Monday, January 21, 2008

Patrick Leung
School of Engineering Science
Simon Fraser University
Burnaby, B.C. V5A 1S6

**Re: ENSC 305/440 Project Proposal for a Home Care Robot**

Dear Mr. Leung,

In the attached document, *Proposal for a Home Care Robot,* we introduce our idea of building a robot for the purpose of completing general home care tasks remotely via Internet.

The proposal shows overview of our robot system, the problems we want to solve and our proposed design solution. A plan how we manage to reach our goal is also scheduled.

We are a group of three highly motivated SFU students with valuable industrial experiences. Rick Wong and Jessica Sun are majored in Electrical Engineering while Feng Ye is majored in Computer Science. We are all interested in making our daily life easier and better by applying the most useful technologies. If you have any concerns or questions regarding this project, please contact us by email, pr-440@sfu.ca.

Sincerely,

Rick Wong
President and CEO
*PRAlpha Robotics Inc.*

Enclosure: *Proposal for a Home Care Robot*

# PRAlpha Robotics

# Proposal for a Home Care Robot

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**Version : 1.0**

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**Module : Overview**

**Created by Rick Wong on : Jan. 16, 2008**
**Last Update by : Rick Wong on : Jan. 21, 08**

## Proprietary and Confidential

PRAlpha
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# Document Information

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# Revision History

| Issue | Author(s) | Date | Description |
|---|---|---|---|
| 0.1 | Rick Wong | 2008/1/16 | ✧ Creation<br>✧ Executive Summary |
| 0.2 | Jessica Sun | 2008/1/18 | ✧ Introduction<br>✧ Design Solution<br>✧ Add System Overview Sketch<br>✧ Possible design solution |
| 0.3 | Rick Wong | 2008/1/18 | ✧ System Overview<br>✧ Resources<br>✧ Budget & Funding<br>✧ Schedule |
| 0.4 | Feng Ye | 2008/1/20 | ✧ Letter of transmittal<br>✧ Proposed design solution<br>✧ Team organization and profile |
| 0.5 | Rick Wong | 2008/1/20 | ✧ Conclusion |
| 0.6 | Jessica Sun | 2008/1/21 | ✧ Formating<br>✧ Sourses of information<br>✧ References |
| 1.0 | Rick Wong | 2008/1/21 | ✧ Final editing |

## Table of Content

# 1 Executive Summary

People concern about their home and pet in situation they need to be away for days, weeks or even months. Traditionally, we bother our friends, relatives or have to hire a person we can trust to take care of these issues for us.

In recent years, many devices have been developed to make our lives easier. For instants, we have home security system, which contains IR sensors, door alarm and maybe some cameras to prevent break-in; we also have automatic pet-feeder to provide our pet enough food. Some people even put IP-cameras on chairs and adjust them so that we can monitor whether there is any water leaking in the kitchen or hot water tank.

However, we have to shop around for several devices and services. Moreover, some of the existing devices do not work very well under variety situations. For example, people might worry about their plants when they are absent from home. Although auto-watering systems are very commonly used in many houses, people have difficulties of scheduling the watering period due to the unpredictable weather. In addition, we also have to learn how to use every individual of these "high-tech" devices, which may not be that enjoyful. Obviously, the market lacks a general solution to this type of problems.

PRAlpha Inc. proposes developing a mobile robot, iBonni, which acts as an interface for household between home and remote site. iBonni can be controlled by an easy to use web GUI (Graphic User Interface) via Internet. User's command could be sent back home to control devices for watering plants, feeding pets, switching lights or opening windows. Furthermore, its sensor system can report the real time status of home, for example, the temperature. People can view their home though iBonni's eye, a night version camera or can even talk with their pets via speakers and MIC. Households can choose to purchase or rent this robot from PRAlpha Inc. In either way, PRAlpha Inc. and iBonni will ensure the users a "bon voyage"!

