PROJECTS DESCRIPTION

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CONTENTS:

Localization of the segway RMP 220V3 by getting information from the GPS, IMU, odometry feedback and using the Extended Kalman Filter (EKF)

AUGUST 2018- CURRENT

An intelligent vehicle must be able to detect its position simultaneously and accurately within its environment In order to have reliable navigation. When a robot travers in the specific course, there is error in estimating of its position which grows unbounded with time if it uses one sensor information to find itself within the map. The motion of the vehicle involves external sources of error that are not observable by the sensors used.
In this project, we are designing and constructing an intelligent vehicle that able to navigate inside a specific outdoor course autonomously. the goal is to have a Segway Robotic Mobility Platform 220 to function as a fully autonomous robot for International Ground Vehicle Competition (IGVC- check out this link for more information). In this teamwork project I want to implement a self-localization method, based on Kalman filter by fusion of GPS, IMU (inertial measurement unit), and odometry data.

SPECIFICATION

Minicomputer: Intel NUC minicomputer [ubuntu 14.04]
Packages: ROS (robotic Operation system)-indigo, Gazebo simulator, Rviz
Sensors:

- Novatel GPS [ProPak6™ Triple-Frequency GNSS Receiver]
- Inertial Measurement Unit (IMU) - CG-5100
- SPARTON IMU AHRS-8

PHOTOS

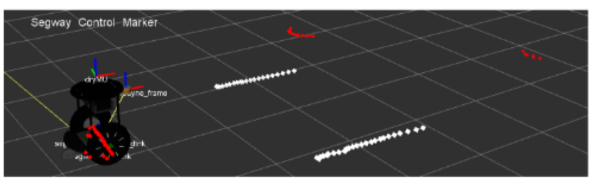

Figure 1 Segway simulation within the gazebo simulator and this result is shown inside the rviz

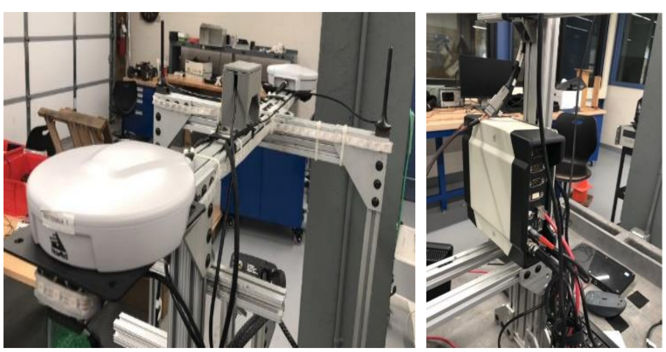

Figure 3 Novatel GPS [ProPak6™ Triple-Frequency GNSS Receiver]

