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Project Design Report

Project Peek-a-Boo

The project consists of a remotely controlled probe (manifested as an off the shelf RC toy car). It will have a mounted camera to record where it has driven. We will implement a remote controller using a glove on the user's hand. Motions with the hand (and the hand alone) will control where the car drives. An accelerometer and flex resistors on the glove will record hand movements and transfer them to a microcontroller on the glove. They will then be transmitted to the car. The car will have another microcontroller on it to take the information and control the car.

By: Team ICU

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Features and Objectives

Our project was initially geared towards being an unmanned probe, however the possibility exists in the toy market to provide a more intuitive method of controlling a remote control car (read: through hand movements). The features of the project are as follows:

- No remote controller. Instead, a control glove will be implemented.
    - 2 axis (minimum) accelerometer to capture left/right turn controls
    - Flex sensors to register throttle with finger movement
- Zigbee IEEE 802.15.4-based wireless communications system
- A method of video capture from car to PC (ideally streaming video)
- Rechargeable power supply (for glove control unit and RC car)

We hope that the car can be controlled for distances up to 1.5 km line-of-sight and 300 feet with obstructions. Furthermore, we hope to beam back video or pictures to a laptop of where the vehicle is once it is no longer in the user’s sight. The transceiver must first be field tested to obtain more realistic expectations.

Concept Selection

The initial motivation for the project was spurred by the Wii Remote for the Nintendo Wii and its applications in areas other than gaming. The innovative motion sensing technology was hailed as a major step forward in gaming and provoked numerous exotic applications unrelated to its original purpose. The team settled on an RC car application because it was seen to have potential in the military or toy market. We think controlling a vehicle by hand and finger motions alone is more intuitive than using both hands to control the vehicle. To be able to control the car with one hand, forward and reverse throttle will be mapped to finger motions because bending one's fingers was observed to be a more intuitive control method for control. Turning will be mapped to hand motions to take advantage of the hand's natural ability to pitch left and right. Driving the car into areas that cannot be seen by the operator also demonstrates a need to install a wireless video camera system on the vehicle.

Technology Selection

The integral components of our project include an accelerometer, two MCU's, a wireless transceiver, and two flex sensors. Below is a brief list of the components we will need and our reasoning for choosing a certain product.

Accelerometer

The accelerometer will be placed in the glove to detect hand roll. This will signal the car to turn a certain direction.

Accelerometer	Cost	Ease of Use	Low Power	# of g's
ADXL 322	Free	High	340 uA@2.4V	2
MMA6271QT	Free	Medium	500 uA	2.5/3.3/6.7/10

Table 1: List of accelerometers considered in project design

When choosing an accelerometer, low power consumption was a big factor. The glove will be battery powered so our components should use up as little power as possible. Also, it was important to have an output impedance of less than 32 kΩ in order to properly interface it with the MCU's A/D ports. An analog accelerometer is preferred for this application because the continuous reading can be easily sampled by our MCU's A/D ports. The ADXL 322 from Analog Devices satisfied our requirements and has also been shown to work with various TI MCU's.

Transceiver

The transceiver will be used to send control signals to the vehicle from the glove.

Transceiver	Cost	Ease of Use	Configuring Difficulty	Range
XBee Pro	High	High	Low	High
XBee	Medium	High	Low	Low
CC2420	Free	Medium	High	Depends

Table 2: List of transceivers considered in project design

The regular XBee seemed to be a good choice at first, but we decided that its indoor signal range was not good enough. We didn't want our probe to be immobilized as soon as it turned a corner. In choosing the XBee Pro over the Texas Instruments CC2420, we attracted most to the low configuration difficulty as well as its ease of use. Although free is a powerful motivator to use a certain part, the CC2420 does not come ready to be used outside of the box. We didn't want to have to choose an antenna and other finicky passive components with our hands already full.

Microcontrollers
One MCU will be placed in the glove to interface with the accelerometer, flex sensors, and Zigbee transmitter. The second MCU will be installed on the car to interface with the Zigbee receiver and control the car's hardware. Table 2 shows the available options followed by the reasoning behind the final choice—the Texas Instruments MSP430F2619.

