Hand-Motion Controlled Robot

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Problem Statement

Conventional controls aren't always the best way to get a remote-controlled object to move. A hand-movement controlled device would avoid steep learning curves and promote ease of use. Physically challenged people often have a hard time commuting and accomplishing their day to day tasks independently due to either restrained movement or disability. Controlling a car, wheelchair or almost any device remotely by slight movements can make their lives easier.

Objective

Our goal is to create a device that enables a user to control any RF controlled driveable object by using hand movements. We are trying to achieve this by using an accelerometer and a controller attached to a wearable glove. The controller will interpret direction based on the accelerometer's input and wirelessly transmit an encoded signal to another controller housed in a robot chassis. The use of buttons has been eradicated in order to make the device as simple as possible. While we are using a robot chassis as a proof of concept now, this project could be expanded to more useful applications such as drones, wheelchairs and robots.

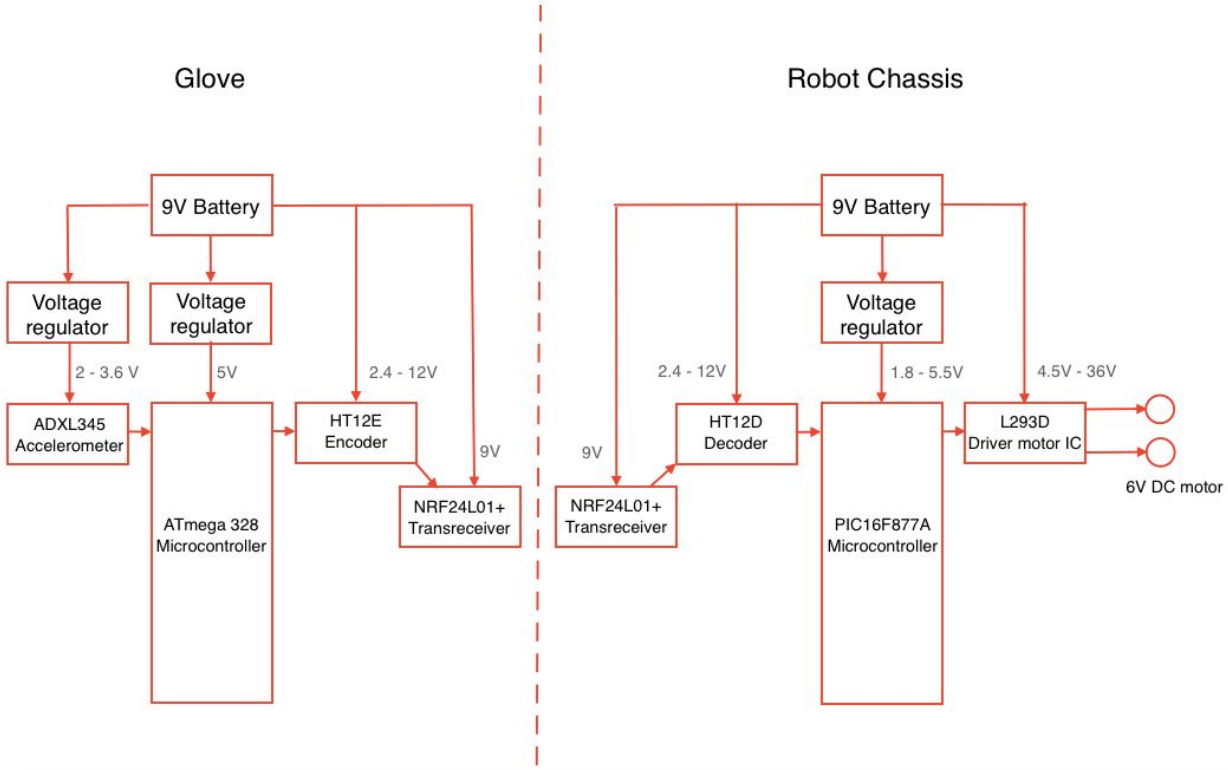
Background

We have seen similar concepts while looking to choose a project, but they invariably used microcontroller boards like Arduino or Raspberry Pi. Also, we haven't seen any of these for sale. We see potential future use for such a product with an application-specific custom board, avoiding the overkill buying an entire Arduino would present.