Figure 2 Our robot with all sensors for IGVC completion

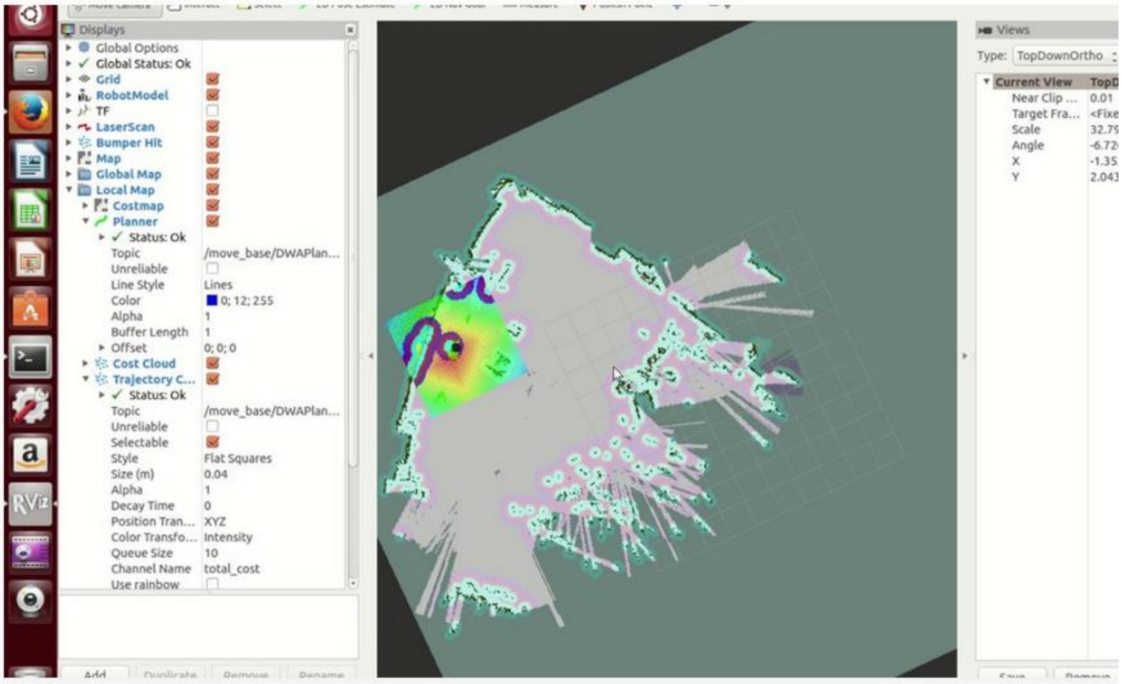

Figure 4 Getting information inside the ROS to finding obstacle and navigate inside the map. This picture is taken from the RVIZ environment and it is included the local and global map.

Data collector with graphical user interface (GUI)
(Based On LABVIEW)

JUNE 2016- SEPTEMBER 2016

This project is designing and manufacturing a device called Data Logger. It able to record and display data from different type of sensors as the same time which are included weight sensors (Loadcell), acceleration (or vibration), air pressure, temperature and angle (optical encoders). This project is manufactured based on the order from one of the professors of K. N. Toosi University of Technology when I was working at my startup company in the Sharif University of Technology.

It has a graphical user interface based on the LabVIEW that communicate with serial port (RS232-protocol) to get information from the device. The user can active every single sensor to get information inside this GUI. Also, the user can use all function of LabVIEW to do math calculation on the outcome data because this GUI is designed as a separate block that it has own Inputs and outputs.

The Printed circuit board (PCB) of this device is designed in the Altium designer software.

SPECIFICATION

Core: ARM cortex-M4 processor (Stm32F407)

Sensors:

- 6X ADXL345 modules (3-axises acceleration sensor)
- 6X angle by optical encoders with 3600 pulses per revolution
- 6X weight by HX711 modules with 24-bit resolution and 80 SPS
- 1X air pressure and temperature by Altimeter sensor (MS5607 module)
- 8X ADC with 10-bit resolution and 1 MHz sampling rate
- **GUI:** based on the LABVIEW

PHOTO

Figure 5 Getting the information from the one channel of acceleration sensor ADXL345 in 3 axes. This GUI has for tabs for each type of sensors [1-loadcells, 2- accelerometers, 3-Encoders, 4-ADC] and depends on each type of sensors, there a are subtabs for each single channel [ch1, ch2, …]

Figure 6 Data-Logger with 6 channels of ADXL45 and one loadcell and one potentiometer that is connected to the ADC (Anlage to digital) input

