A.L.I.S.

Automated Learning Intelligence System
Developed by Jared Broad,
Year 10 (Form Four)
Domestic Learning Robot
First Started Designing on 11/98

"A.L.I.S."

"The road to success is always under construction"

BluePrint

Introduction

Robotics is a use of a wide range of technologies. In order to build a robot you must also build power supplies, motors and gears for motion, sensors and if wanted design Artificial Intelligence.

Robotics is an interesting hobby with almost unlimited additions that can be made, who knows what might be developed in the next 100 years.

History

The history of robots starts with the Ancient Greeks who made moveable statues. Then a bit later on a Greek engineer made organs and water clocks with moveable figures.

The definition of a robot is a computer-controlled machine that is programmed to move, manipulate objects, and accomplish work while interacting with its environment. Robots are able to perform repetitive tasks more quickly, cheaply, and accurately than humans. The term robot originates from the Czech word *robota,* meaning "compulsory labour." It was first used in the 1921 play *R.U.R.* (Rossum's Universal Robots) by the Czech novelist and playwright Karel Capek. The word robot has been used since to refer to a machine that performs work to assist people or work that humans find difficult or undesirable.

The concept of automated machines dates to antiquity with myths of mechanical beings brought to life. Automata, or manlike machines, also appeared in the clockwork figures of medieval churches, and 18th-century watchmakers were famous for their clever mechanical creatures.

The robots that you and I know today have only been around for the last 30 years, the progress made is easily worth 100 years. Robotics is soon going to become a general thing in the home. Then soon after that there will be intelligent machines that learn off what you say.

Aim

My dream and goal over the next 3-5 years is to create a mobile robot. It will be able to speak and reply to speech. The onboard light, temperature and humidity sensors will keep records of the area around it. Once the basics have been sorted out it shall be able to learn from experience and follow instructions. For protection of ALIS there will be an electric shock device and maybe a laser cannon.

Later I will add on a arm with touch sensors. After a period of time Alis will have learnt new words and actions and a screen to observe what comes and goes when trouble-shooting. Stereo vision and pattern recognition will be essential for A.I.

Standards to meet

The goals I have for ALIS are high. I know that in order to achieve these goals I must work hard and diligently, though it will pay off in the end.

- Mobile:- Move at walking pace, 0.5 to 1.5 meters per second(m/ps)
  Achieved by windscreen wiper motors

Controlled by MCB(Motor Control Board), this also includes steering control

- Impact Collision Detection:- Detect an impact coming and avoid it
  Controlled by ICDU 1, 2, 3...etc (Impact Collision Detection Units)

Response time = 0 = High priority

- Weather Sensors:- Sense the weather and light conditions
  Main board is WS(Weather Station)

Response time >10 min = Low priority

- Protection unit:- Activates electric shocking device
  Control board SDU (Self Defense Unit)

Response time > 1min = High - medium priority

- Manipulator:- Arm to change external environment
  Control device is the EMCU(External Manipulator Control Unit)

- Video Cameras:- Provides sight information to the mother board.
  Response time = 1 second = High Priority

Cameras short-hand = VC1, 2. Control Circuit = ESDC (External Sight Device Control)

- Power Supply:- Supplys the power to all the circuits and motors
  Control Device = LAP1. Response time = 2 min = Low priority

Needs the switch the whole robot off by itself. No self-power up is allowed for obvious reasons

- Interface Circuits:- These interface between the computers ports and the external environment
  No control device. Labled PIOI 1, 2, 3, 4, etc. (Parallel Input/Output Interface)

- Gound Sensors:- Scans the ground to see any drops ahead
  Response time = 0 = High priority

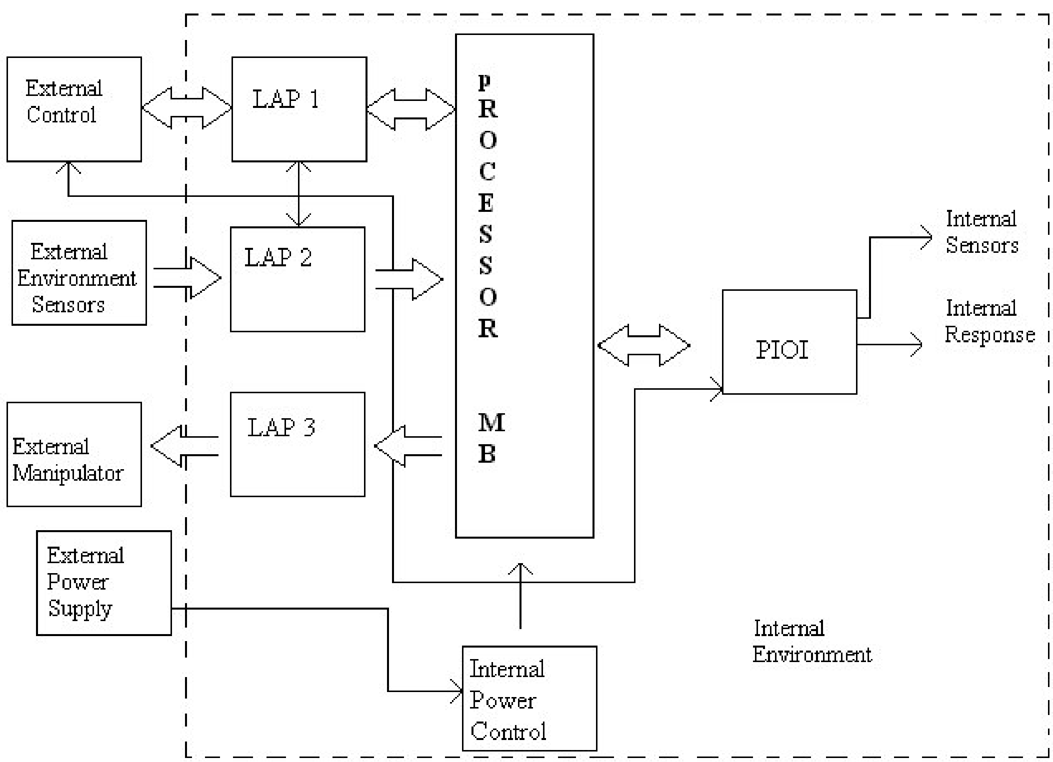
Circuit Boards - GVM 1, 2, 3, etc.(Ground Variation Meter)

- Amp Board:- To amplify speech and other voises to be heard at a comfortable level depending on the noise around it
  Labeled - ACU(Amp Control Unit), VCU(Volume Control Unit)

- Communication:- Computer need to be constantly communicating between themselves, using COM ports, passing status information.

System Block Diagram

This diagram shows the layout for control and computation of the electrical system. All electrical devices that have contact with the outside word have a similar diagram.



