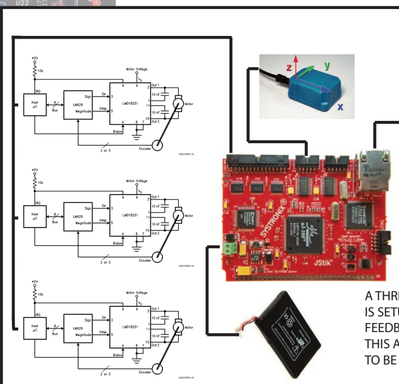
SIMULTANEOUS LOCALIZATION AND MAPPING FOR A CABLE ACTUATED ROBOT

BACKGROUND

SENSOR LOCALIZATION IS AN IMPORTANT PROBLEM

IT HELPS IN MANAGEMENT AND CONTROL OF PRODUCTS

ELECTRICAL DESIGN



A THREE MOTOR PID CONTROLLER IS SETUP USING A LM629 IN FEEDBACK LOOP WITH LMD18200 THIS ALLOWS **CONTROL COMMANDS** TO BE SENT TO THE MOTORS

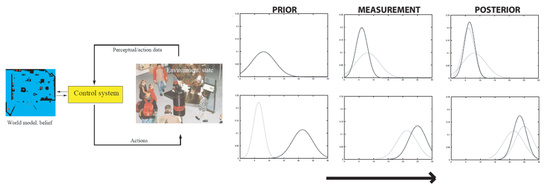
AN IMU IS LINKED ALSO WITH THE PLATFORM TO ACQUIRE **OBSERVATIONS** ABOUT ORIENTATION

SIMULATION

0. DEVELOP A KINEMATIC MODEL OF THE CABLE ROBOT
1. MOVE THE CABLE ROBOT ONE STEP IN SPACE
2. TAKE MEASUREMENTS OF THE POSE OF THE ROBOT
3. APPROXIMATE THE POSITION OF THE ROBOT BASED ON BOARD MEASUREMENT
4. MATCH WITH A CALIBRATED POSITION TRACKER AND CALCULATE THE ERROR MARGIN
5. WEIGH THE POSSIBLE POSITIONS BASED ON THESE ERRORS
6. DO NORMALIZED WEIGHTED RESAMPLING
7. GOTO 1

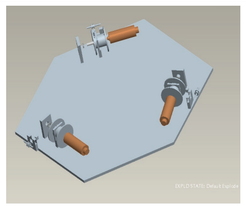
PROBLEM DEFINITION

LOCALIZATION INVOLVES FINDING OUT THE COORDINATES IN SPACE 3D WHERE DIFFERENT SENSORS ARE LOCATED BASED ON A GLOBAL COORDINATE SYSTEM.
THE PROBLEM BECOMES MORE INTRICATE BY THE FACT THAT MOST OF THE OBSERVATIONS AND MEASUREMENTS ARE NOISY , THIS REQUIRES THAT THE ANALYSIS TO BE CARRIED OUT IN A **PROBALISTIC FRAMEWORK**.

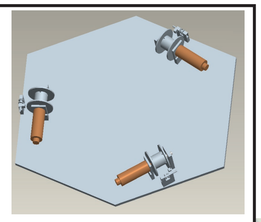


WE HAVE A BELIEF OF THE WORLD BASED ON PRIOR INFORMATION AND WE TRY TO IMPROVE OUR ESTIMATES THROUGH MEASUREMENTS OF OUR SURROUNDINGS.

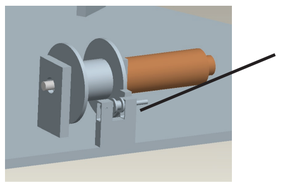
MECHANICAL DESIGN



EXPLODED VIEW



ACTUAL VIEW



DESIGN IMPROVEMENT SUGGESTED THIS ALLOWS TENSION IN THE CABLE WHEN THE SMALL PULLY LOSSES THRESHOLD TENSION CONTROLLER INTERRUPTED TO SPIN THE MOTOR SO AS TO PULL THE CABLE UP AGAIN

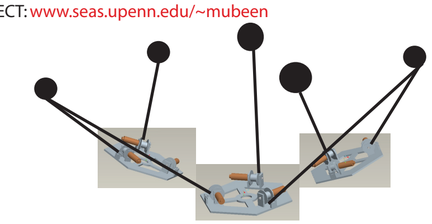
FUTURE WORK

THE NEXT STEP IS TO MAKE AN ADAPTIVE FEEDBACK MOTION PLANNING PROGRAM FOR ONE CABLE ROBOT.

IN PARALLEL, WORK IS BEING DONE TO MAKE SURE THAT IT WOULD BE POSSIBLE TO MAKE MULITPLE ROBOT CABLE ROBOTS WORK IN A COLLABORATIVE ENVIORMENT.

HOWEVER: USING MULITPLE CABLE ROBOT IN OVERLAPPING REGIONS OF MOTION CAN BE A HARD PROBLEM TO WORK ON...

BUT WE ARE HOPPING FOR THE BEST, KEEP YOURSELF UPDATED OF THIS PROJECT: www.seas.upenn.edu/~mubeen



PROPOSED SOLUTION

TO BETTER UNDERSTAND LOCALIZATION A CABLE ACTUATED ROBOT WAS USED. LOCALIZATION FOR THIS PLATFORM WAS TWO FOLD:

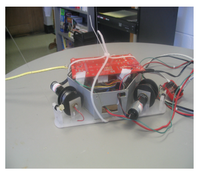
1. WHERE IS THE CABLE ROBOT LOCATED ?
2. WHERE ARE THE ATTACHMENT POINTS FOR THE CABLE ?
   (ie relative to the global coordinate system)

THIS PROBLEM FITS VERY WELL INTO A TRADITIONAL PROBLEM OF **SLAM** (SIMULTANEOUS LOCALIZATION AND MAPPING). TRADITIONALLY:
- KALMAN FILTERS: EXTENDED AND UNSCENTED, PARTICLE FILTERS, HAVE BEEN USED

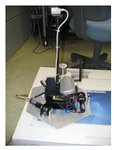
OUR PORPOSED SOLUTION USES A **RAO BLACKWELLISED PARTICLE FILTER** IS USED WHICH COMBINES THE EFFICENCY OF KALMAN FILTERS AND ROBUSTNESS OF PARTICLE FILTERS. INSPIRED BY WORK DONE BY DIETER FOX AND SEBASTIAN THRUN

IMPLEMENTATION

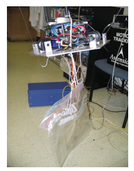
CABLE ROBOT BASED ON THE MECHANICAL AND ELECTRICAL DESIGN ABOVE WAS IMPLEMENTED

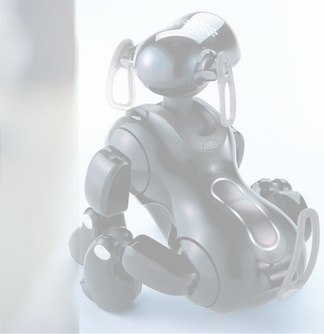


CABLE ROBOT WITH A MOTION TRACKING SENSOR TO MATCH PREDICTED AND GROUND TRUTH RESULTS OF POSITION OF THE ROBOT



PERFORMING WEIGHT TEST TO MEASURE HOW MUCH THE MOTORS COULD WITH STAND





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