Figure 8 Front view of data logger and input sockets

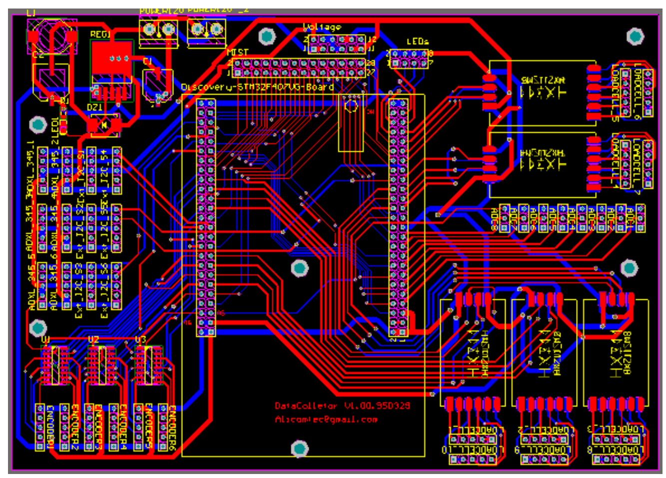

Figure 7 PCB of the device that designed with Altium Designer

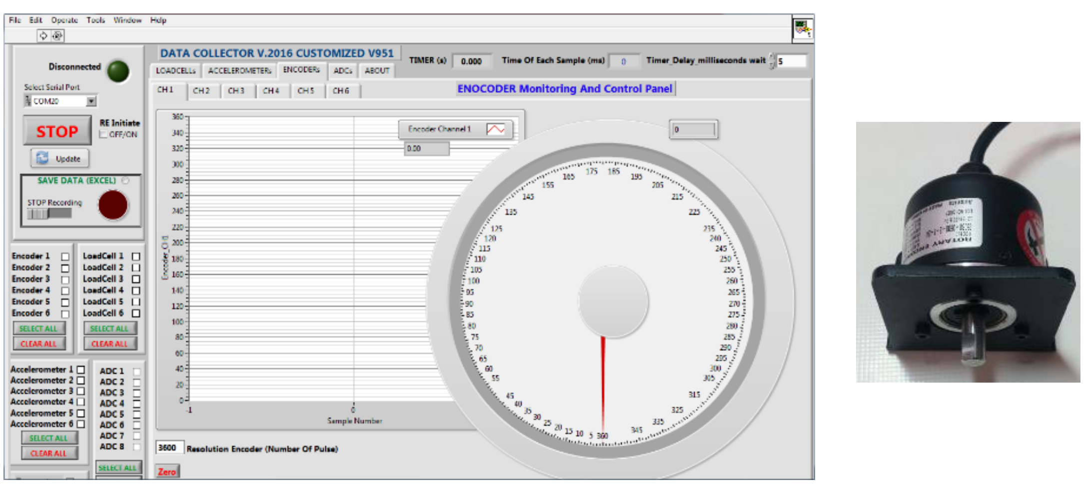

Figure 9 Graphical User Interface (GUI) based on the LabVIEW - this tab is related to the optical Encoder (you can see an optical encoder sensor at the picture at the right)

GPSM (GPS+GSM) tracker

MARCH 2016- JUNE 2016

The aim of this project is tracking of a moving object within the global map. First, the device waits to get the location of the board from the GPS module then coded the position information into specific format and send it through the GSM network. Also, is provided an acceleration module in the device in order to sense the motion. (motion detection) By means of this feature, the microprocessor able to detect the stationary state and change power mode of system to the sleep mode for energy saving.

This device can be use in Internet of Things (IOT) application to gathering data remotely and sending the outcomes to the server to process them also, it can get the commands from the server to do specific task (e.g. triggered an actuator) remotely.

The Printed circuit board (PCB) of this device is designed in the Altium designer software. The size of this device designed small as much as possible, so it can be connected to small objects to determine their location.

SPECIFICATION

Core: ARM cortex-M3 processor (Stm32F103C8)

Sensors:

- GPS module (UBLOX NEO 8M)
- GSM module (Sim800c)
- acceleration module (ADXL345).