System Block Diagram

The processor will be a set of 3 laptops and 1 motherboard. They act as 1 computer because they will be in constant communication. Sending data through the

COM ports about various functions that need monitoring. Laptop 1(or LAP1) is the drive laptop. It controls the motors, power on LED, power control - when it needs turning off, all impact switches and the joystick input. Laptop 2 is the sensor laptop; it will monitor the sensors such as weather, light, battery, tilt, ground variation, sound level and temperature. Laptop 2 (or LAP2) will be in constant communication with LAP1 as it passes the ultrasonic sensors information on to be used for long-range object detection. Laptop 3 (or LAP3) is the manipulator laptop. This controls the arm and speech generation, which are big tasks in themselves and require a large number of inputs and outputs. The motherboard not only acts as a intersection for communications but also does the vision recognition processing.

Laptop Requirements

The requirements I have for the laptops are quite large, they need to be fast, small and have a good port, but along with this here are the details of the laptops requirements;

LAP1; - Drive

Motor Control, Speed Control, Impact Switches, Power Control, Read joystick input,Recieve data from the COM port

LAP2;- Sensor

Tilt sensor, Groung Variation Meter, Humidity sensor, Light sensors, Battery sensor, Sound Meter, Temperature sensor, Constantly communicating with motherboard and LAP1

LAP3;- Manipulator

Arm - 4 stepper-motors, 8 outputs per stepper-motor, Total of 32 outputs needed Communicating with motherboard

Mother Board(MB);- Brain

Video Image Processing, Communicate with LAP1, LAP2 and LAP3, A.I. Programming;- 2 - 4 GB of Hard Disk, Ultra Fast Pentium Chip

Triangle Hierarchy

Alis will have a triangle hierarchy arrangement for programming. Various inputs will have a higher priority than others, this means that they will be scanned and checked on regularly. Here is the hierarchy arrangement for Alis:

1st Priority: - Impact Sensors
Joystick Input
Keyboard Input
Low Battery Alert

2nd Priority: - Protection
Voice Commands
Ultrasonic Transducers
Monitor External Environment Sensors
Keep Motors going
Speed Control
Amp Control

3rd Priority: - Pre-programmed tasks
Speech Generation
Speech Recognition
Map Surroundings
Sight Recognition

Chassis

Requirements

This chassis needed to fit a lot of requirements. It needed plenty of room to improve and adjust. But most off all it need to be maneuverable. It also needed to be light a hold a lot of equipment. Easy to work with is a bonus too.

Statistics

- Made of 0.9mm thick aluminium.
- Cars are made of the same thickness aluminium.
- There are 3 levels;- Ground Floor, Level 1, Level 2.
- Uses approximately 2.4m * 1.5m of sheet aluminium.
- Weighs approximately 3kgs.

Chassis Contents

Item	Volume	Weight	Clearance
	L * W * H(in mm)		
Battery	181 * 76 * 16.7	9 Kg	20mm
Motors- drive	150 * 100 * 80	2 Kg	50mm
arm	10 * 10 * 10	2 Kg	50mm
Chassis	-	3 Kg	-
GVM	50 * 50 * 50	160g	20mm
Power Supply	150 * 70 * 50	300g	30mm
Circuit boards(total)	1000 * 1000 * 200	3 Kg	200mm
Mother Board	200 * 150 * 100	1 Kg	50mm
LAP1	200 * 150 * 60	500g	10mm
LAP2	25 * 200 * 30	500g	10mm
LAP3	200 * 150 * 50	500g	10mm
Sensors	(20 * 20 * 20) * 8	80g(total)	5mm
Ports/connectors	100 * 150 * 10	200g	50mm
Screen	-	200g	20mm
		22.94 Kg	

This figure is a gross over estimate. It is purposely over estimated so that I chose the motors and have force left over. It is important to have room for expansion.

Brainstorm

In the designing of the chassis I have come across many ideas which have all been feasible except have had there various problems. These include:

Octagonal:
This chassis was going to be octagonal is shape and have 2 - 4 levels. Its problem was the construction. The more folds in a sheet of metal the harder it will be to make it fit. The octagonal shape had 8 folds making it harder to fit the outer shell. Its advantages were the ease of turning and extreme stability. This was overcome however by the fact of its large width, thus inability to easily manoeuvre through doorways.

Rectangular:
This was the shape used it was used not only because of its simple but because of how easy it is to add-on extra levels. The rectangle can easily fit through a doorway and is stable in normal conditions. The four sides make it easy to fit the outer shell. The chassis is quite strong and can easily carry the various computers and equipment that it will be required to do. The individual panel on the back was used for mounting of ports. the other side can be easily disconnected as well. Its disadvantages were that turning in a doorway was virtually impossible due to length of construction. With sensing distances the sides will have to have a longer range than the front and back.

The rectangular shape is the shape I have chosen for Alis.

Design

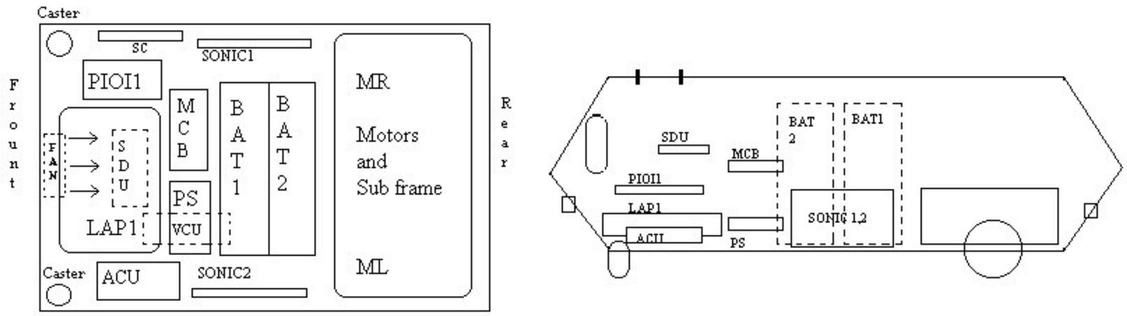
The following pages are the design and brief notes on the construction of the chassis and problems overcome.

Layout

With the layout of the chassis items I must be careful and try to take everything into consideration. It is just as important as choosing the battery. At the moment I have 3 levels, in 3 - 4 years I will add on an extra level to accommodate more equipment. The following pages are layout plans off the first 3 levels.

Ground Floor

The base or ground level is mainly the drive functions but also includes power control and cooling functions for the battery and motors. The CPU is LAP1.