PRAlpha Inc. is formed by two fourth-year Electronics Engineering students and one Computing science student. Members are experienced in areas of microcontroller, signal processing, real-time embedded system and both high level as well as assembler programming. In addition, members' rich computing knowledge and networking skills will also contribute to the successes of this product. The engineering cycle for this project including research, design, construction and integration will span a 13-week period as the scheduled completion of an operational prototype. The entire project is budgeted at $1500, which will obtain from a variety of sources.

# 2 Introduction

From the Crime Statistics report, although the rate of break-ins in Canada in 2006 was the lowest in over 30 years, there were still 250,000 break-ins reported of which almost 60% were to residences.[1]   Home secure system, which contains various sensors pre-located in home, can efficiently reduce break-ins.   However, it cannot cover other emergencies such as water and gas leaking.   "In 1996, a major North American Insurance Bureau reported that the number of claims from water damage to homes ranked third (19% of all claims), but ranked first in total dollar damage at over 50%. Some surveys show the number of flood-related claims could be much higher, as many go unreported".[2]   More importantly, travelers worry about pets or plants and may want to have a look by themselves.

The objective of our project is to build a multi-functional robot platform which will be capable of manipulating objects and allows future add-ons and user-definable functionalities. For home secure usage, house owners can remotely access robot from anywhere via internet and drive it to monitor their house through night vision camera.   Using the powerful built-in sensor system, our robot can take the roles of smoke detector, flood detector, temperature detector, etc and generate alert in case of emergency.   Besides security applications, our robot is also able to operate other home devices via IR transmission as a universal remote controller which can be accessed by house owners through network.   Therefore, our product can achieve various functionalities.   For instance, with speaker and MIC on robot, house owner can even talk and play with their pet.

On the way of achieving this goal, we can apply the knowledge we learned in many ENSC courses to the real world, such as Input Capture and Output Comparator, sensor detection and motor control with PWM, microcontroller I/O and memory access, real-time system with interrupt handler and priority control, PCB and feedback control system designs, as well as communication interface with PC.

The main challenges of this project are the power supply and positioning.   For power supply, besides using light-weight and fast-charge batteries, we could develop a self charge function for our product.    Positioning is a big issue for today's robot, both accuracy and cost efficiency should be considered.   Meanwhile, the challenges and chances of learning different areas of micro-controller are the main reasons of choosing this topic as our project.