GUI: based on the C#

PHOTOS

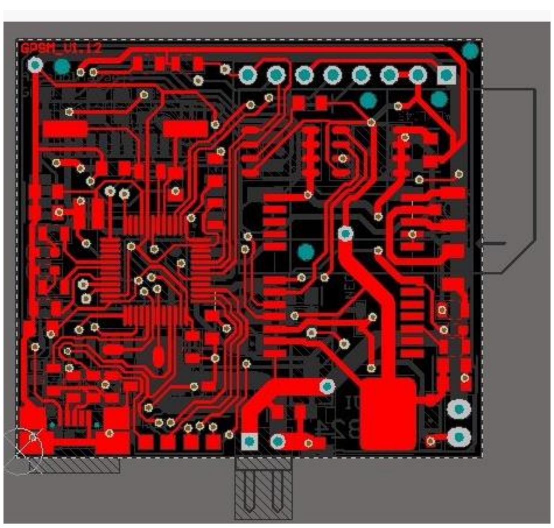

Figure 11 PCB of the device that designed with Altium Designer

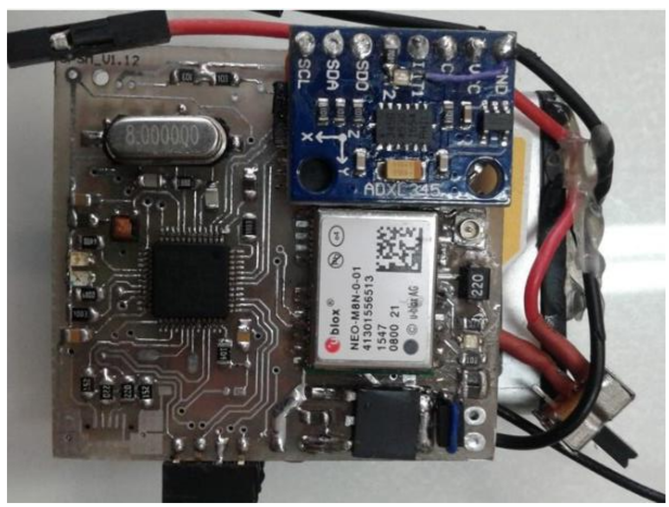

Figure 10 Manufactured prototype board (top layer) you can see the ARM microcontroller, lithium-ion battery beneath the board, GSM Module (the white one), ADXL345 Module (the blue one)

Figure 12 Manufactured prototype board (bottom layer) you can see the GPS Module and SIMCART

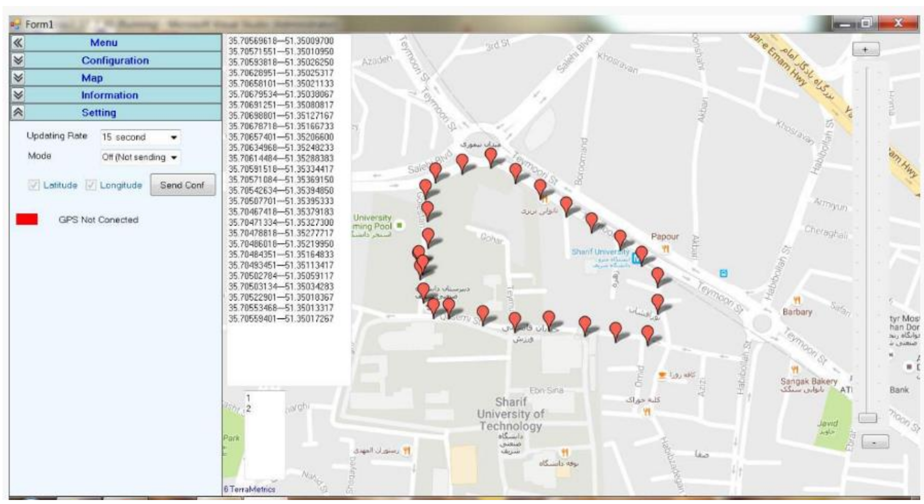

Figure 13 Received data from the board and plotted on the Map in the Graphical User Interface based on the C# - the location is around the Sharif university of technology