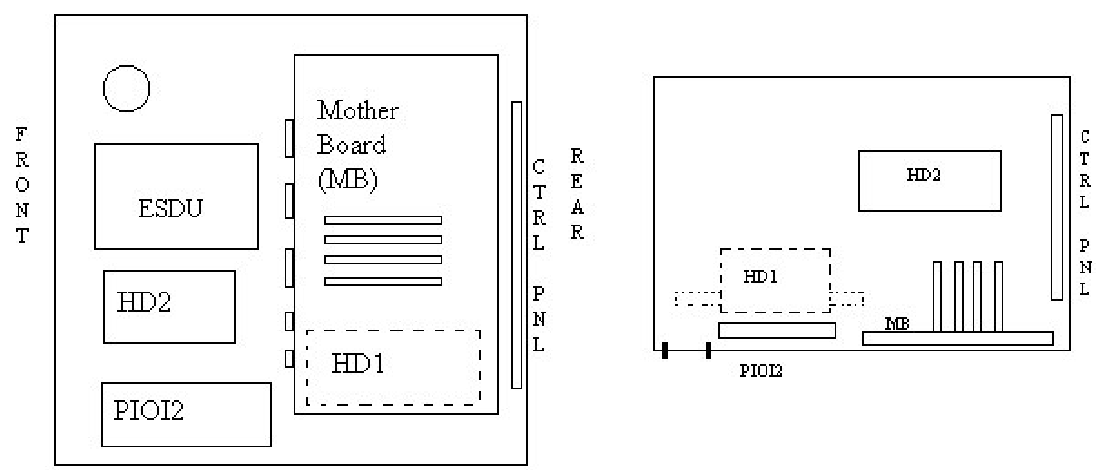


Ground Floor Layout

The fan is mounted at the back and the air flows from front to back. Ultrasonic long-range object collision boards are place on their sides. Along with what is shown in this there will also be several small circuit boards that act as connectors, such as a small interface board between the PS and PIOI1. These will be secured to the walls or floor where there is room.

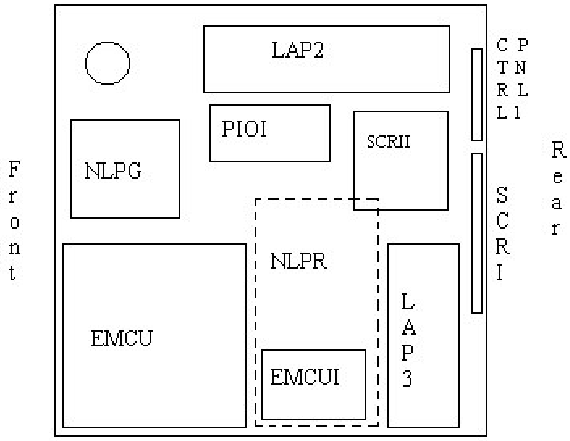
Level 1

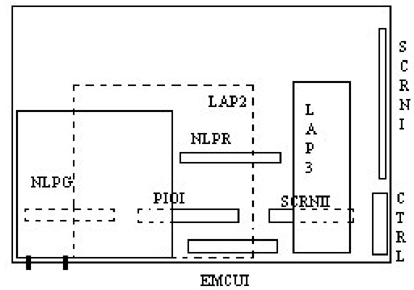
The level one or L1 will contain the brain of the operation. This is a hard decision as I needed the heavy things down the bottom, the LAP2 and LAP3 are probably going to be heavier than a Mother Board. I also needed the sensor laptop to be close to the sensors, but then again I needed the video camera processor or MB to be close as well. I found that the MB hard drives would likely be heavy enough to counter act the weight of LAP2 & 3.



Level 1 Layout

Level 2





Level 2 Layout

Level two does most of the everyday 'house keeping' jobs. It contains the management of senses (LAP2), arm and speech (LAP3). Both are in communication with the motherboard and LAP2 is communicating with LAP1 as it needs to pass the surrounding information on. The level two is quite laden with equipment as both the laptops need their various support equipment. This level also contains the mechanics needed for the arm and its motors.

Level X

This level contains the sensors and the viewer interaction screen, this screen is what people will be looking at when communicating with Alis. The height and width of the level is based on the screen's measurements, the sensors probably won't take up much room in the overall environment but the video cameras and the mounting hardware that makes the camera move(through motors) will be awkward and need lots of clearance because of the moving parts. The microphone will be a large disc microphone. These microphones are extremely sensitive and will be ideal for 'listening' for a spoken command.

Energy Vs Output

In such a big structure there is alot of weight, this needs to be compensated by applying a greater power output. This is generally not wanted. Thought due to the technology of today or lack of it extra power must be added to compensate for the weight of motors, computers and mechanical technology. Here are the calculations required to see if the 2 motors I have chosen are powerful enough to drive around twenty Kg's of metal, PCB and battery.

Motors internal resistance = 1Ω
Power applied = 12V
Calculated Current = 12A

This is only the stall current, the motors stopped and can’t to go.

Summary

The construction and design of ALIS' chassis was not as easy, and in some areas, not as hard as hard as I first expected. It was a challenge that had plenty of problems that popped up and needed addressing. Though I had a great deal of help from Brian Hall as I have little knowledge of metalworking. Brian Hall helped me see my original designs in a whole new, improved way. There are a few problems with the layout plans as the L1's floor is GF's roof, this creates an access problem to GF. These can be easily enough overcome through putting a side panel on the GF. In the future I would like to put some curves in the construction of Alis. The square type arrangement is not very pleasing to the eye and will soon be replaced by a cylinder shape. But for now I believe that this chassis has served its purpose.

Electronics

Without electricity and mechanics robots are virtually impossible to even think of. This section is on the electrical and electronic side of Alis. I will describe the circuits, how they work and where they will go. As well as the circuits I will run through the different wire gauges need and the other electrical parts of her construction. The circuits shown here are not all the PCBs that will be on Alis as I only blueprint the more important ones. There will be many circuits that just serve as connection points between say the impact switches and the PIOI1.

Electrical

Power Supply

The power supply is the centre of all the electrical devices. It supplies the power and can turn off the robot with a signal. I decided to have the leads between the battery and the power supply the shortest as this would stop losses through the wire. If the current going through the wire is 1 amp the the losses won' t be much, because of the P=IR^2. If the current through the wire is 8 amps the losses will be far greater. So I will run the wire from the battery--power supply----------circuits. '-' being length.

Scenario 1:- 1 amp - circuit board power(5v regulated)
P= I^2 R
P = 1(amp)^2 * 0.067 ohms(1m of copper wire 0.6mm thick) = 0.067 Watts

Scenario 2:- 8 amps - cable straight off the battery
P=I^2 R
P = 8(amps)^2 * 0.067ohms (1m of copper wire,0.6mm thick) = 4.28 Watts

Motor Drive

The second big item on the electrical list is the motor control board and the motors themselves. The motors are pre-geared so gearing them isn' t a problem though driving them is. They are going to be carrying a heavy load and thus drawing alot of current. If I use a relay the heat problem would be fixed but I would have no control over the speed. Darlington Transistors are specially designed for high current draw and would suit this application well.

Motors internal resistance = 0.7 ohms
Calculated current = $I = E / R$, 12 / 0.7 = 17amps(stall current, maximum current able to be drawn)

This is the current that the motors will draw if they are on but cannot move the chassis or stall current. If the stall current was drawn then the Darlington's would almost certainly give out in a puff of smoke! No signal transistor could handle this type of current. As an estimate I think the motors will draw 2amps each for normal operation, which the Darlington's could easily handle with a heat sink.

Cabling

Throughout the chassis different cabling will be used to suit the different applications. For example heavy-duty cables will be used to take the power from the battery to the power supply. This will be necessary as these 2 wires will carry the current for the whole chassis. If a cable does short large sparks can be given of and fire is a possibility. Due to the danger of this will be fuses at various points around the chassis, not only on the power supply.