This proposal for PRAlpha Inc. outlines a system overview for our product, iBonni, and our proposed design solution, budget and funding considerations.   This proposal will introduce our company profile and our team organization and give a schedule and resources information for our project.
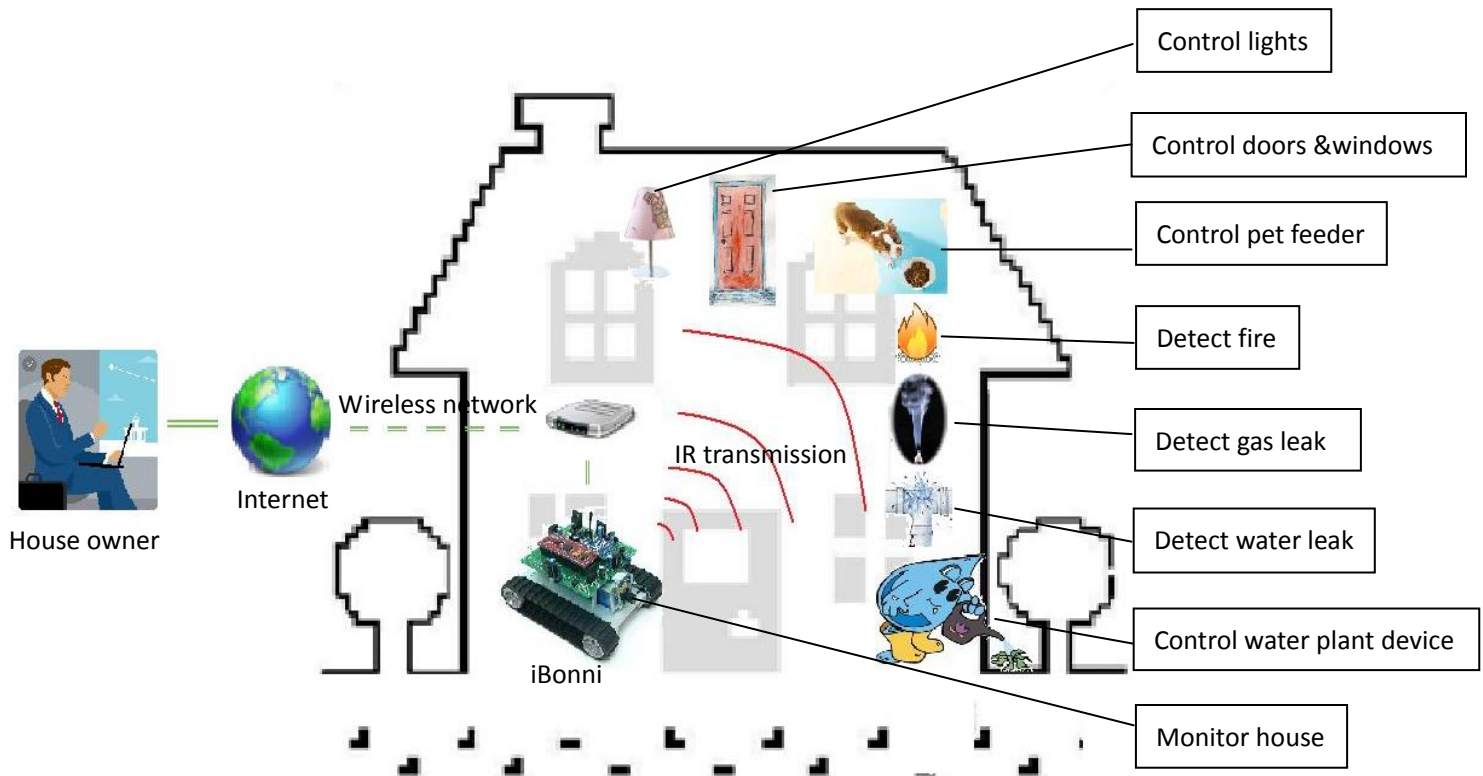
# 3 System Overview

## 3.1 System Sketch



Figure 1: System Sketch

This robot, iBonni, is a center command device which interface home and remote site.   As shown in Figure 1, households can remotely control and monitor iBonni by accessing a web based GUI in favor Internet Brower.   The sensor system and cameras installed on iBonni will provide the real time status and feedback to the user.

The user can choose to be text messaged on his cell phone in cases of fire, gas or water leaking emergency situations.   On the other hand, iBonni can pass the command inputted in GUI to other home devices such as pet feeder, plant watering system and light switches via IR transmission.

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## 3.2   System Block Diagram



