**Final Project Proposal: Bomb Defusal**

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**Project title**: Bomb Defusal (hand gesture mimic robot)

**Problem statement and goals**:

*Motivation*

Hazardous tasks such as bomb defusal and volcanic research claimed the lives of many. There are several solutions developed to tackle these problems, this project uses a robot arm that can be controlled remotely using hand motion and gesture to defuse bombs or carry out other hazardous tasks. The system pairs the user’s hand motion and gesture to a robot arm which can thereby give faster complex control to the user. The user is able to mimic what they actually want to perform instead of fumbling with a joystick.

*Overview* (“What will the system do?”): The system will move a robot arm according to the movement of the user’s hand and actuated by electric motors. An action such as a motion for cutting a wire can be made by the robot and controlled by the user with a hand gesture. An attachment to the user’s hand will contain sensors that characterize the hand’s motion. The robot arm and the attachment on the human hand will communicate using wires to the MSP microcontroller.

*Performance Goals*: The performance goals of the system consist of the following:

* Track motion of user’s hand using sensors on hand attachment
* Control 4 DOF serial robot using brushless motors
* Map user hand motion with that of the robot arm
* Correct system error using PID with encoders to follow hand motion, and correct user error using PID with proximity sensor to allow precision interaction with the environment

**Breakdown of the project components**:

*Mechanical design*: The mechanical design will require:

* A robot arm with 4 degrees of freedom (RRR and end effector clamping)

*Electrical design*: The electrical design will include:

* Accelerometer (3) and strain gauge for the attachment on the hand to detect its motion
* Proximity sensor on robot end effector to measure proximity to bomb and confirm position
* Brushless motors (4) to control the joints of the robot arm
* Switch to initiate control
* Electrical safety measures: voltage regulators, diodes, etc.

*Software and Control Theory*: The software and control will involve

* PID controller to prevent the robot arm from overshooting or minimize oscillation based on hand motion or proximity sensor.
* Coding to translate data from accelerometers/strain gauge/proximity sensor into robot arm joint angles.

**Project Milestones and strategies for handling anticipated challenges:**

*Milestone 1*:

* Goal: To minimize the error of the displacement of the robot arm from the bomb relative to the human arm
* Potential challenge 1: Translating the data recorded from accelerometers into displacement accurately
* Potential challenge 2: Position might change all the time since accelerometers might detect trivial movements of the arm. Setting a suitable threshold will be tough.

*Milestone 2*:

* Goal: To increase the degrees of freedom to achieve more realistic hand motion and increase mobility
* Potential challenge: Potential computational performance issues and lower stability in structure and in control

*Milestone 3*:

* Goal: Integrate hardware/software use of accelerometers with MSP.
* Potential challenge: Finding compatible, suitable, and cheap components

**Method of Evaluation and Failure Modes:**

*Evaluation*: The system responsiveness will be evaluated on the delay between the user motion and the robotic motion. The error between the position of the robot arm and the human arm relative to the bomb will be measured to determine the system precision. A successful system will be whether the robot arm successfully “defuses” the bomb by cutting the wire. Less than 10% error in displacement of the robot arm. (displacement should be 1:1 to the displacement of the human arm)

*Potential Failure Modes*: The accuracy of the displacement can be lost when translating the data from the accelerometer into a displacement. The system’s precision is a critical element. The accuracy of the accelerometer, proximity sensor, strain gauge, and complementary PID control might not be accurate enough for the robot’s end effector to effectively reach and cut the wire.