Processor	Cost	Programming	Functionality
Atmel 2560	Free	Medium	Medium-High
PIC	Free	Low	Low
MSP430F2619	**Free**	**Medium**	**High**
MSP430F2013	Free	Medium	High
Other	>0	High	High

Table 3: List of microcontrollers considered in project design

Initially we were leaning towards the MSP430F2013 by Texas Instruments. Unfortunately, we felt limited by its low pin count. Upon further analysis of the requirements, we decided that interfacing our components with an MSP430F2013 cousin—the MSP430F2619—would be a better choice. Since we are both fluent in assembly programming and familiar with C, the MSP430F2619's programming learning curve should not be a major hurdle.

Flex sensors
A flex sensor will be placed on the user's index finger to detect the degree of bending, which will correspond to the forward throttle. Likewise another flex sensor will be placed on the pinky finger whose motion will correspond to reverse throttle. Research was done on this part; however we have not been able to find a suitable device. This device should be 4" in length and thin enough to be taped to the finger of a glove.

Video Camera
This item is a less essential part of the design that will be added last, once the controlling scheme has been perfected. As a result a model has not been ordered yet.

Flowchart and Diagrams

Below (Figure 1) is a block diagram of the components that we will be interfacing for this project. Two TI MSP430's were chosen (rather than two different chips) to cut down the learning curve of picking up a new processor for the vehicle.