PC

On Board

Web GUI Server

CMM

I²C  BUS

UDM          SCM          ACM

ACK

Results

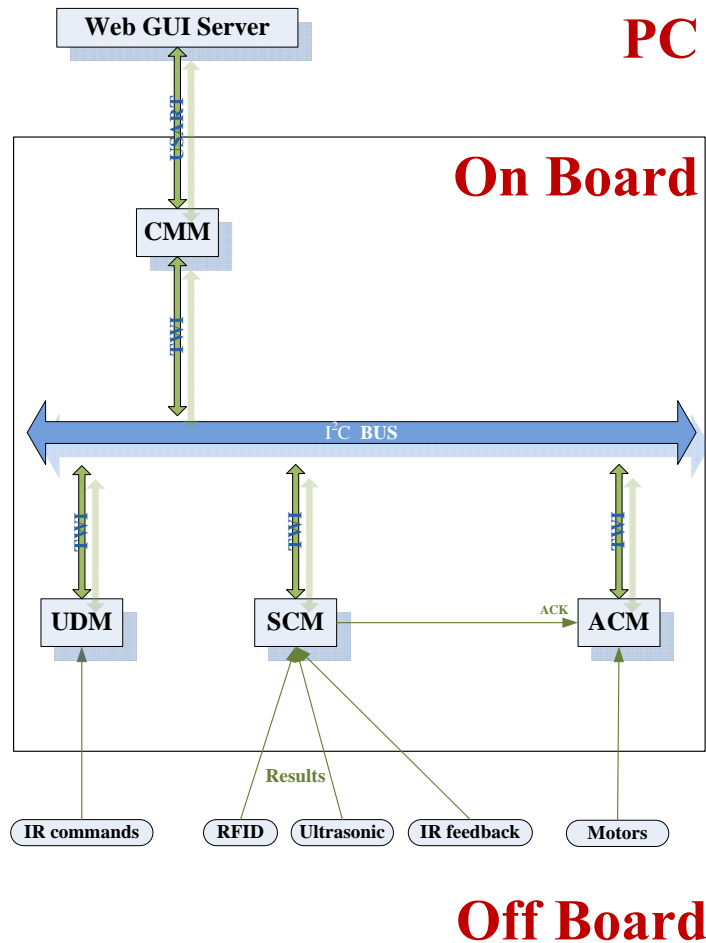IR commands      RFID    Ultrasonic    IR feedback      Motors

Off Board

**Figure 2: System Block Diagram**

The core features of this robot include home monitoring, pets and plants caring and other user definable functions on extra micro-controller chips.   As shown in Figure 2, it contains a nano PC on which the web GUI server runs, a set of AVR ATMega168 micro-controllers that each of them form a module (with possible redundancy design on critical modules), and peripherals such as sensors and motors.   USART on USB port will be used to communicate PC and the Center Manager Module (CMM), while I2C BUS (TWI) will be used between the CMM and other sub-modules.   Our target is to build a generic platform which allows future add-ons and user-definable functionalities.

# 4 Design solution

## 4.1 Possible design solution

- **ADT Home Security Systems**

It can only monitor break-ins from several fixed locations and is unable to distinguish most miss-triggered cases since sensors are not intelligent enough. For example, wind may come in through the window gaps and blows curtain to trigger the IR motion sensor. Here is a true story: the home security alarm went off when a friend was doing midterm at school. As he had been told in the phone, the company could not call the police unless he is there. So, this friend had to borrow a car and drove 30 minutes back home. It ended up to be a miss-triggered case again. For sure some existing security companies can send someone to check the status if you pay for much more advanced plan and sign forms to release your privacy.[3] People prefer to monitor the inside of home by their own rather than other strangers.

- **XCam2 Camera**

Through some cameras, videos of monitored areas can be transmitted to you simultaneously. The drawbacks of fixed security cameras are obviously. They are only able to monitor a narrow pre-defined area and easily to be blocked by objects. If you want to view random places in your home, it will be very costly and may ruin your indoor decoration. [4]

- **FloodStopper water leaking detector**

As mentioned before, water damage ranked first in total dollar damage at over 50% in year 1996. Some existing companies such as FloodStopper provides automated water leak detection solutions and the customers also receive 10% discount from Westland Insurance. However, their solutions can be very costly. For instant, a fixed single zone detection FloodStopper package will cost up to $689.95 CAD easily.[2] Obviously, it is not an economic choice for monitoring potential water leak in home since multi zones need to be monitored.

- **Automatic Pet Feeders**

Automatic pet feeders are timer-based pre-defined devices and always dispense the exact amount of food at exact time every day. They do not compensate for leftover food neither they can handle unexpected circumstances like the pet is sick. They are only inflexible solutions. [5]

For home care purpose, there are many existing products (such as pet feeder, auto water plant machine, fire or leaking detectors, etc) can provide previously defined actions but all of these devices are provided separately and unable to manager unexpected situations.