The cabling I will use for general, circuits and interfacing use is 0.6mm solid core cable and where flexibility is needed light duty (14 * 0.14mm) speaker type cable both of these cables have a current rating of 1 amp. The power leads and distributors will need a slightly higher current cable. For this I will use the medium duty (14 * 0.2mm), it can handle up to 5 amps.

Electronics

The electronics section is what makes it all tick. Without this robot' s would only be a dream. The next few pages will go over the electronics and circuitry, starting with the simple circuits and working up to the more detailed schematics. A brief description will be given and where the circuit will be applied.

Power Supply

The power supply is a key part in any electrical system. It supplies power to the whole system. The requirements for Alis' power supply were huge. I needed it to be able to turn itself off and supply a great deal of current to the electrical system. A battery will be able to supply the current but to make the regulator not give out under strain is something else. The power supply will be located as close to the battery as possible, as stated above about power losses. Also if the cables short the risk of fire is less if the fuses on the power supply blow quickly. Alis' power supply supplies +5V reg, +12, +12V reg,-5Vreg, -12V reg and earth or 0V. The minus voltages are only in comparison to earth. The main special function of the power supply is its ability to turn itself off. This function will be handy when the battery is too low for it to do anything, or when it needs to recharge in the sun. The way it can do this is because as soon as you push the ON button a relay latches inside. This holds the power supply on while the relay that holds it on is controlled by a pulse, sent by the programme.

Line Sensors

Line sensors will be something I add on if I find the need. What they do is sense a line by sending out Infrared Beams, a white piece of tape will reflect the tape while carpet won't. It is on this principal that I will use white strips across the floor to 'tell' the robot places where it is not allowed to go. Such as before stairs or places where it might get stuck. Although these sensors are not completely necessary they are useful and take up little room in PCB. They will be mounted on the GF facing down through a hole in the floor. The chips require +5V. The circuit works by an Infrared LED's sending out pulses powered by the transistor, for higher current. The receiving section is a PIN photodiode, this has an IR filter over the sensing area so it will only pick up IR. The signal is amplified then feed into the computer.

Electrical Protection

When Alis is sitting still, for instance recharging or waiting for a command for longer than 20min her self defence unit will be activated. This is a module that sends electric shocks through the chassis and one wire. The wires will be placed in place where your hand would go to pick up the chassis. The module is automatic and will be activated when your hand touches the wire. The approximate voltage varies, above 500V. Because of the little current flow you don't die! The circuit works by a Nand gate switching a relay on and off. One of the inputs detects the finger on the wire and the other serves as the enable function. This circuit board is fairly small and goes in the GF. It will draw a minute amount of current when quiescent but about 50 - 100ma when activated.

Speed Control

The speed control board or SC interfaces with the MCB. A whole other board is added to free up the Lap1 so it doesn't have to send continuous pulse to keep the speed up. It works by a 556 IC which determines the width of the pulses to send to the motors. The speed selection is done by a 4066 bilateral switch. This chooses the right component for the speed required. This goes on the GF and will be almost constantly activated, still very little current drawn as it only has to power IC's.

Motor Control

Motor control is done by 4 relays which decide which polarity a motor is. Most of the time both of the motors leads are grounded but when a control line is activated 1 of the 2 relays per motor turns on, this relay decides whether the motor goes forward or reverse. The speed of the motors is controlled by the 2 high current MOSFET transistors. The transistors have an ultra efficiently rate compared to normal Bipolar transistors. They can handle 14A. Speed is controlled by the speed of the pulses, faster the pulses applied to the base of the transistor the faster the motor. This is called PWM or Pulse Width Modulation. Using this method voltage doesn' t have to be boosted to get more speed. The induced EMF generated by the relays is counter acted by 4 diodes. This circuit is simple in method but large in construction, it uses 4 relays to switch the contacts on a motor between positive and negative. Typically the contacts are both grounded but by moving one of them to positive the motor turns in one direction, and vice versa. The motor control board (MCB) is a major part in Alis and has to suit lots of needs of which this schematic fits all.

Parallel Input/Output Interfaces

These interfaces serve as a connection between the computer and the external sensors. All the conversions necessary are done on them, conversions such as between analogue and digital. LAP1' s PIOI works as a parallel to serial converter while LAP2' s converts analogue voltages of the sensors into a form the programme can understand.

LAP1 PIOI:
This is a parallel to serial converter. The computer needs more inputs and output than the 8 the parallel port gives us to suit all the tasks it has to do. Speed is a big factor to consider when converting from parallel to serial, the programme has to written so every function doesn' t take very long or else the Alis would crash into a wall and not do anything for 2 - 3 seconds. The circuit works by 4, 4067, 1-16 Multiplexers. Their address inputs are supplied by 4040 binary counters which all have a common clock and reset. The 4067 chips all have separate inhibits and data lines. With the inputs and outputs arranged in this way all that is needed to control it is one parallel port. 32 outputs and 32 inputs are gained through this method of operation, though not all of them can be on at once. This is where the speed of the computer comes into use, the faster the computer the faster the outputs will be renewed. For all the important outputs such as power control a latch can be used, this will hold the output at the level until a new choice is entered.

LAP2 PIOI:
While LAP2 still holds an important role, it is not as important as LAP1. LAP2 has a kit set parallel port interface on it. The kit set has 8 digital outputs, 2 analogue outputs and 11 analogue inputs. The programming difficulty matches the I/O, very difficult. Though it is not slow it is still difficult. The 11 analogue inputs will be used on;- 4 light, 1

ultrasonic, temperature, humidity, tilt and sound. The last 5 will be open for future developments. The catalogue code for the kitset is K-2805.

Other PIOI:
Other interfaces that can be classified as interfaces will include Lap3's interface to the arm, video camera movement or External Sight Device Control and motherboards interface for its needs(PIOI3)

Speech Recognition

Speech recognition is going to be done with a text type programme. Though it needs a circuit because I will filter out all the high frequencies before feeding the result into the computer. This will ensure the computer is not mixed up and gets the same data all the time, a low pitched voice nearly identical in every circumstance. The filter works with the main components being a capacitor. The capacitor only lets a certain frequency past it, this way the computer only hears certain sounds.

The microphone will need to be greatly amplified before it is to be dealt with. It needs to be able to hear a voice from across the room clearly. The disc microphone will give a noise output alot more than a normal microphone, due to the large surface area. A pre-amplifier gets the noise level up to a level that a amp accepts, the microphone will be feed into a pre-amp then to the computer.

Speech Generation

Generating speech can be done in many ways thanks to today's technology. These ways include sound card programmes, specially made chips and the hard way, self programming the codes in manually. I have experimented with a specially made chip that can put out speech with inputting certain codes.

There are many advantages to this chips as you do not have to follow a list of words. If I was going to use a sound card there would be a list of words to follow and no flexibility. All that I have too do is put the right code into the chip and a sound will come out. This sound depends on the binary code inputted. The defult voice is a males but with a litle bit of tweaking a females voice can be generated. The big advantage with this system Alis can listen to what certain noises make and associate a variable to them. Thus learning how to say words by trial and error.

