# Internet Controlled Smart Movable Platform
# Project Proposal

Team 46

Kecheng Liu
Yubo Liu
Yigao Shao
TA: Mustafa Mukadam

University of Illinois at Urbana-Champaign
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# 1.0 Introduction

### 1.1 Statement of Purpose

The goal of this project is to build a real-time, WIFI controlled virtual-tour vehicle that enables users to "visit" any location with WIFI connection. Many network-controlled vehicles exist on the market, varying from hobbyist models to commercial products such as the VGo from Verizon Wireless. However, none has a complete system that includes a robust backend (software) and a versatile front-end (hardware). These include automatic driving, path memorization, environment sensor, self-correcting/repairing network, and a functional website. The product we plan to develop is unique and will help revolutionize how people "visit" and view the world!

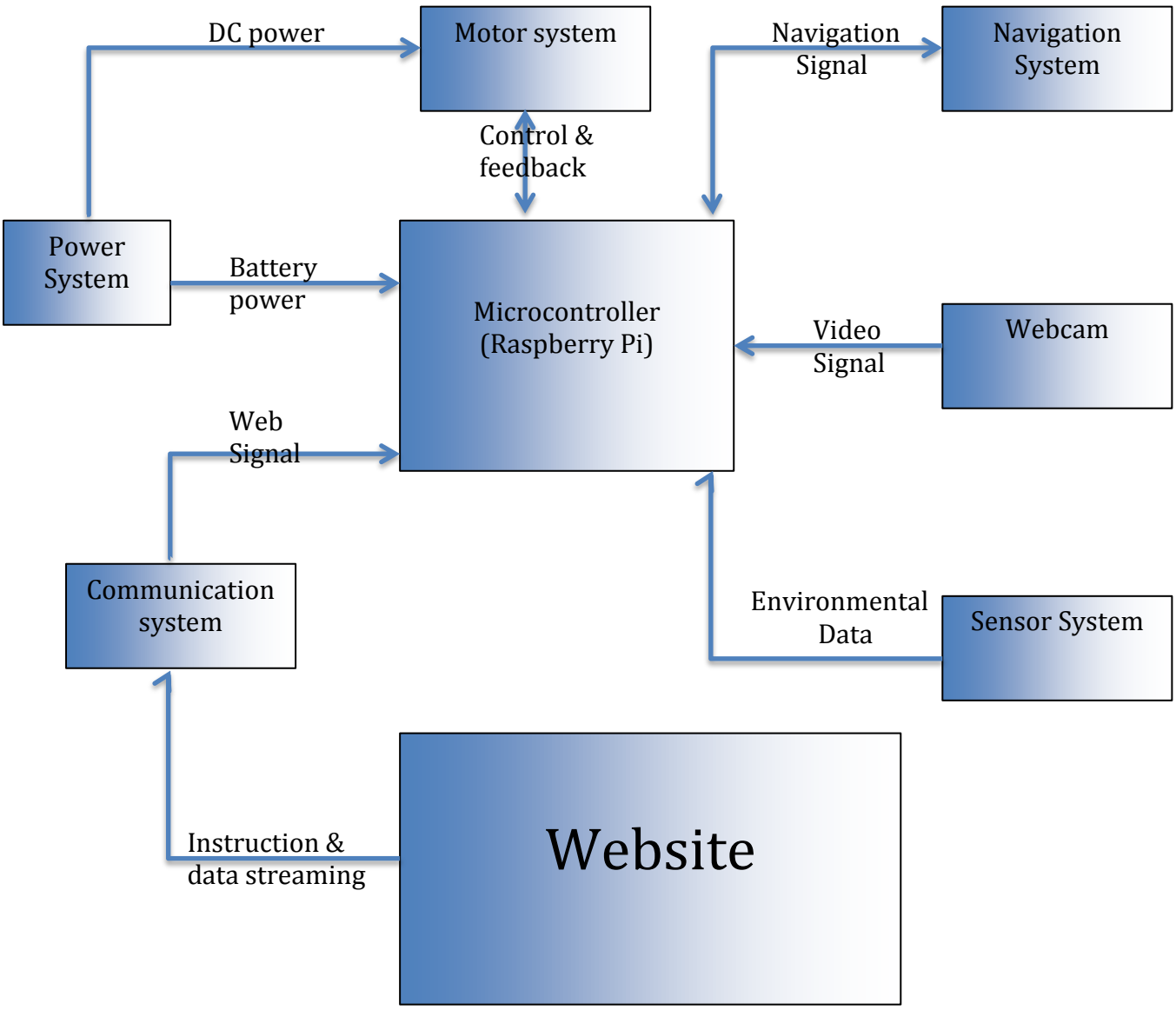
### 1.2 Objectives

In this project, we intend to create a complete virtual tour system that combines a robust network between our website and the moving vehicle (MV). In the backend, we will use a web server and a server on the MV to create a P2P connection between the user and the MV. Different users can safely control the MV from the users' computer. The user needs to create an account on our website, after which the user will be able to log in and take control of any idle MV. Considering the safety issue of the MV, we will implement an environment detector by using ultrasonic sensors. This allows our MV to automatically change speed and direction in emergencies such as seeing an obstacle. In addition, for friendly usage and control, a GPS will be installed on the MV to allow automatic controls and navigation. In summary, our project will have following features:

1. Travels in different directions and speed
2. A live video camera to provide vision
3. A website for users to log in, choose the desired car which is provided by a car owner and control
4. Collision avoidance system to protect our car from unpredictable hazards.
5. Four driving modes
    a. Full real-time manual control
    b. Programmed route control
    c. Automatic navigation via path memory to starting location
    d. Automatic control under GPS navigation.
6. Multi-person tour.

# 2.0 Design

### 2.1 Block Diagram




### 2.2 Block Description

#### 2.2.1 Hardware Blocks

Power System

The power for the vehicle, microcontroller and PCB's are separated. The vehicle is powered up by 6 AA batteries. The microcontroller is powered up by a USB connection battery. All PCB's are powered up by the 5V pin out and ground on microcontroller. All batteries are carried on the vehicle and rechargeable.

Moving Vehicle (MV)
The MV is a toy car and will be the platform for housing hardware components. It will be able to move based on the control of the user or by itself if in automatic mode.

Motor System
This unit contains two DC motors, H-bridge circuit and PWM circuit, all implemented in PCB.
Each motor has 0.49W rated power and controls the rotation on one side of the vehicle. H-bridge and PWM are the core elements to control the speed and direction of the motor rotation.

Webcam