## 4.2 Proposed design solution

We propose a general solution for people who need to perform simple monitoring and controlling from remote sites to their home. Our product, iBonni, acts as your agent with night vision and ability of controlling other home devices via IR transmission. As internet access is provided, you can virtually be at home. In case of lacking internet, iBonni also can provide emergency text messages to your cell phone device. We are expecting that insurance companies shall give our users certain discounts since the risk of home damage reduced after using our product.

Main features of our product iBonni:

- **Mobility**
  iBonni has a tank-belt chassis, so that it can move from room to room while keeping the camera stable. Power is supplied by 2 step-motors controlled by a power management microcontroller.

- **Vision**
  Vision is the most important way of human perception. iBonni has a web camera connected to a video stream server, so that the user can watch their home by the video with a web browser of the client program from us.

- **Control**
  iBonni is equipped with a preprogrammed remote controller. A graphic user interface of the remote controller is provided, so that the user can use the remove controller by a mouse click and the commands would be sent to the corresponding device at home.

- **Server**
  A video stream server is installed on the nano-computer on the iBonni, it provide web services like the video stream, web start of the graphic user interface client, etc.

- **Power**
  A powerful and light weighted Li-ion battery unit provides power for the chassis motors, camera, on board computer and other devices. The battery should last 3 hours after a full charge.

# 5   Sources of Information

We can acquire information from various resources.   The most useful resource is internet. We will use Google to collect most of the required information for our researches.   There are some of the valuable websites listed below:

- **VIA Technologies Inc. (nano-ITX motherboard)**
  http://www.via.com.tw/
- **Atmel Corporation (Microcontrollers)**
  http://atmel.com/
- **Mini-Box (PC power supply)**
  http://www.mini-box.com/
- **Digi-Key Corporation (electronics parts)**
  http://digikey.ca/

Library is another important resource for our project. We will borrow some course textbooks and tool books from SFU library.   In addition, many faulty of engineering school at SFU are currently involved with their specified roles, their contact information are listed here: [6]

- **John S. Bird** (*Underwater robotics*):
  bird@cs.sfu.ca, (Professor)

- **Patrick Leung, PEng** (*CEO and CFO*):
  pleung@cs.sfu.ca, (Senior Lecturer)

- **Steve Whitmore** (*CIO and VP Human Resources*):
  whitmore@cs.sfu.ca, (Senior Lecturer, Communication Program Coordinator)

- **Brad Oldham** (*VP Engineering*):
  boldham@sfu.ca, (Teaching Assistant)

- **Jason Lee** (*VP Engineering*):
  leeaj@sfu.ca, (Teaching Assistant)

The information of our project is accessible from our website and mail list:

- **PRAlpha (PRAlpha Inc.)**
  http://pralpha.info/

- **PRAlpha team mail list:**
  pr-440@sfu.ca

# 6   Budget & Funding

## 6.1   Budget

Table 1 outlines the components and estimated cost of our project.   To ensure the project process within the budget, a 15% unpredictable overshot has been added to the total cost.

| Equipment | Estimated Cost |
|---|---|
| Nano-ITX PC motherboard | $ 484.50 |
| Microcontroller | $90.90 |
| Wireless Networking | $61.56 |
| Power supply and battery | $200.00 |
| Chassis | $100.00 |
| Storage of PC | $100.00 |
| Sensors (Ultrasonic, IR, Temperature, gas, water, camera) | $250.00 |
| Stepper Motor | $13.22 |
| Miscellaneous (LED, switch, cable, IC chips) | $50.00 |
| Unpredictable | %15 |
| **Total Cost** | **$ 1553.86** |

Table 1: Tentative Budget

## 6.2   Funding

Table 2 shows the source of funding that are available to our project.   Personal investment is the main source and will cover the lacking of other funding resources.

