumper Controller**

  The controller is made of two physically connected components, a MCU unit and a motion control unit. The controller is designed for use with the Wild Thumper Chassis and similar setups.

  - **MCU Unit**

    The MCU unit is the logic in the ground vehicle. It is a microcontroller housing an Atmel ATmega168 processing chip. The unit is based off the Arduino development platform that has become popular recently. It interfaces the receiver, the ice detection unit, and the motion control with its I/O ports.

  - **Motion Control unit**

    The motion control unit is responsible for the motion of the vehicle. It is built into the Wild-Thumper controller. It consists of two H bridges for both left and right motors, and two 15A slow blow fuses to protect the H bridges. This will interface with the motors directly.

- **Power Supply**

  A 7.2V sub C battery pack is served as a power source that runs Wild Thumper Robot Controller, dispensing unit, ice detection unit, and the receiver. The PSU will power the components on the ground vehicle with various voltages.

- **Salt Dispensing Unit**

  The unit is responsible for mechanically dispensing the salt. It consists of the rock salt to be dispensed, a container for the rock salt, a motor to control the flow of the rock salt, and an opening for the outflow of rock salt. The control for this will come from MCU pins and power will be supplied form the PSU.

- **Ice Detection Unit**

  The unit notifies the MCU unit whether there is ice below the vehicle or not. Consisting of an emitter and a detector, the unit acquires the information that helps user to decide in the decision of the spread of rock salt. The data will be delivered to the MCU via I/O pins.

Performance Requirement

Ice Detection

- Our Ice Detection unit accurately detects ice underneath the vehicle. It should not result in a positive reading with just water or irregularities on the ground. This requirement is a factor in conserving the rock salt and only depositing it where there is ice.

Wireless Communication

- The remote vehicle should receive the signals sent correctly XBee radios are known to be reliable and so we expect a low percentage of packets to be dropped.
- We want the secondary protocol to be modular. Since it is done in software, we would like to be able to add a new command at any point in the design process.
- We want to cover at least 100 square feet in our wireless communication range. as expected as an estimate for the area of an average front yard.

Rock Salt Dispensing

- A non-concentrated rock salt dispensing is required. The spread of the salt should be uniform and a command to dispense sent from the user should result in immediate dispensing.

Verifications

Ice Detection

- Ice Detection unit should achieve a 95% success rate with at least 20 trials

Wireless Communication

- Data received by Rx XBee radios should have an error rate of at most 3% assuming no connection failure
- At least 90 square feet range.

Rock Salt Dispensing

- the concentration of salt should be the same every where. number of salt crystal/area occupied should be constant.
- Reaction time (from when the user triggers dispensing mechanism to the dispensing) should be less than 1 second.

Vehicle Driving Capabilities

- directions- FORWARD, BACK, LEFT, RIGHT- should be 100% operational.
- Our vehicle should be able to climb over small stairs and uneven ground. The outdoors are by no means flat, and our design should take this into account
- Our battery should last at least one complete salt-dispensing job, about an hour. The vehicle must be able to cover the entire area desired to be checked for salt and dispense properly. We do not expect larger areas to be covered by a single container of salt. When the salt runs low, the vehicle is brought back to the user and the salt is refilled. The vehicle must go back to finishing its job all on a single battery charge.

Tolerance Analysis

Tolerance analysis will be performed on the salt dispenser and ice detection system, which will be placed under extremely cold weather. The mentioned systems will have its design analyzed to see which tolerances impact the performance of the systems.

Cost

Part Cost

Part	Unit Cost	Quantity	Subtotal
XBee 1mW Chip Antenna - Series 1	$22.95	2	$45.90
XBee USB Explorer	$24.95	2	$49.90
Lightsource (flash light)	$10	1	$10
Wild Thumper 6WD Chassis	$249.95	1	$249.95
Breadboard	$15.00	3	$45.00
Wild Thumper Robot Controller	$74.95	1	$74.95
0.1uF capacitor	$1.00	1	$1.00
10K ohm resistor	$2.50 /package	1	$2.50
2N2222 NPN transistor	$0.41	1	$0.41

Total part cost: $479.61

Labor cost

So far we have devoted 20-25 hours into the project, and we are about a third way through. We then approximate that we will both put in around 80 hours of work into this project. We approximate our salary to be $200/hour. A simple calculation, salary per hour times hours worked times number of workers, yield a total labor cost of $64000.

Total cost

Summation of the total part cost, $479.61 and total labor cost of $64000 yields a total cost of $64479.61.

Schedule (Tentative)

Week	Task	Member*
2/13	Confirm XBees are intact (not dead on arrival) Research on XBees' applications Confirm and assemble Wild Thumper Research on Wild Thumper's control	**Naman** Chun-Ting
2/20	Confirm communication between XBees with XBee USB Explorer (PC-PC) Confirm communication between XBee and MCU Confirm operation of Wild Thumper with its micro controller. Start Designing Salt despensing system	Naman **Chun-Ting**
2/27	Secondary protocol from PC to MCU via XBee Finish designing Salt dispenser start assemble a protype	**Naman** Chun-Ting
3/5	Figure out I/O of Wild Thumper controller Start writing code for controller Ice detection research and start designing Ice detection system revised Salt dispenser prototype	Naman **Chun-Ting**
3/12	Finish writing code for controller Start testing finish designing ice detection and producing prototype Have a Salt dispenser ready	**Naman** Chun-Ting
3/19	Put together a working system Debug the working sytem	Naman **Chun-Ting**
3/26	First Demo	

***** Bolded name indicates the member in charge at a given week.