Constraints

- Transmitter side must use ATmega328 microcontroller to implement input functions from an accelerometer.
- Transmitter side must use an encoder to convert digital signal from ATmega328 microcontroller to an RF signal that receiver side can detect.
- Receiver side must use PIC16F877A microcontroller to deliver fast output to DC motors.
- Receiver side must use a decoder to convert an RF signal from the receiver side to a digital signal that PIC16F877A can detect.
- Both transceiver must communicate within a tuned frequency range.
- Must have 2 separate PCB's each containing a microcontroller and any supporting circuitry.
- No jumper wires.
- Must have voltage regulators to supply sufficient power to components.
- Unit cost should not exceed $100.
- Github usage is necessary for version control, documentation, Wiki, and weekly reports.

Block diagram



Engineering Requirements

Functionality

The RF transmitter and receiver pair should be able to transmit and receive signals without any interference.

- Input: acceleration measurements (x, y, and z) from an accelerometer
- Output: DC motors connected to the two wheels of robot chassis
- Communication: One transceiver on the glove to transmit the input signal from the accelerometer. Another transceiver on the robot chassis to receive the transmitted signal.
- Compatibility: Existing products which uses the same transmitter-receiver pair and the same processors.
- Standards:
    - Interface: USB
    - Others: UL, CE compliance

Performance

- The device should operate within the RF range of the transmitter/receiver pair.

- Should move forward, backward, left and right based on the tilting of the hand.
- Should be compliant to Zigbee and WiFi protocol on adding a WiFi module (this feature is not going to be implemented during the practicum but the compliance criteria will be satisfied).

Operational

- Preferably indoor.
- Can be used by any physically challenged person.
- Can be used as a hand-held or wearable device (remote, watch, glove, jockey etc).
- Can be attached to a stationary object that can be tilted (wheelchair, walking stick).

Reliability & Availability

- Transmitter end on the glove should be sturdy enough to resist any tension that may arise if the glove stretches.
- The system should work within a range of at least 50m when no obstacles are present.
- System must be designed to avoid any ESD from the user.

Social & Cultural

- This device for all ages, and it can be operated both indoor and outdoor area.
- Circuitry on the robot chassis is not covered; customers can design personalized cover or third party vendor may promote production of personalized covers.

Economic

- It takes 4 students, 10 weeks to develop a complete unit of hand motion controlled robotic vehicle.
- The estimated budget to build the prototype is around $100. Once the prototype is built and tested, the production cost may decrease due to previously purchased components. If customers wish to add accessories, the cost of production may increase depending upon components and parts.
- 9V batteries for both glove and robot chassis may need to be replaced when needed.
- There is no regular maintenance required.

Energy

System needs to follow these power standards:

- Power on transmitter end (glove): <15 mA, estimating battery life at ~30 hours with a standard 9V cell.
- Power on receiver end (robot chassis): <150 mA, estimating battery life at ~3 hours.

Health & Safety

- Should follow *NISTIR 8118r1* (United States Electrical and Electronic Equipment Compliance) requirements.
- Mainly electric circuits on the glove and the robot chassis should be covered to prevent possible electric shock and other safety hazards.

Legal

- Non-infringing
- No personal data stored.
- The system will use 128-bit encryption for all transmitted data and stored user data.

Environmental

- There is no harmful or hazardous chemical used during production.
- The device uses disposable batteries. Customers may alter the method of power. supply upon their preference, such as non-disposable batteries.

Maintainability

- No regular maintenance required aside from battery.
- May need to reset.

Manufacturability

- Product only uses sensors which can be sourced from other vendors.
- Product only uses electrical components that are easy to solder.
- PCB for product must be no larger than 4'' x 4''
- Wait time for components should not exceed 15 days.

Usability

- No programming, no installation, and no sign-in.
- Turn on the switch on the glove and the robot chassis, then tada!

Documentation

- Instruction on assembling a robot chassis
- Block diagram
- Schematic
- Troubleshooting