A webcam with USB connection will be plugged into the microcontroller. The microcontroller will receive the vision and interact with website through data streaming.

Sensor System
A sensor system will be on the MV to for protection of the vehicle. An ultrasonic sensor methodology will be adopted. A total of six sensors will be used: two on the front, two on the back, one on the left, and one on the right. The sensor system will be able to detect obstacles up to 10 meters. It will help the MV to steer clear of obstacles when the MV is controlled by the user or by automation.

Communication System
This system will allow us communicate between the platform and the web server. We will use WIFI (when available). We plan to upgrade it to 4G network; a 4G USB plugin will be used. For the WIFI network, a WIFI adapter that can be readily plugged in will be used.

### 2.2.2 Software Blocks

Website/Server
Website will act as the interface between MV and users. It will allow users to control MV and give instructions. Data from Webcam will be streamed up to website and users will be able to have vision. A waiting list will be generated if multiple users want to access the same MV.

Microcontroller Unit (MCU)
The microcontroller will be the center of the whole system. It provides the connection between the network and the MV and manages the control and navigation of the MV. Our project requires a powerful MCU, so we chose Raspberry Pi. The MCU will need to process data from the video camera, sensor data, navigation system, power system, and the motor system.

## 2.3 Performance Requirements

- WIFI range up to 50 meters indoors and 100 meters outdoors
- Webcam should provide at least 10 frame/s at resolution 480X320 to guarantee fluent vision (lagging less than 1s ±0.1s)

- Sensors able to accurately detect obstacles up to 1 meter ±0.1 meters
- Motor should have following performances:
  - Operate within reasonable temperature at maximum duty cycle (10 degrees ±1 degrees above ambient Temperature)
  - React to control signal within reasonable lagging tolerance (less than 0.5s ±0.1s)
  - Ability to operate continuously at 90% duty cycle
- Batteries should be able to support 45 minutes ±10 minutes
- GPS should be able to accurately track the moving platform (within range of 5 meters)

# 3.0 Tests and Verification

### 3.1 Verification

Sensor Module Test:

The sensors are used to detect obstacles at the 4 sides of the MV. So we will test the module by placing objects in front of the sensor at distances up to 1.5 meters at 0.05 meter increments to check for accurate detection. We will use small LED lights as an indicator when detection is made. Then all six sensors will be tested on the MV while the MV is moving to test for accurate detection. An accurate detection means that the sensor detects an object exists multiple successes.

MCU Module Test:

The microcontroller is the central brainpower of the system. To test this module, we need to check its ability to handle data streaming in and out. Data from the sensor module is vital. We will manually input data to the MCU (i.e. a '1') and check for a corresponding output. The same test can be performed for other modules that are connect to the MCU.