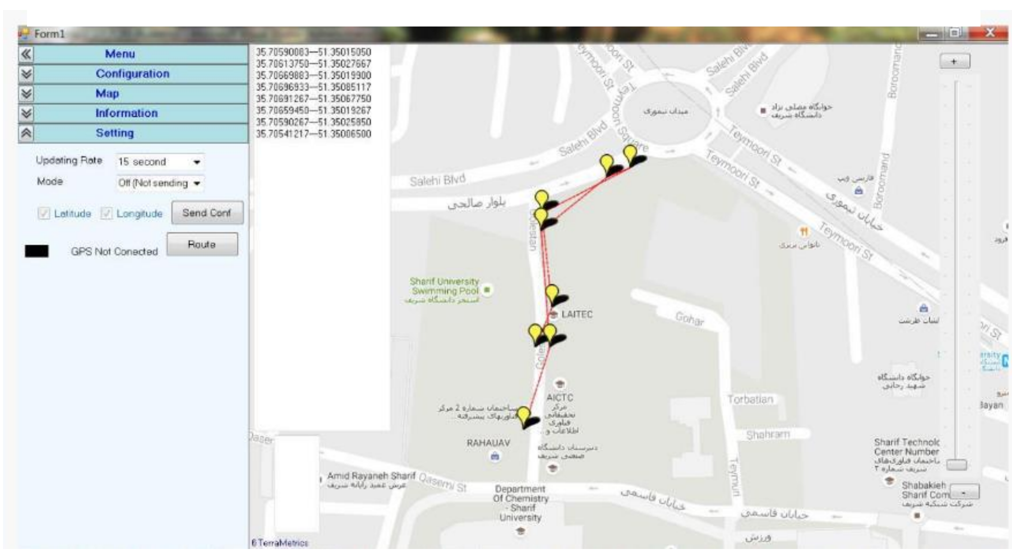

Figure 14 Testing the board at another path- the location is near the Sharif university of technology

Optimization of the interpretation of visual stimuli using neural network brain waves

AUGUST 2014- NOVEMBER 2014

Inferior temporal (IT) cortex is one of the most important parts of the brain that plays an important role in response to visual stimuli. In this study, object decoding has been performed using neuron spikes in the IT cortex region of monkeys. Single unit activity (SUA), which provides a method of measuring the electro-physiological responses of a single neuron using a microelectrode system, was recorded from 123 neurons in IT cortex. Data was recorded while each monkey was shown one of the 7 objects that were presented at three different locations. Each object was presented approximately 20 times in each of the three locations and at the end, 420 trials were performed for each neuron. Pseudo-population firing rate vectors were created, then dimension reduction was done, and an artificial neural network was used for object decoding. The object decoding accuracy was measured for 50 ms, 75 ms, 100 ms, 150 ms, and 200 ms window lengths and various window step sizes from 25 ms, 50 ms, 75 ms and 100 ms. The results show that 150 ms length and 50 ms window step size give the optimum performance in average accuracy.

The result of this research published at 2014 21th Iranian Conference on Biomedical Engineering (ICBME), Tehran

PHOTOS:

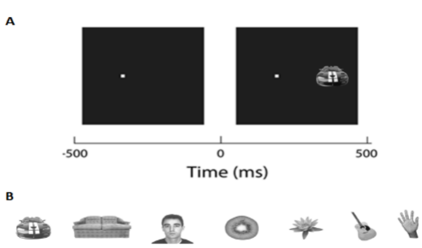

Figure 19 the seven different pictures that could be shown to the monkey

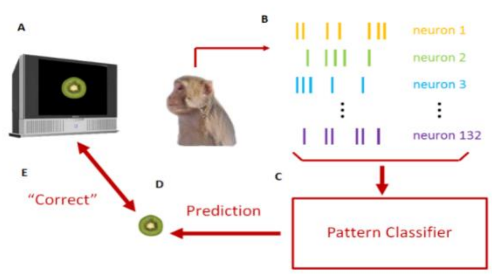

Figure 18 the procedure of decoding analysis for one trial

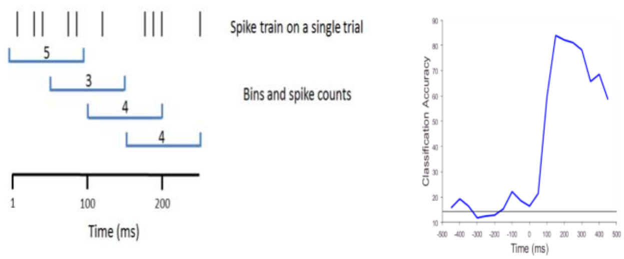

Figure 16 creating a continues signal by using a moving window with difference lengths and steps

