eyeCue

Assistant Eye

Team 9
v 1.0

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Preliminary Design Document

Behic Bugra Bacanli

Mevlut Turker Garip

Burak Isik

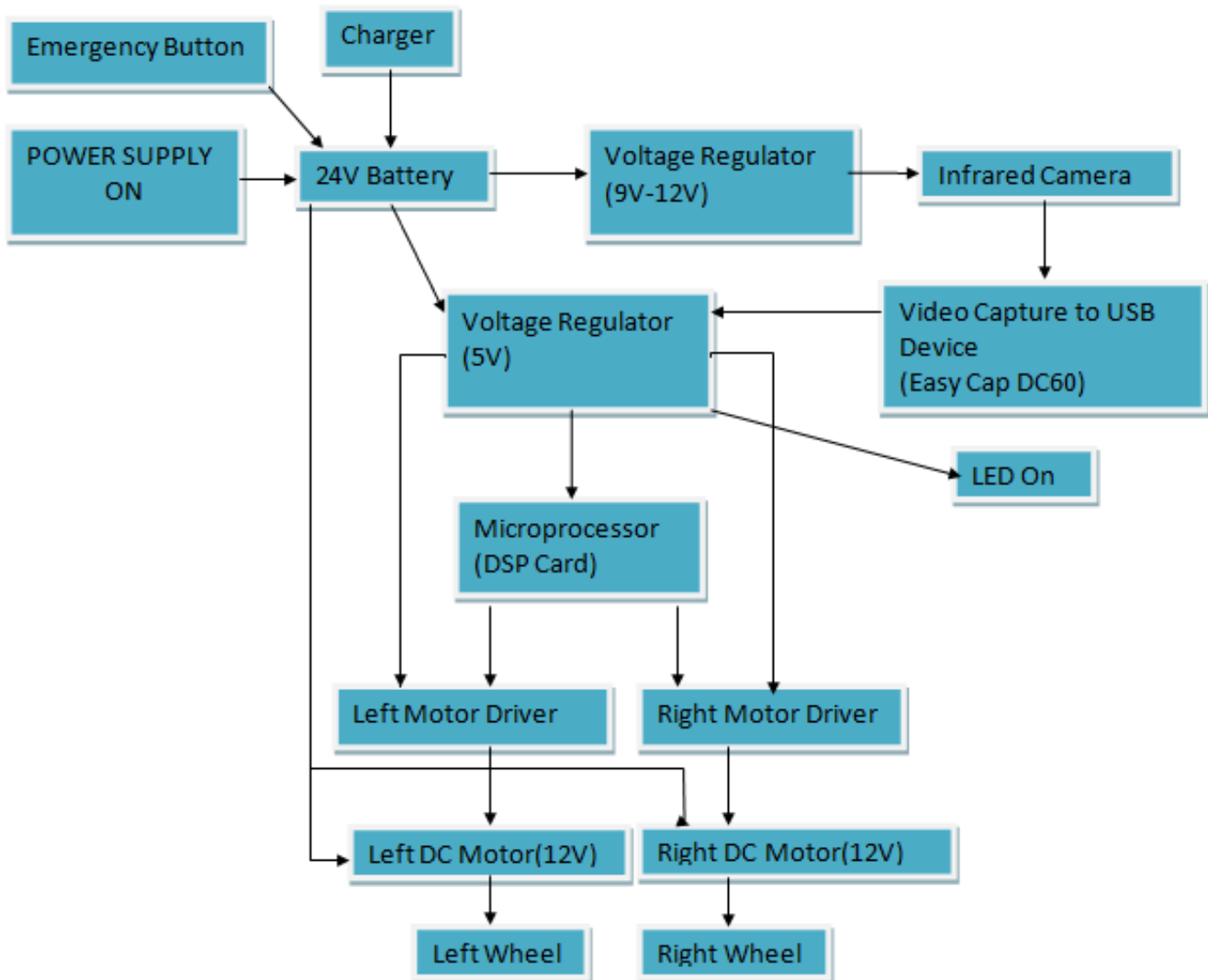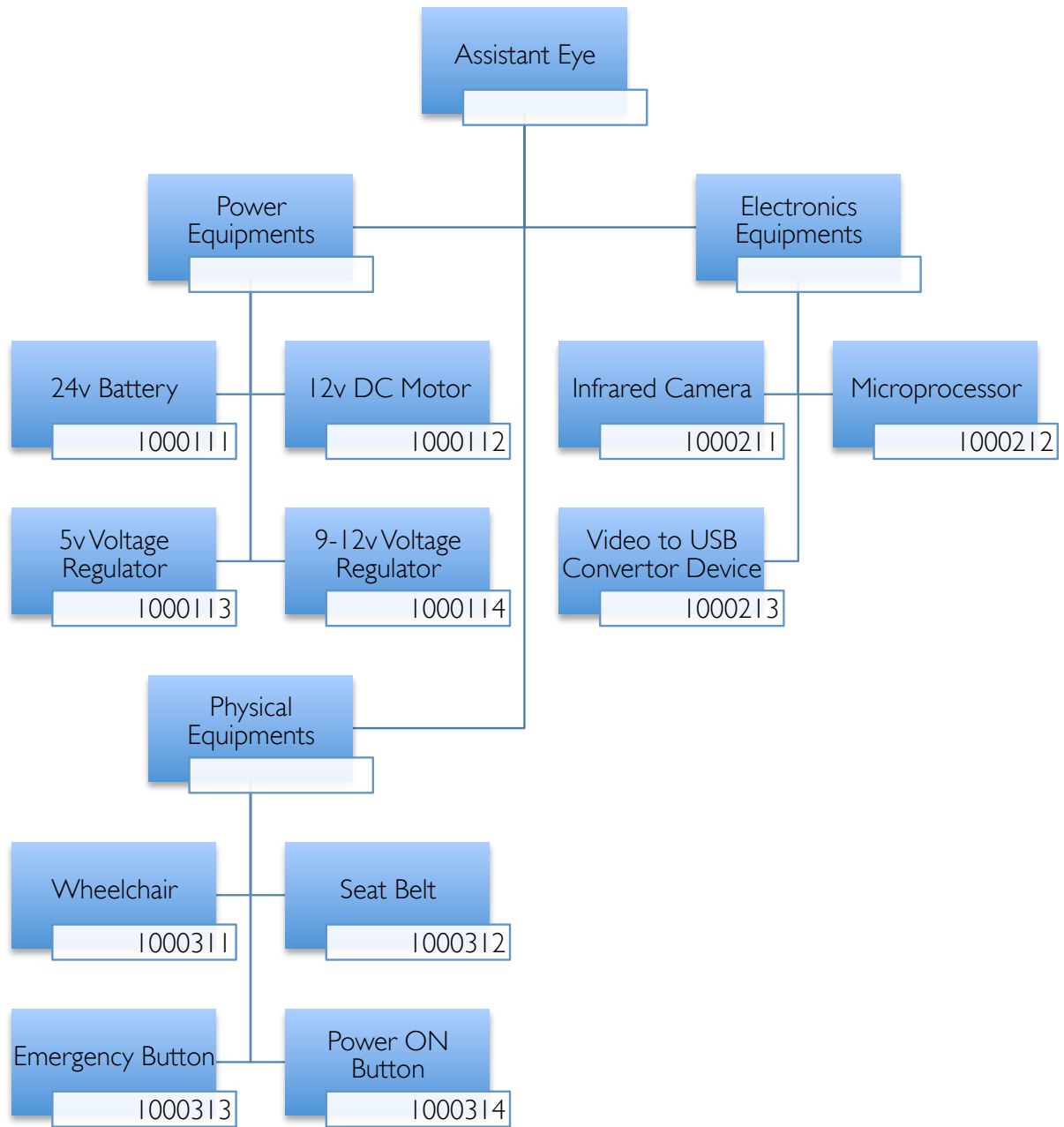Yunus Burak Sucsuz