MV and Motor Module Test:

To verify operation temperature, we will use thermocouple to determine casing temperature at maximum operation. Simulate duty cycles from zero to maximum to simulate motor controls given by microcontroller. Measure time after control signal is sent by user to verify reaction time.

Communication Module Test:

The WIFI adapter will communicate between the on-board server and our server. Its range is important. To test its range, we will bring the WIFI adapter up to 50 meters to check its signal strength.

GPS Module Test;

The GPS allows for locating the MV and automatic driving. To test its locating ability, we will place the MV at a known location (longitude and latitude) and verify its correctness via the data sent back. To check its automatic driving ability, we will set the car to navigate automatically under GPS navigation between two known locations. Then we will verify the MV's final location.

### 3.2 Tolerance Analysis

The delay time between the website to the MV is the most important factor of our design. There will exist delay time between the MV and the website as well as delay time between the microcontroller and its attached components. Having immediate response from the MV is desired for the users' experience. For example, if a user enters a command on the website to navigate the MV forward, the command should reach the MV and performed by the MV within one second or less. In addition, having a short delay time between the microcontroller and its component will ensure the safety of the MV. For example, if the sensors see an obstacle, the MV should respond quickly to avoid potential hazards.

# 4.0 Costs and Schedule

### 4.1.2 Labor cost

| Name | (Rate/hour)×(2.5)×(Total Hours) | Total Price |
|---|---|---|
| **Yigao Shao** | $\$30/hour \times 2.5\ month \times 150\ hours/month$ | $11,250 |
| **Kecheng Liu** | $\$30/hour \times 2.5\ month \times 150\ hours/month$ | $11,250 |
| **Yubo Liu** | $\$30/hour \times 2.5\ month \times 150\ hours/month$ | $11,250 |
| **Labor total** | | $33,750 |

### 4.1.2 Part Cost

| Part Name | Description | Quantity | Price/Unit | Total Price |
|---|---|---|---|---|
| **Mr. Basic** | Vehicle | 1 | $30 | $30 |
| **Raspberry Pi** | Microcontroller | 1 | $35 | $35 |
| **GPS** | | 1 | $30 | $30 |
| **Webcam** | | 1 | $50 | $50 |
| **Ultrasonic Sensor** | | 6 | $5 | $30 |
| **AA battery** | Rechargeable | 6 | $3 | $18 |
| **IC & transistors** | | | | $30 |
| **Resistor, caps** | | | | $20 |
| **PCBs** | Fabricated by Part Shop | 3 | $0 | $0 |
| | | | Total | $243 |
| | | | | |

### 4.1.3 Total Cost

| | |
|---|---|
| **Part Cost** | **$243** |
| **Labor Cost** | $33750 |
| **Total Cost** | $33993 |

### 4.2 Schedule

| Week | Yigao | Yubo | Kecheng |
|---|---|---|---|
| 1/14 | Discussion about project ideas, talk about ordering parts | Discussion about project ideas, talk about ordering parts | Discussion about project ideas, talk about ordering parts |
| 1/21 | Discussion about project ideas<br>Set up server and domain | Discussion about project ideas<br>Research about radar and ultrasonic system | Discussion about project ideas<br>Research about H-Bridge and PWM |
| 1/28 | RFA and proposal | RFA and proposal | RFA and proposal |
| 2/4 | Set up video streaming on website, RPi I/O configuration, order parts | Get PWM and H-Bridge onto PCB, order parts | PWM and H-Bridge schematic and design, order parts |
| 2/11 | Interfacing between the software and hardware | Ultrasonic sensor design | Research about GPS |
| 2/18 | Implement the speed control's software | Put ultrasonic/sensor system on PCB | Implement GPS |
| 2/25 | Design Review | Design Review | Design Review |
| ¾ | Finish up internet reliability problem | Test and verify sensor system | Test and verify GPS system |
| 3/11 | Individual Report | Individual Report | Individual Report |
| 3/18 | Spring Break | Spring Break | Spring Break |
| 3/25 | 4G implementation | 4G implementation, Combine hardware with software | 4G implementation, Combine hardware with software |
| 4/1 | Debug/Test | Debug/Test | Debug/Test |
| 4/8 | Final Paper, Debug | Final Paper, Debug | Final Paper, Debug |
| 4/15 | Final Paper, prepare for demo and presentation | Final Paper, prepare for demo and presentation | Final Paper, prepare for demo and presentation |
| 4/22 | Demo | Demo | Demo |
| 4/29 | Presentation | Presentation | Presentation |
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