Volume Control Unit

Volume control is a useful thing for when there is little or alot of noise in Alis' surrounding area. To keep being heard Alis will measure the surrounding noise and decide the volume of the amp on that. This will work by taking several samples and averaging them then deciding on a suitable output. Manual control would still be an option with a motorised variable resistor. The disc microphone output will be split for this units input. The computer will also have control over this circuit board because it might need to vary the volume for the speech input. This PCB will be located in the GF near the amp.

Amplifier

The sound amplifier has to amplify the sound to a decent level which can be heard across a room depending on the information the volume control unit sends back. eg if the volume control unit sends back that there is alot of noise then the speakers volume will be raised. For the first stage in Alis development she will put beeps and warning sounds out the speaker. Along the way the speech will be feed into the amp. As all amps they work by taking the signal in then clearing it up and sending it back out amplified. Speaker will also affect the noise output. The speaker I have chosen to use is a high output telephone type. It can produce alot of noise on a less powerful amplifier. The PCB is going to be locate at the front of the GF near the speaker.

Impact Switches

Though simple the impact switches play an important role in movement. They do not have a circuit really but have to be grounded normally. That is be tied to earth while not activated. This stops the stray static voltages in the air from activating. The impact switches are micro' s with a 240V rating, which is more than enough. While they take up little room they will still be moderately hard to mount as a bar needs to extended from the switches lever. There will be four impact switches which all over lap slightly, this is so if Alis gets hit on a corner then she gets activated to do something about it.

Due to Alis' significant height she might be going under a table and hit it without the impact switches detecting it. There will be an extra impact switch added so to avoid this, but instead of across it will be mounted upwards, the whole height of the chassis.

Low Battery Alert

This circuit alerts Laptop 1 that the battery is running low. It is extremely important as it will make Alis save any existing data and go find light for the solar panel or the nest to recharge. The four light sensors will find which direction the light is strongest and go into low power mode in that position until the battery is recharged sufficiently. The circuit will have 2 outputs these will be 1 a state of charge and one to inform that the battery is charging. The low battery monitors is only really a backup as LAP2 analogue to digital converters inform it of the batteries voltage. The A-D converter is sensitive to 20mv, plenty sensitive for monitoring a batteries voltage. This circuit works by a difference multiplier, the op-amp takes the difference between one voltage and the batteries, if the batteries falls below a certain voltage then the OP AMP detects this and alerts the computer.

Ground Variation Meters

When these send out a pulse they wait for a reply and if one doesn' t come then it tells LAP2 that there is no return. As these are aimed towards the ground that means that there is no ground in front of the robot. As a tool they are useful for the survival of Alis. They work in synchronisation with the line detectors to stay away from things it should not be near. They need to be able to receive weak signals because of the need to bounce the signals off non-reflective surfaces such as carpet and concrete. The angle is crucial to the operation of these sensors. The board works by an ultrasonics set next to each other listening for the responses from the signal they send out that bounces back off the ground. The signal is a 40KHz burst of sound. This frequency is too high for human to hear. Ultrasonic transducers resonate at a frequency of 40KHz, this is what makes them so suit to the job. When they resonate they generate a little electricity which can then be picked up by the receiving circuit.

Weather Stations

External environment sensors are part of any creature. Alis will be able to sense light, heat, humidity, tilt and sound level. Smell could be added on later on if necessary. These sensors will be located at the top of Alis in level X. Most will have a small board to connect them to LAP2. This board will just invert or amplify the signal. The three tilt sensors will be arranged so that one is facing up, the other lying down and the other diagonal. This will give LAP2 all the angles of tilt, instead of just lying face down or standing up.

Advanced Impact Sensors - Ultrasonic Transducers

To be able to avoid walls without banging into them you must have some form of long range detection. Ultrasonic Transducers or sonics for short do this by giving out a pulse of sound then listening for a response. If one comes then a wall is coming up. So humans can not hear the sound the sonics are pulsed at 40KHz. This is a very effective method as they are not effected by the environment. I have experimented with IR LEDs to see if they could do the trick, unfortunately they are affected by bright sunlight. Sonics circuit board is relatively large when compared to the other things in the GF so they are mounted standing upwards. The board works by a high power 40KHz signal that is then feed into a ultrasonic transducer. The receiver is basically a amplifier, that amplifies the signal from the receiving ultrasonic transducer.

External Sight Device Control

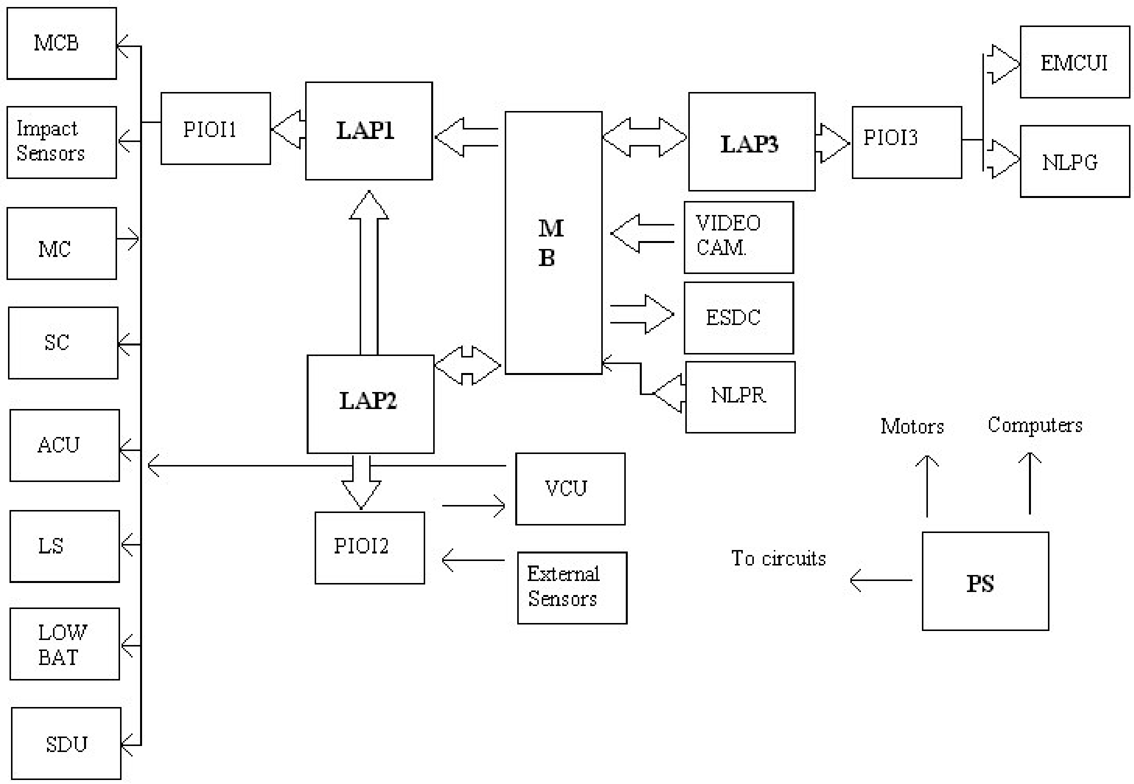
This board controls the direction/angle of the video camera. It has to drive three small stepper motors and is located in the upper part of L2. This board should be medium sized and have a great number of inputs. As a circuit it is relatively simple and is just three stepper motor drivers on the same PCB. The mother board will be controlling this in parallel with the video camera itself. The three degrees of freedom it will have are up/down, left/right and in/out (for easy of focusing). The circuit and the motor will be locate at different parts of the chassis, while the motors and gears are just above the Level X screen, the circuit is in L2. Stepper motors have four coils which are activated in a certain sequence to make the motor turn. One coil is activated after another to pull the shaft round. This circuit works by applying this pattern to the right motor for the direction the camera wants to be facing. The coils have induced EMF, this is where when a coil is turned off it generates a voltage spike, which could destroy anything in its path. This is prevented by having a diode across the terminals of the transistor or what ever is driving the coil.