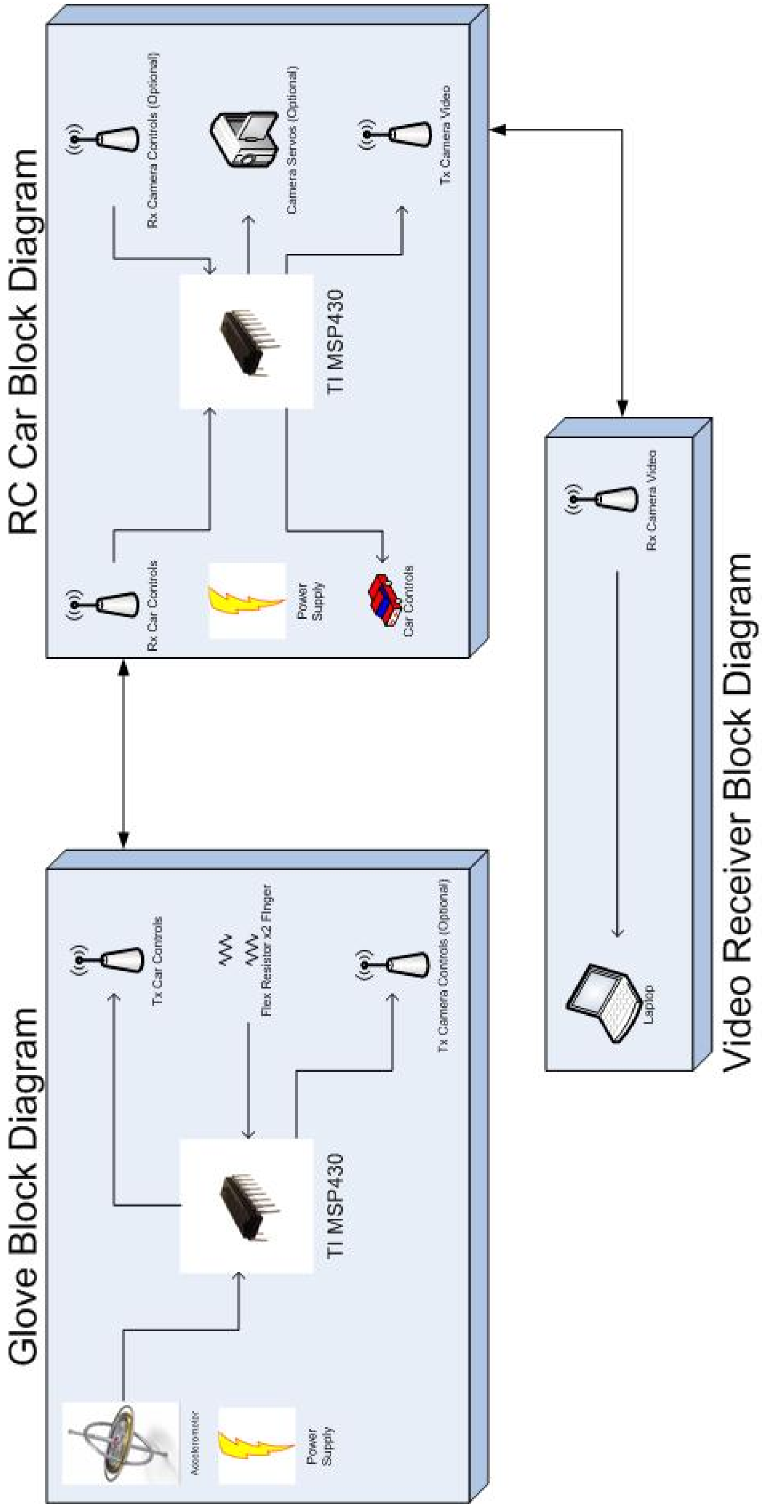

Figure 1: High level block diagram of components implemented in Project Peek-A-Boo.

Below is a data flow chart from the input (user input) to the output (the car's reaction) and the components that will be used to transmit this data in our communication system.

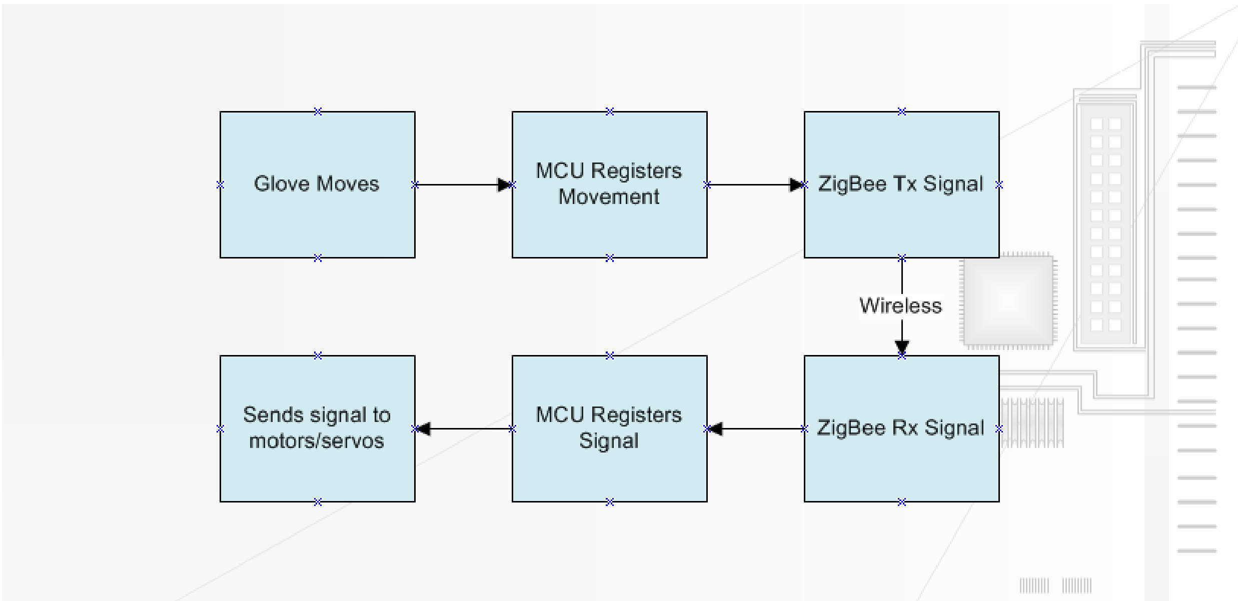

Figure 2: High level flow chart from input to output

Gantt Chart (Delegation of Duties)

There is much initial research that must be done to determine what parts are needed for the design. This includes opening the RC car and seeing what we have to work with. Once the background research is completed, many of the project components begin to parallel each other. Some parts may not be available through our lab and will need to be reordered throughout the semester or ordered for the first time. With this in mind, we plan to have other project tasks that can be worked on if we are left waiting. We have vigorously discussed the timeline and the project is expected to be completed according to this schedule. The distribution of the work among the team is also seen on the chart.