| Source | Estimated funding |
|---|---|
| 440 Course | $150 |
| ESSEF | $300 |
| Personal Investment | $1046.36 |
| **Total Funding** | **$ 1553.86** |

Table 2: Funding source

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# 7 Schedule

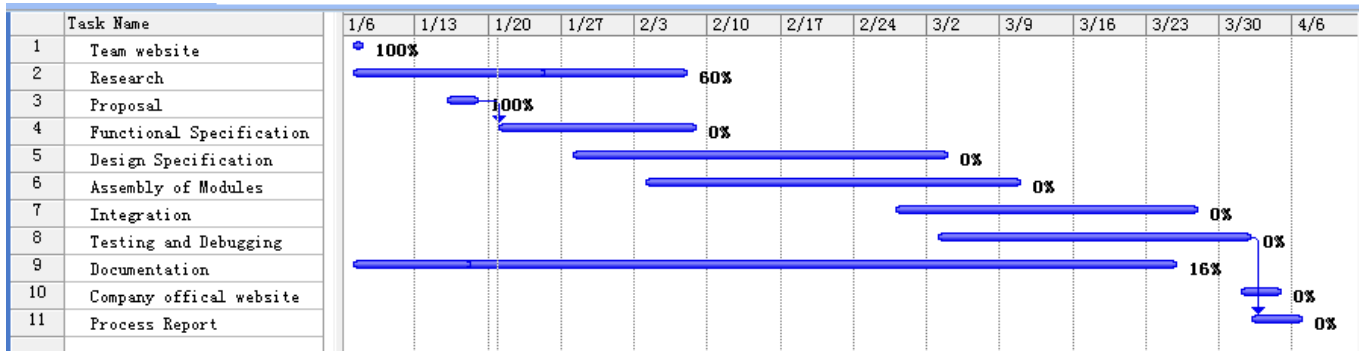Figure 3 and 4 show the schedule and milestone of our project.



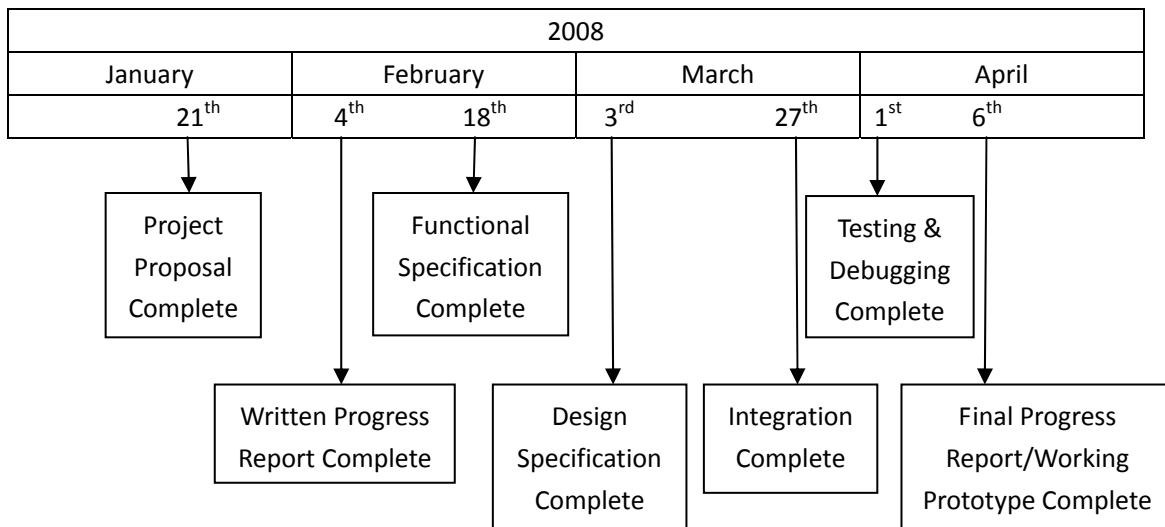**Figure 3: Gantt chart of tasks with their expected duration**



**Figure 4: Milestone Chart**

# 8 Our Team

## 8.1 Organization

PRAlpha Robotics Inc. consists of two electrical engineers and one software engineer: Rick Wong, Jessica Sun, and Feng Ye.   The team has balanced hardware and software knowledge and experiences which ensures the success of software development and hardware design, integration and testing.   Our creative thinking and passion will lead us to achieve the goal of making daily life easier with the modern automation technologies.