Melik Koray Uster

Caglar Varan

Table of Contents

Block Diagram

Emergency Button	Charger
POWER SUPPLY ON	24V Battery	Voltage Regulator (9V-12V)	Infrared Camera
	Voltage Regulator (5V)	Video Capture to USB Device (Easy Cap DC60)
		LED On
	Microprocessor (DSP Card)
	Left Motor Driver	Right Motor Driver
	Left DC Motor(12V)	Right DC Motor(12V)
	Left Wheel	Right Wheel

Product Tree

Assistant Eye

Power Equipments

Electronics Equipments

24v Battery
1000111

12v DC Motor
1000112

Infrared Camera
1000211

Microprocessor
1000212

5v Voltage Regulator
1000113

9-12v Voltage Regulator
1000114

Video to USB Convertor Device
1000213

Physical Equipments

Wheelchair
1000311

Seat Belt
1000312

Emergency Button
1000313
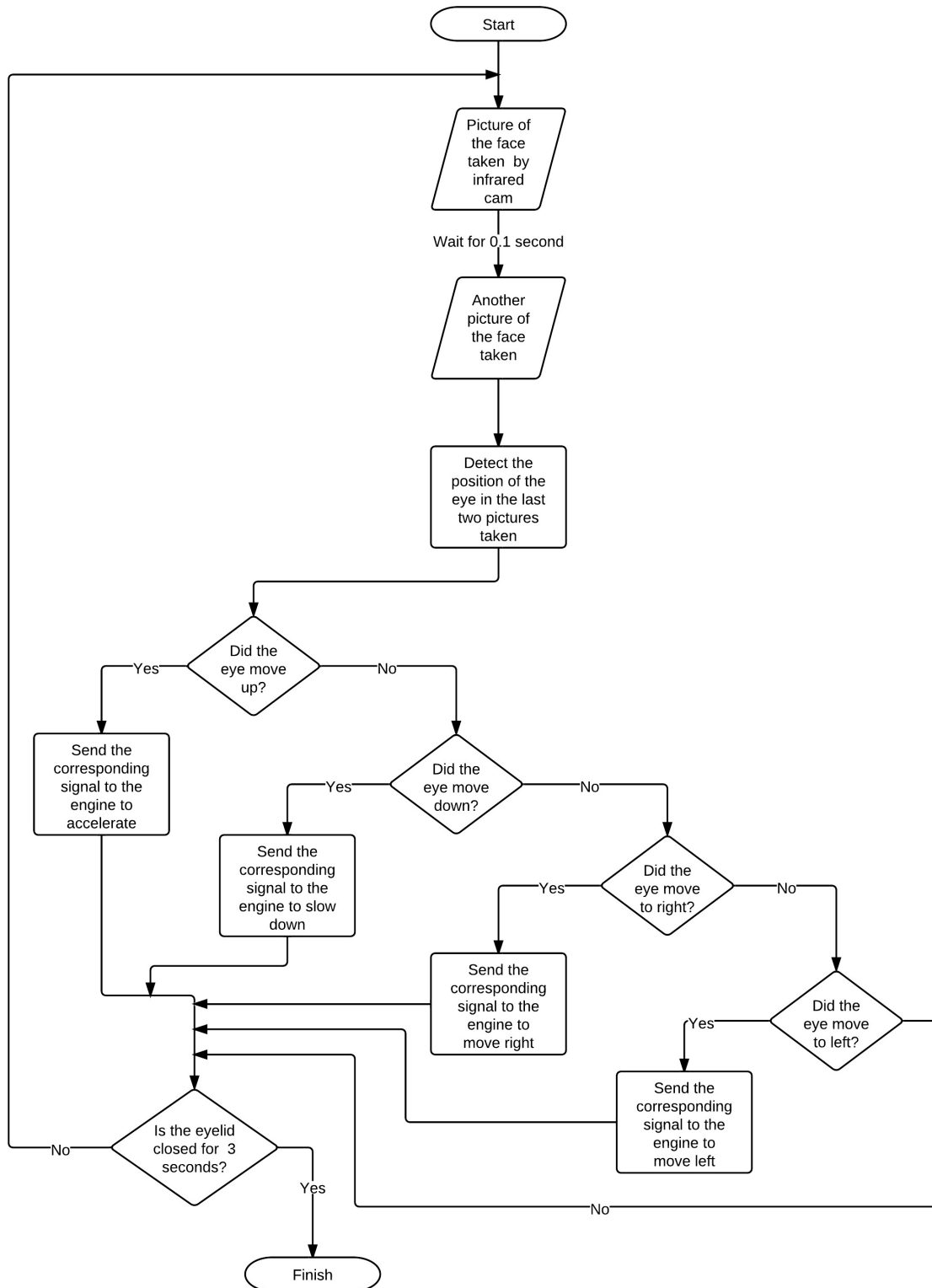
Power ON Button
1000314

Relationship Between Blocks

Initially, the system should be turned on by the user. This will let 24V battery begin to supply voltage to the system. Directly afterwards, camera starts to take frames of the pupil of eye and LED will turn on in order to show the system start its procedure. Following that part, the changes of the eye position will be calculated by the processor and accordingly, the processor sent the signal to the motor driver in order to make driver to move the DC motors. When the signal reaches to the DC motor, correspondingly the wheels are going to begin their movements. There exists an emergency button that directly cuts the voltage support to the system to prevent undesired situations. There are three outputs of the main block, two of them are the DC motors and the other one is LED display, apart from this, there is just one input, which is detection of eye movements. Additionally, charger can be also considered as input while batteries are charging.

Interface Between Blocks

There exist a start system button that enables or disables the system complete the circuit. When it is on, in the other words, it completes the circuit, 24V battery begins to provide voltage and current to the system. From now on, the system splits into three fields. First of all is that since the camera needs 12V, initially one of the output of battery will be regulated to 12V to supply power to camera and afterwards according to the camera output, it will be turned into digital signal via video capture to USB device and directly be sent to the DSP card input by USB connection. At the second output of the battery, again a voltage regulator will be used in order to obtain 5V so that required voltage to DSP card and both the motor drivers can be supplied. In addition to that, a LED that is attached for the user just after regulator in order to make him/her to understand whether the system is on or off will be on. When both drivers and microprocessor have the started up energy, the communication between camera and microprocessor begins and also interaction between processor and both drivers starts. The last but not least part after the battery are motors that each one are 12V being directly supplied by battery are attached to the wheels so as to provide motion to wheels according to the eye movements that are detected by infrared camera and afterwards executed by microprocessor and then it gives the necessary information to both motor drivers that give orders to motors. Finally there exists an emergency button that is linked with battery and is used for directly cutting the voltage support to the system to prevent undesired situations.