Arm Manipulation and Control Board

This is also a matter of four stepper motor drivers on the same PCB, all with a common controller. In this case it is LAP3. LAP3 has to keep in contact with the MB as the MB has all the sight information. This is why it is crucial to have the sight installed before the arm. This board has to power 4 heavy duty stepper motors, I hope the arm to be able to lift 1 Kg. This is only for small training missions such as "Move the blue box onto the yellow box". Though once Alis has the above goals I have set then I will strengthen the stepper motors. Stepper motors have four coils which are activated in a certain sequence to make the motor turn. One coil is activated after another to pull the shaft round. This circuit works by applying this pattern to the right motor for the direction the arm wants to go. The coils have induced EMF, this is where when a coil is turned off it generates a voltage spike, which could destroy anything in its path. This is prevented by having a diode across the terminals of the transistor or what ever is driving the coil.

Complicated Block Diagram

As Alis progresses various parts on the next diagram will be added. In the beginning only the basic movement functions will be present the later Alis will grow in human likeness. This section goes over and shows a complicated block diagram of Alis.



Complicated Block Diagram

This is the version 1 of Alis' block diagram. Future revisions might need to be made if there show any problems. While LAP1 seems to be doing all the work, the other laptops and motherboard are also doing a lot of work just not a lot of little things like LAP1. LAP3 has many outputs and inputs to monitor as it needs to make the arm get to the right place. LAP2 has to monitor all the signals from external sensors, and pass some information on to LAP1.

Motherboard:

The motherboard is the organiser of this setup and controls most of the robot. It acts as a brain, common connection point and gathering of information.

As Alis gets more and more advanced her MB's job description gets more and more. In the beginning before video cameras, all it will have to do is organise the information and store if necessary. Then later it does the video camera decoding. This pattern recognition is a major step to AI.

The requirements for Alis' mother board are as follows, it needs to be small. Small enough to fit in a reasonably small space. Secondly it needs to have 9 expansion slots. These ports will be designated as follows; 1 video capture, 4 COM ports, 2 parallel ports, 1 sound card and 1 modem. The COM ports will all be for inter chassis communication. The modem will be used for communication to a future home base computer. Parallel ports will be used as a method of interaction between external environment. Along with these slots she will need to be fast for processing requirements, preferably a P200+. Alis will need alot of memory to deal with the images captured, 1 - 4GB. I have tested computers with only 5V and -5V to power the motherboard. The main functions work and no foreseeable disasters have happened yet.

Programming

Programming is one of the most important aspects of Alis. It is the programmes that instruct and instruct on how to learn. There are a variety of languages available to use. All of different speeds and format. The programme needs to be able to edit the course of action that Alis takes. As an experimental language Quick Basic offers alot of attractive features. While QB is not very fast in comparison to other languages it can offer very easy editing. I have looked into other languages such as C and Assembly Language and they have not been eliminated yet as they offer an advantage of speed which QB doesn't have. Assembly is alot more versatile than QB and can do practically anything, including programming itself! I feel it would be very beneficial to have imbedded micocontrollers for some jobs. As for now before I learn Assembly I shall use Qbasic.

Laptop 1:

Laptop one does the 'normal' things that a robot would do. These include movement, obstacle detection and battery up keep. Though these are simple functions they all soon add up. But along with the functions that it has to do it must also work through a serial to parallel converter, thus slowing down the process even further. I am can't deny the advantages that serial
to parallel converters have as the advantages far out number the disadvantages as long as the computer used is fast enough to keep up.

As probably guessed I am using a serial to parallel converter for the outputs and a parallel to serial for the inputs. Thus in the programming it is not quite as easy as just telling the motors to go forward. The need arose for an easier way to programme, then having to put a huge list of commands just to get an input value. To fix this I have made a platform, a level up from the more detailed outputs and hex codes. Due to this 'extra level' all I have to do to get an input is type in the tasklist a one line command. For example, OUTNO1 = 2: OUT1DEMULTI. This command tells the computer to output out chip one, then to output into the second line of the sixteen availible on chip one.

The programme is a continuous loop in which breaking is not possible as the keyboard scanning routine takes too long for preference. The loop includes a designated sub programme for reading the impact switches as it take a while for them all to read individually. Along with this is an exploring programme which plots out the path of the robot so far. The main module of the programme is the TaskList. This list contains all the necessary jumps and simple data.

Laptop 2:

Laptop two is the external sensor laptop. It monitors the external sensors and passes the information on to the other computers. It will be responsible for the processing and converting of the data to a readable form. This laptop also controls the volume control unit by averaging the sound from the microphone and outputting at that magnitude.

This has a serial to parallel converter as well but this one is a Dick Smith Electronics kitset. The PIOI2 can have eight digital and two analogue outputs. Along with this it can have 11 analogue inputs. In future I will make a platform up like LAP1' s as programming this board is harder than my multiplexing board. There are 5 chip to address on the circuit board 3 of which are through each other, that is the data has to go through 3 chips before it gets to its destination. Although there are some obvious disadvantages to this PIOI it also has a number of advantages, these include the 11 analogue inputs.

The 11 analogue inputs will be used as follows; four light sensors, three tilt sensors, one heat, a humidity, sound and ultrasonic transducer mounted upwards. The four light sensors are mounted in the four side of the chassis, these detect which direction the light is strongest for the solar panel to recharge. Three tilt sensors give the computers all the degrees of tilt as they are all mounted facing in different directions. The ultrasonic is for table detection, that is if the GF happens to walk under a table by accident the tower would normally hit and nothing would happen. With this new sensor the robot would back up and find a different route.

This laptop does not have any control inputs as all it does is send outputs to other computers. the main communication link is the communications port or COM port, this will pass the necessary information on to LAP1 and the motherboard.