PRAlpha corporate is formed by two major development departments: hardware and software.   Jessica Sun leads the hardware department, which is in charge of PCB and chassis designs.   On the other hand, Feng Ye leads the software department, which is in charge of user GUI and application designs.   Under limited human resources, members are shared in these two departments.

Rick Wong, President and CEO, is in charge of the overall progress of the project and also responsible for funding and human resource aspects.   Jessica Sun, CFO, will manage the budget and resolve financial issues.   Feng Ye, CTO, is in charge of the technical operation and shall acts as a "Devil's advocate" to suggest alternative solutions and rise opposite options.

## 8.2 Profile

- **Chief Executive Officer:     Rick Wong**

Rick has the ultimate responsibility for all aspects of the company, including finance, product engineering, marketing, and business development.   The management team reports directly to Rick.   Rick is also responsible for funding resources.   During his studies at Simon Fraser University, Rick has acquired an excellent knowledge of both software and hardware design.   While working for Glentel Inc. as a system administrator in the IT team, Rick practiced his hardware skills and gained the capability of deploying different kinds of network services.   Worked for Redback Networking Inc. as a software developer in the platform team, he has not only future improved his networking knowledge, but also obtained hands-on experiences on both programming and debugging.

- **Chief Financial Officer:     Jessica Sun**

As a key member of the management team, Jessica is responsible for the business strategy, managing and setting all aspects of the company's financial and administrative direction within key functional areas, including finance, and investor relations.   Jessica did one year Co-op recently as software testing engineer at Redback Networks Inc. and gained valuable hands on experience and knowledge in network programming and software development and testing.   These skills make her an asset to PRAlpha and its continued success.

- **Chief Technological Officer:     Feng Ye**

Feng is responsible for overseeing the company's research and development, maintaining product standards, and developing the technological strategy for the company.   He also guides the company's investments in advanced research and development of its patent portfolio.   Feng is an experienced software engineer with strong background in electrical engineering.   He is good at graphical user interface design and implementation and familiar with low level programming on microcontrollers.

# 9   Conclusion

The mission of PRAlpha Robotics Inc. is to make people's life easier when they need to be away from their home and pets.   By applying the modern automation technology, we provide a general solution to varieties of home cares while reduces the potential damage on things we treasured.    By choosing our product, people experience a reassuring journey.

Our proposed mobile robot is more cost effective and requires short learning curve than similar existing products in the market.   More importantly, users have more freedoms of obtaining the current status and providing timing controls.

We have demonstrated system overview in details and presented the advantages comparing to the existing solutions.    We have analyzed project's budget and potential funding sources. We have an excellent team whose members will donate their strengths and energy to achieve our goal.   We will dedicate to the accomplishment of this project within the scheduled time frame.

## 10  References

1.  Crime Statistics in Canada, 2006, *by Warren Silver*
    http://www.statcan.ca/english/freepub/85-002-XIE/85-002-XIE2007005.pdf

2.  FloodStopper
    http://www.a-leak-detector.com/

3.  ADT Home Security
    http://www.adt.ca/en/residential/products/packages/

4.  The Best Security Device for Home or Biz
    http://www.x10.com/key_products/security-device.htm

5.  Automatic pet feeder of Choice
    http://www.perfectpetfeeder.com/

6.  People & Contact Information
    http://www.ensc.sfu.ca/~whitmore/courses/ensc305/