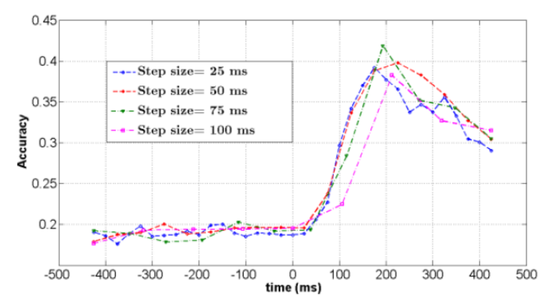

Figure 17 Accuracy for 150 ms windows duration and various step sizes [25 ms, 50 ms, 75ms,100 ms]

TABLE I. PERCENTAGE OF AVAERAGE ACCURACY

		Duration *				
		50	75	100	150	200
Step Size *	25	30.6	33.3	33	33.2	33.2
	50	31	32.5	32.4	34.9	31.5
	75	–	32	32	34	32.7
	100	–	–	33.4	31.2	32.7

*. The time is expressed in millisecond

Figure 15 This table shows that 150 ms length and 50 ms window step size give the optimum performance in average accuracy

Data logger (AVR version ATXMEGA128)

JUNE 2016- SEPTEMBER 2016
This project is a Data Logger device that designed based on AVR microcontroller (ATMEL ATXMEGA128).it has two cores. It is able to record and display data of different sensors that are included differential air pressure, acceleration (vibration), air pressure, temperature, position and angle. In addition, it has high currency DC motor driver (Up to 12 Ampere) with PWM speed controller.

SPECIFICATION

Core: 2X ATMEL ATXMEGA128.
Sensors:

- 1X ADXL345 modules (3-axises acceleration sensor)
- 6X angle by optical encoders with 3600 pulses per revolution and using the quadrature peripheral
- 4X weight by HX711 modules with 24-bit resolution and 80 SPS
- 1X MS5607 modules (Air pressure, Temperature and Altimeter sensor)
- 1X air pressure and temperature by Altimeter sensor (MS5607 module)
- 6X ADC with 8-bit resolution and 1 MHz sampling rate
- 1X GPS (UBLOX NEO M8N)
- 2 channel high current DC motor MOSFET driver (Up to 12 Ampere) with PWM speed controller
- **GUI:** based on the LABVIEW

PHOTOS

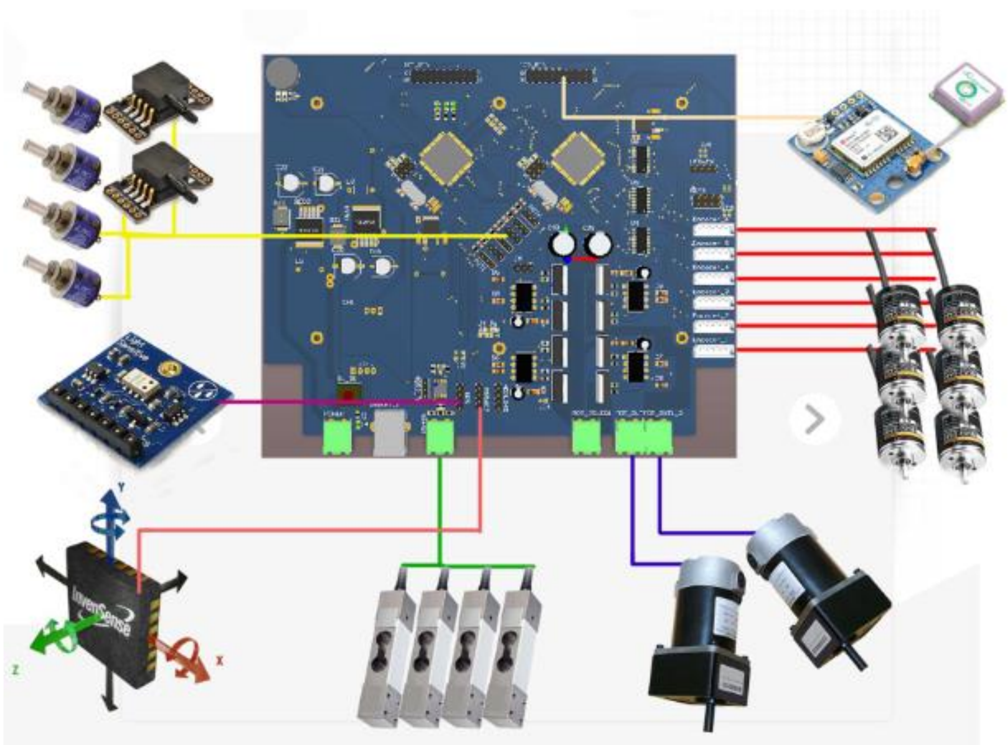

Figure 20 Data-Logger (AVR version) with all sensors and actuators that able to connect to this device