Laptop 3:

This computer does quite alot in making the robot look human like. It controls the arm and speech generators. As the arm needs to be mounted after Alis can see or has video camera then it makes this computer the very last one to be put on. The motherboard will send some of the video data (summarised) and directions for the arm to go.

The data it sends will be simple, such as pick up box at co-ordinate x, y, z. The computer will have to control the stepper motors to get to that co-ordinate. It is very possible that if I have learnt enough about microprocessor then I will not use a full scale computer but only a microchip. This will save in power consumption and overall room. Microprocessors are alot more versatile then laptops and can be made to do hard things.

The programme would also be a continuous loop in which the COM port is monitored for new data. It will not be necessary for a PIOI, but instead there are designated stepper motor drivers. There will be four stepper motor drivers will be the four degrees of freedom, 1 the whole arm, 2 elbow movements, 3 wrist twisting and 4 the gripper.

On the gripper there will be two pressure monitors, these will make sure that the gripper does not shatter the object that it is gripping. The arm will be able to pick up about 0.5 - 1kg of weight. This will make it useful for light things around the house or experiments with boxes to develop Alis' A.I.

The speech generator will be likely a chip method. As this doesn't use up alot of memory in hard drive and does not require a sound card. The advantages of using a speech chip are great. There is alot more versatility in a chip than a card. I plan on Alis having all the phonemes programmed into her then she can decide what ones she wants and pick out the right one for the job. Once Alis starts to learn then she will experiment with different sounds to make herself have perfect speech. The microphone output will be split between LAP2 and then motherboard. Then the MB decides and sends the words down to LAP3 to speak out.

Mother Board, MB

As the central unit in this robot it has quite alot to process. The mother board or MB, or CPU is the organiser, developer and learning part of the operation.

The list of things that the MB has to do are numerous in comparison to the other computers so the board will have to be fast by today's standards. I have estimated a P200 - 450 depending on what the video cameras processing requirements are. There are alot of bitmaps and sound files that will be stored in the hard drive so two large ones would be preferable. As a guess I have estimated 2 - 4 GB of data. To save space not all data will be remembered. Only that which has been classified as important will be put into long term storage. Also some data such as faces will be deleted if it has been present for a period of time without being updated, thus forgetting some people who she doesn't deal with regularly.

When programming I have to remember to include camera recognition software, instructions for other computers (organising), any artificial intelligence programming needed(not that you can label it), speech recognition and anything else that shows up. This is quite a busy schedule as I imagine the human mind must have. But along with being able to run all these at a reasonable speed Alis must also have plenty of time to react should something happen.

In order to make running faster I have designed a small board that puts all the inputs into one, but this one there is only the one input and one telling the computer that there is a signal, thus the computer knows that if there is no signal on the data receive line then it doesn't need to scan through all of the inputs. The human mind uses this sort of system, if your sleeping lightly then a signal will make you more alert to fully comprehend the data.

The vision recognition software is not going to be my own. It will be someone else's that has been pre-made and is very flexible. I hope it will be able to pass the data through file to the main module programme elsewhere. The programme will then use its artificial intelligence programme to try and figure out the best way to achieve the goal assigned.

Communicating is probably the most important aspect of multi-processing, the system I have designed for Alis. Without communications then a whole lot of processors doing what they want won't be any good. Virtually all computers have a Communications port so this is what I have decided to use for her passing of information. There will be links between the MB and all the laptops, but also one going directly from the LAP2 to LAP1. This passes external sensor information on so the computer can steer, or stop correctly.

Camera Software

Movies and TV are only multiple frames per second passing the viewers eyes. The faster the pictures passing then the better quality the picture. As a robot I only expect Alis to see about 2 or 3 frames per second as opposed to the 24 or 40 that the TV puts out. Those 2 - 3 frames would then be analysed and used to the fullest. Obviously Alis will be able to choose whether she take those 'photos' or not. For example when recharging she would stop processing the data and turn off. But if Alis is wanting a better picture of someone's face then she would take 2 or 3 the get the best one of the lot and store that in memory.

The video camera's direction is controlled by the ESDU, External Sight Device Unit. This units statis is controlled by the mother board. This is so the MB decides which direction it wants the camera to go by taking information from the cameras, choosing where it wants to go then sending the direction data to the stepper motor drivers.

Multi-Tasking

The idea of multi-processing is not a new one yet is the best for A.I. systems. Individual computers can be very slow when assigned a long programme. For example if the impact switch was hit on a single computer system then it might take up to several seconds for the motor to stop going forward, depending on whether it is busy or not. With multiple computers then one can specialise in a area thus speeding up a system dramatically. The idea system, for example humans, have millions of minute computers all doing one part of the processing and passing the 'answer' on to the BIG computer which deals and presents the data. While the mind is the BIG computer there are several small computers all around the body, except by today's standards those small computers have the power of a household computer.

Languages

When Qbasic is compared to other languages it is a good experimental language. It is all round a good language to use, that is why I have decided to use it while Alis is in her experimental stage.

If it comes to the crunch and another language is more suited for the given job then I will change as Qbasic still has its disadvantages. These disadvantages are numerous the speed is a major one, qbasic lacks on the speed of individual instructions. Speed has to be watched in all programming languages but especially Qbasic. I have investigated other languages such as C++ and various assembly languages and they all have a far greater programme execution.

Assembly is a language far more more versatile than Qbasic as it directly controls the CPU. This can make it do virtually anything. I am also learning how to use microprocessors, that is individual ones with only the RAM and an EPROM attached. With this arrangement versatility is at a max, this including self programming.

C++ is a language similar to Qbasic in many ways but it has a few distinct advantages. One of these is the speed of the average programme. This speed far out does Qbasic. C++ programmes in words unlike assembly which is all hex numbers or shorthand. It is alot harder to learn as qbasic was specially designed to be easy to learn. C++ serves as a good language for those who are patient enough to learn.

Self Programming, A.I.

The correct definition of Artificial Intelligence is still being battled out by philosophers, but for now I will quite simply use, the ability to put to use information that ' a being' has learnt. Hopefully once a being has learnt enough it can be declared intelligent by its actions, and say on its own free will that ' yes I am conscious' .

The first step to Artificial Intelligence is the ability to self programme and edit the programme that you the being are following for better results. The reason why you the being are doing this is because you have experienced problems in the course of events and need a change. Humans do this in every day activities, even in simple things such as walking. If you normally follow one path but today there is a chair in the way then in order to save a bruised shin then you walk around the chair. But people might say that that could be achieved by simple adding the impact sensors and bumping the way around the chair. That, although it serves the purpose, is not intelligent. The human mind sees the obsticle, ' thinks' and then implants it into memory to avoid the offending object.

Microcomputers can self-programme in a way. By having a list of all its commands that it can refer to in memory it can then copy the right ones into the programme execution column to see if they will work. This would no doubt be a very hard programme to write but I believe it is possible with a bit of work and the technology to come.