Software Flowchart of the Software and Its Explanation

Start

Picture of the face taken by infrared cam

Wait for 0.1 second

Another picture of the face taken

Detect the position of the eye in the last two pictures taken

Did the eye move up?

Yes → Send the corresponding signal to the engine to accelerate

No → Did the eye move down?

Yes → Send the corresponding signal to the engine to slow down

No → Did the eye move to right?

Yes → Send the corresponding signal to the engine to move right

No → Did the eye move to left?

Yes → Send the corresponding signal to the engine to move left

No

Is the eyelid closed for 3 seconds?

No

Yes → Finish

In the software, main procedure running is the image analysis. The images to be used in the software are taken from the camera in a frequency of 10 images/sec. The software processes the last 2 images taken and locate the locations of the eyes. After comparing the two different coordinates of the pupil, it decides the direction of eye movement and sends the corresponding signal to the engine.

At the end of each iteration, if the system detects that the user's eyelids are closed for 3 seconds, it goes to the pause state where no eye movement would trigger the system. This check is designed to provide the user to pause the system any time and allow him/her to look around while not affecting the software.

Looking left or right will tell the engine to start turning in that direction by not changing the speed of wheel chair. Therefore, if the wheel chair has no velocity, the wheelchair will not move no matter whether the user looked left or right. The wheel chair starts moving and will be affected by the direction change only if the user looks up to accelerate it. Looking up will make the wheel chair start moving or accelerate like a gas pedal in the car. Contrarily, looking down will stop the wheel chair or slow it down a brake pedal in the car.

## Software Structure and Operating System Environment of the System

The software will run in the DSP Card which is a microprocessor optimized for image processing. Therefore, it will not need an operating system environment to run on. The software will focus on the image analysis since it compose the major part of the system logic. The images taken to the system will be converted into grayscale format with a threshold. As a result, color differences between skin and other parts of the face will be omitted. This will provide more accurate identification of black areas in the image such as eye pupil that we are searching.

The eye pupil will most probably constitutes the biggest circular black area in the image. The software will differentiate the connected components of the image and try to find circular ones. To achieve this, it will calculate the areas by pixel counting and compare the result by the areas found with mathematical formulas. The component with maximum size, which also gives by pixel counting the closest area to the one found by mathematical formula for circular areas, is very likely to be the eye pupil. Consequently, the coordinates of the center of this area will give the location of the eye.

Since most of the operations performed in the software are matrix arithmetic, the algorithms will be optimized for this purpose. The methods will focus on the optimization of speed in matrix accesses and calculations.

User Interface of the System

The images for the software will be taken using a camera attached to the user's head. This camera will always point directly to the user's eye no matter which direction he/she turns the head to. This mechanism aims to increase the software accuracy by keeping angle between the camera and the eye constant. Below is the figure representation of the interface between the user and the camera:
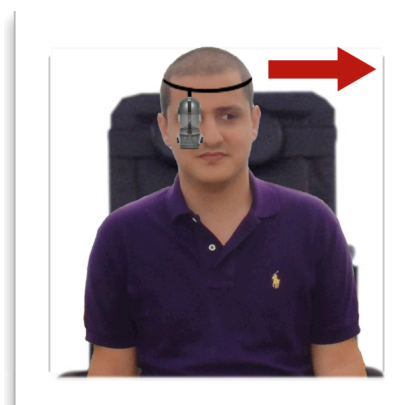
The images will be sent to the DSP card to be processed with the software and the card sends the corresponding signals to the engine according to the outputs of the software. The system can be shutdown any time with the emergency stop button in case of emergent situation. Besides, there will also be a start button on the wheelchair to turn on the system. These interfaces are shown below:

Bill of Material

Assembly Stock Number	Assembly Part Description	Number Used
1000111	24v Battery	1
1000112	12v DC Motor	2
1000113	5v Regulator	1
1000114	9-12v Regulator	1
1000211	Infrared Camera	1
1000212	Microprocessor	1
1000213	Video to USB Convertor Device	1
1000311	Wheel Chair	1
1000312	Seat Belt	1
1000313	Emergency Button	1
1000314	Power ON Button	1
Drawing	**Prepared By**	**Checked By**
Assistant Eye	Yunus Burak Sucsuz	Yunus Burak Sucsuz
Assembly Part Description	**Date**	
Assistant Eye	Friday, December 9, 2011	