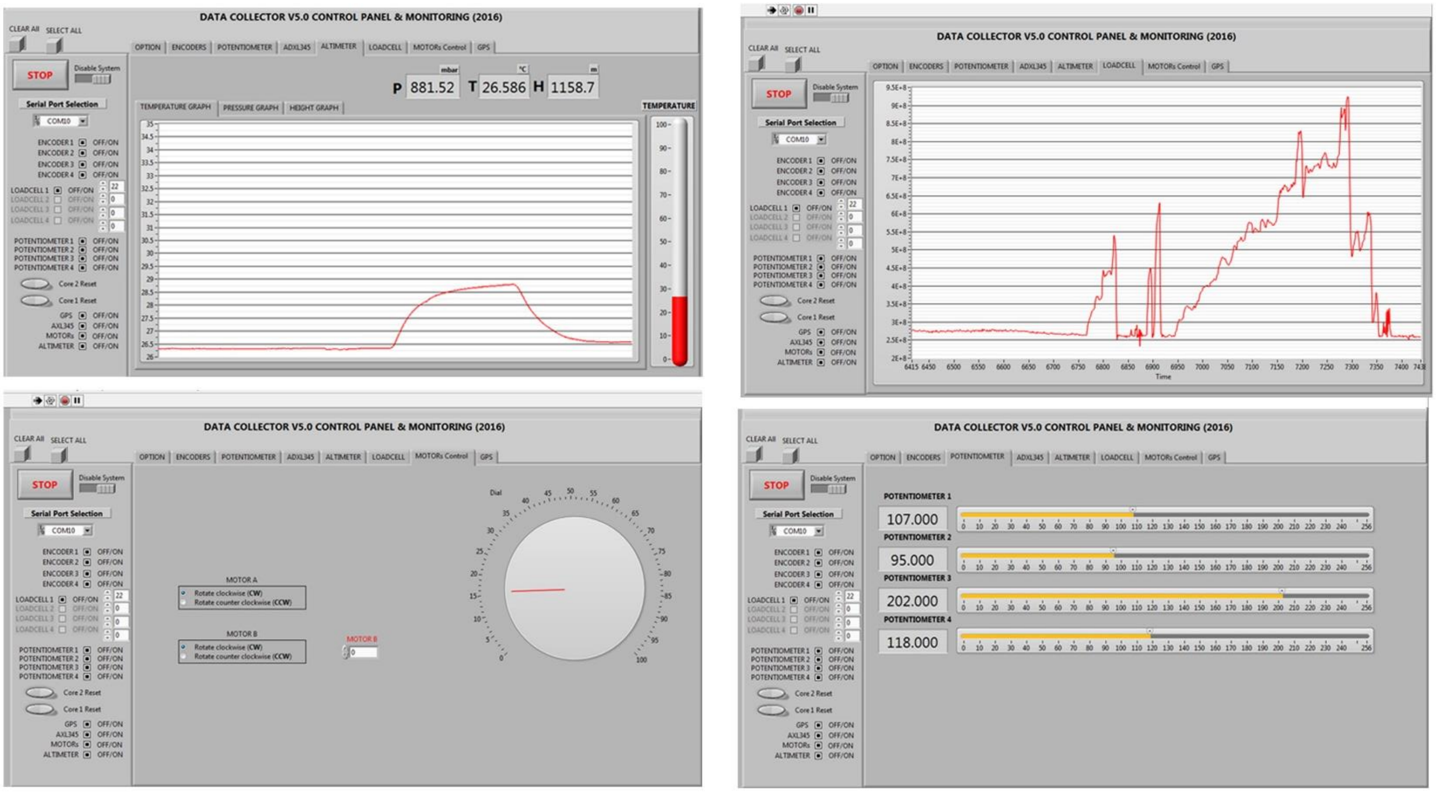

Figure 21 The Graphical User interface based on the LabVIEW top-left: shows the temperature-pressure and Height of the device from the sea top-right: shows the graph of the weight information bottom-right is the control panel of the DC motor driver that the user can change the speed and direction of the motors bottom-right: shows the output of Anlage to digital voltage with 8 bits resolution

Figure 22 the first prototype for the manufactured device

Arm robot with six degrees of freedom

JUNE 2016- SEPTEMBER 2016

Designed and fabricated a six-degree-freedom arm robot. It was performed as my B.S thesis. All of the mechanical parts were designed by CATIA software, then it was made of Aluminum and metal and