The way I plan on having A.I. with Qbasic is making all the variables self defined. This would mean having everything inside the programme a variable, no numbers at all. There will be more variables created every second, with old ones being deleted. The sensor inputs would be assigned a variable and this value would be altered regularly. ' If...then...' statements would be used with practically every second line, such as " If heat > 29C Then ' complain of heat exhaustion' ". Though even this is not intelligent behaviour as all it is doing is following a command.

I do not think that machines can be intelligent because I, as a human, learn, know that I exist, and thus am self-conscious. To say that humans brains are machines that will be created in a few hundred years isn' t the type of thing you would want to hear and could be a threat to mankind. I believe it is fair to say that humans have a logical mind and that with a little bit of skill and patience it will be possible to replicate the mind. Whether or not the replica can be classified as self conscious is another matter altogether. In fact, as humans we will never believe that we have created something intelligent, but as a bystander looking at ourselves from a hundred years ago, we can believe because we do not know the technology involved!

Humans will be classified as machines the instant that we build one that we believe has intelligence, and not just replicates intelligence as many machines do today. It is as if a computer designer were to show a little child how a programme such as Encarta or any other encyclopaedia works, the child would be amazed no matter what the complexity, and would think the programme is ' smart' . The child symbolises the human race today, while the computer designer represents the human race in 100 or even 1000 years time. Once those 1000 odd years have passed and humans are no longer amazed by simple things which we today consider advanced, and research into human body workings has long been mastered, that is when humans will become no better than machines.

[redacted]

Summary

Everyone has goals and projects no matter who they are and how small the goal. I plan to complete the objectives and aims mentioned at the beginning of this project, or the whole way through this blueprint. The time period may be many years, and it might even go on the back shelf for a while but whether it sinks or swims is my decision.

I believe Alis will be a hard project, of which I could not do without the help that I have received. Through the programming to the chassis construction, I have received help on everything. Including some funding and financial help. At the end of this project I believe that I would have made hundreds of adjustments that need to be included in this blueprint, as it is impossible to think of every possible disaster.

Future

Alis has a huge future ahead of her. Once the goals I have mentioned have been completed then the testing and work on the quest for artificial intelligence will set in. As this is slowly ' perfected' then I will take Alis to sit the turning test. The turning test is the recognised test for declaring intelligence among machines. Of course this will be after 1-6 months of sitting watching BBC and Discovery type TV programmes so that she can get some general knowledge, which is essential to pass the turning test. If Alis passes then the world will want to know about this machine that can offically be declared intelligent. Mass production and/or conversion to a computer programme which can still learn will begin. After that point though Alis will be declared obselete as people would have gotten hold of the general idea of my A.I. programming and edited it to oblivion, excelling it in every way!

I have choosen this next saying as I believe it applies to every aspect of goal setting and especially robotics.

"The road to success is always under construction"

Acknowledgments

I would like to thank all these people for their assistance in this project, which I could not have done without:

Mr Fenton - Science teacher
Encarta 97
Dick Smith Electronics - $50 donation towards ALIS
School Colleges
Brian Hall - Helped construct the chassis

Books:
"The age of spiritual machines" - Ray Hurzwel
"Cognisors" - R. Colin Johnson
"The eye, the brain and the computer" - Martin A. Fisher and Oscar Fisher

The Human Mind

The human mind is the perfect specimen to follow in the quest for A.I. as it is the one that judges whether the created is indeed intelligent. That is why I have choosen to follow this perfect example in my robots programming. Along with this I am arranging some of the internal components in the same positions, such as a ' spinal cord' that runs the length of the chassis.

Similarities

Although you might not like to admit it the worlds super-computers and the human mind have quite a lot in common. In fact the modern super computers already have intelligence past that of a bacteria, leach and is catching up on the household fly. This is quite spooky as computers were invented in 1945, only 55 years ago, and the speed is doubling every 18 months. By today' s rate of speed increase in 100 years computers will be 67 times faster than they are today. The super-computer will be 67 times better, the size will probably be 1 or 2 hundredths of what they are today. The very first computer was approximately the size of a normal house and weighed about 27,000kg. It contained about 18,000 vacuum tubes of which 2,000 had to be replaced each month.

The adult human brain is a 1.3-kg mass of pinkish-grey jelly-like tissue made up of approximately 100 billion nerve cells, or neurons; neuroglia cells; and vascular (blood-carrying) and other tissues. Each of these neurons has the equivalent processing power to a small super computer. The neuroglia is the support device for the neurons, they help new neurons ‘on their feet’ by supplying chemicals and doing maintenance to the neurons surroundings.

Since we had 100 billion of these neurons all working together in a hexagonal structure, we can have intelligence that machines can only dream of by today' s technology standards. Even small things like the memory arrangement, emergency reaction points and sight recognition computers are eventually learning to do. Currently computers can recognise a pre-programmed object on a camera, while other machines can learn words based on sound around it.

Though I don't believe our minds ever want to think we have created something intelligent, if this were to happen we could die like in the movies, or be slaves to the evil living machines. Although none of these things will come true, people are still freaked about Artificial Intelligence. A real life science fiction

Close-up

In studding the structure and power of the human mind you'll be amazed. Its level of organisation is huge. We need all of this organisation and computing power to make us have the computing power that we do and to make us know that we exist. No one is really sure how humans have self-awareness but are very keen to find out.

In the memory department there are three types alone. These are ionic, short and long term. Pretty simple you say well the shortest term memory lasts no longer than 1/10 of a second. It is called ionic memory. This is for remembering small insignificant things, such as a bug flying past your eyes, or a person when walking down the sheet. This information gets passed on to the brain and analysed and sorted to whether it should be forgotten or stored in short term.

The eye is a mini super-computer itself. It does not pass raw data to the brain but processes it then send the data. For example it might, when it sees a pie it might send "pie:-cooked, hot, golden, mince", this would be instead of 2845645767666717678648653896456, the shading values of the pie and objects around the pie itself. If the brain had to do the computing of those values, the brain would be a lot slower. The eye sees 10000 by 10000 pixels approximately, all in colour, that' s a lot of computing to do.

When the doctor hits you on the knee with that big red hammer he is testing the reflexes of the nerves in your leg. Due to the long distance the knee would have to send to get to the brain and back the body has put a nerve system about half way. The knee senses the hit and sends the message to the nerves, which in turn tell the knee to fly upwards. This protects the knee cap from a great deal of pain.

The human body is a perfect specimen. When building my robot I have taken this into consideration and based all the programming on the human mind. Everything is arranged in a similar fashion, the memory, some physical organs(parts) and most of all the programming.

Statistics

Here are some interesting facts on the brain:

- All of the 100 billion neurons in the brain have approximately 1000 connections each. All with the equivalent computing power to a super computer.

- The eye sees approximately 10000 by 10000 pixels.

- The short term memory, or ionic memory, lasts no longer than 1/10 of a second

- The brain can make about 25,000 decisions per second

- The average adult human brain is a 1.3-kg mass of pinkish-grey jelly-like tissue. The heaviest brain recorded was 2.2-kg

- The neuroglia is the support device for the neurons, they help new neurons 'on their feet' by supplying chemicals and doing maintenance to the neurons surroundings.