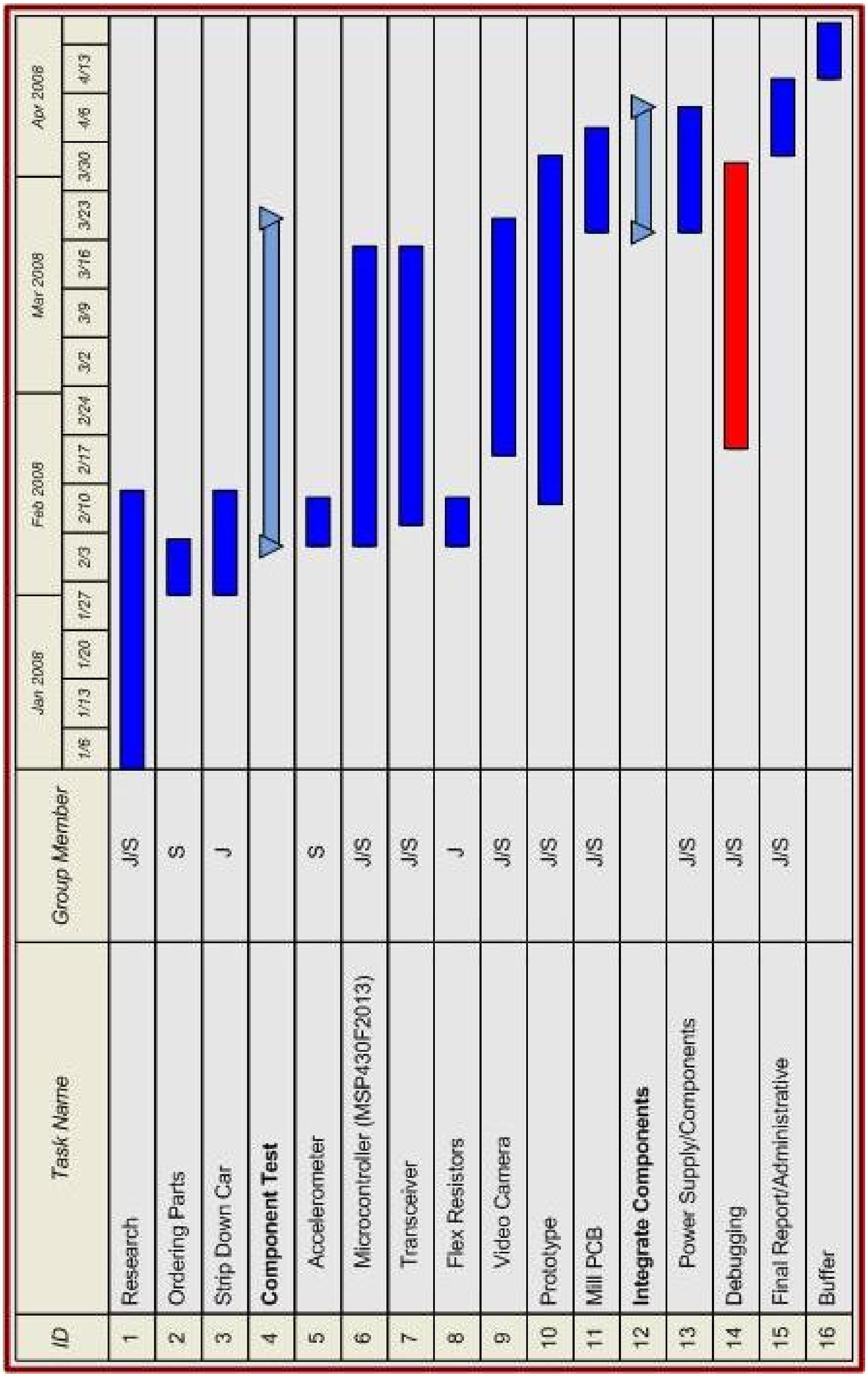
ID
Task Name
Group Member
Jan 2008
Feb 2008
Mar 2008
Apr 2008
1/6
1/13
1/20
1/27
2/3
2/10
2/17
2/24
3/2
3/9
3/16
3/23
3/30
4/6
4/13
1 Research J/S
2 Ordering Parts S
3 Strip Down Car J
4 Component Test
5 Accelerometer S
6 Microcontroller (MSP430F2013) J/S
7 Transceiver J/S
8 Flex Resistors J
9 Video Camera J/S
10 Prototype J/S
11 Mill PCB J/S
12 Integrate Components
13 Power Supply/Components J/S
14 Debugging J/S
15 Final Report/Administrative J/S
16 Buffer

Figure 3: Gantt chart timeline with group member workload. J= John Kurien, S= Santiago Gutierrez.