assembled together. Electrical part of this robot included 6 Dc MOSFET driver with voltage feedback to identify motors position. Each joint of robot has an electrical board that received motion commands from a primary board. Primary board exchanges information with PC and GUI interfaces.

SPECIFICATION

Core: 6X ATMEL ATXMEGA8 & 1X ATMEL ATXMEGA32.

- 6X Dc MOSFET driver
- 1X control board

PHOTOS

Figure 24 Manufactured parts from the 3D model and electrical board

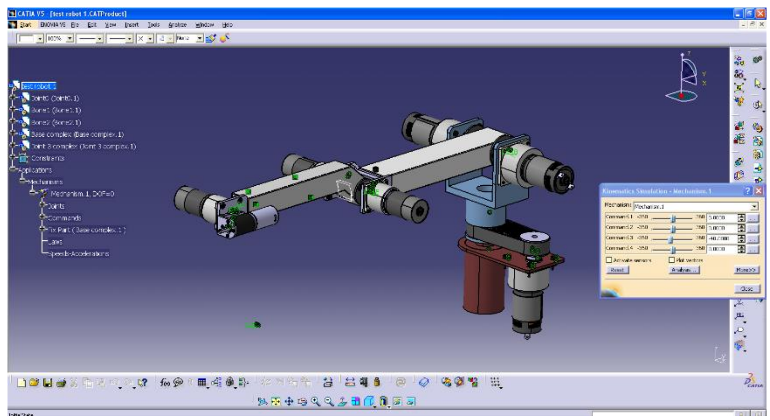

Figure 23 Designed model of the arm robot inside the Catia software (without the gripper). It is designed based on existing DC motors in the market

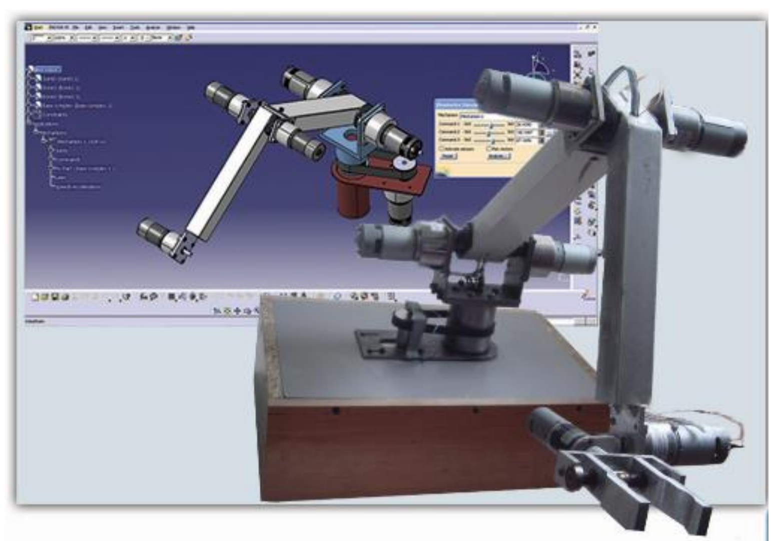

Figure 25 The final project and comparing with the 3D Model