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Study of GSM Controlled Robotics

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ABSTRACT : The wireless controlled robots user circuits, which have a drawback of limited working range, limited frequency range and limited control. Use of mobile phones for robotic control can overcome these limitations. It provides the advantages of robust control, working range as large as the coverage area of the service provider, no interference with other controllers and up to twelve controls. Generally, the preceptors are sensors mounted on the robot, processing is done by the on board microcontroller and the task is performed using motors or with some other actuators. In the project the robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed a tone corresponding to the button pressed is heard at the other end called 'Dual Tone Multiple frequency' (DTMF) tone. The robot receives these tones with help of phone stacked in the robot. The "GSM Technology Demonstrator" robot is remotely controlled by a mobile phone using GPRS and is able to receive and reply to SMS and MMS messages.

I. INTRODUCTION

A remote control vehicle is defined as any mobile device that is controlled by a means that does not restrict its motion with an origin external to the device. This is often a radio control device, cable between control and vehicle, or an infrared controller. A remote control vehicle (Also called as RCV) differs from a robot in that the RCV is always controlled by a human and takes no positive action autonomously. One of the key technologies which underpin this field is that of remote vehicle control. It is vital that a vehicle should be capable of proceeding accurately to a target area; maneuvering within that area to fulfill its mission and returning equally accurately and safely to base.

The object of this research is to develop a wheeled robot to be used in the science center of a mobile network service provider as an educational and advertising tool. In the science center, the robot will play the role of a "GSM Technology Demonstrator", showing the public the importance and how to use the wireless technologies and services implemented therein.

The "GSM technology demonstrator" project has mainly been initiated to address the challenge of making known certain technologies and services offered by MTN, one of the three GSM network service providers in this country. The project entails the design and construction of a remotely controlled mobile robot, in which most of the latest telecommunication technologies such as GPRS (General Packet Radio Service), MMS (Multimedia Messaging Services), voice recognition and phone web browsing, is implemented.

II. GSM

The main focus of this study is to establish a wireless man-to-machine communication using the existing PLMN, and also implementing some of the services offered by the PLMN in order to showcase their usefulness. Currently, all the PLMN in South Africa and most of the countries in the world are GSM networks, therefore the wireless man-to-machine communication achieved in the research is done through (based on) GSM networks.

The section below is a general overview of the GSM technology, from its origin, the type of services available, the network structure and briefly how it operates.

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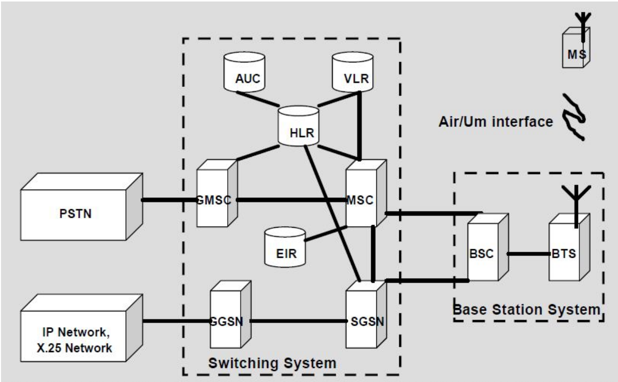
GSM HISTORY

GSM is a standard for digital mobile telephony developed in Europe to substitute the existing analog mobile telephony technology which by that time, was confronted to a number of problems such as increased demand, capacity, and incompatibility with other networks.



GSM-GPRS NETWORK ARCHITECTURE

In 1982, the Conference of European Posts and Telecommunications (CEPT) established a study group whose objective was to study and develop a public land mobile system for Europe. The group responsible for this work was called "Groupe Speciale Mobile" (GSM). In 1990, phase I of the GSM specifications was published and in 1991 the commercial service was started. From that time, GSM gained worldwide popularity and GSM which originally was an acronym for

"Groupe Speciale mobile", was later set to stand for Global System for Mobile Communication.
The GSM recommendations, do not specify the actual hardware requirements, but instead specify the network functions and interfaces in detail, guaranteeing the proper interworking between the components of the system. This allows hardware designers to use their creativity to provide the actual functionality and at the same time makes it possible for operators to buy equipment from different suppliers (Scourias, 1994; Ericsson, 1998)

GSM SERVICES

GSM offers three categories of services. The first category of services is related to the transportation of data to or from an ISDN terminal. These services are referred to as bearer services. The second category of services is referred to as Tele-services. This category includes services such as telephony and SMS. The third category of services is referred to as supplementary services. This include services such as caller identification, call forwarding, call waiting, multiparty conversations, and barring of outgoing calls (Scourias, 1994).

III. ROBOTICS

ROBOTICS HISTORY

The word robot originates from a Czech word "robota" which means tedious labor. In 1920, a Czechoslovakian playwright Karel Capek in his play R.U.R (Rossum's Universal Robots), introduced the word robot to the world. Long
before the word robot was used, a number of mechanical systems or machines were already developed (Dowling, 1996).

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In ~350 B.C a brilliant Greek mathematician Archytas of Tarentum built a mechanical bird propelled by steam and ~200 B.C another Greek inventor and physicist Ctesibus of Alexandria designed water clocks that measured time as a result of the force of water falling through it at a constant rate, this revolutionized the way of measuring time from the time glasses that had to be turned after all the sand had run through (Brief history of artificial intelligence, 2004).

1495, Leonardo DaVinci designed a mechanical device that looks like an armored knight. In 1738, a French inventor Jacques de Vaucanson started building automata. He built three automata in all. The first one was a player that could play twelve songs, the second one could play a flute, a drum or tambourine, and the third one which was the most famous, was a duck that could move, quack, flap its wings and even eat and digest food.
The duck was Vaucanson's attempt at what he called "moving anatomy" or modeling human or animal anatomy with mechanics. In 1770, the Swiss Pierre Jacquet-Droz and his son Henri-Louis Jacquet-Droz, clock makers and inventors of the modern wristwatch started making automata for European royalty. They created three dolls each, having a unique function. One could write, another could play music, and the third one could draw pictures. In 1898, Nikola Tesla built and demonstrated a remote controlled robot boat at Madison Square Garden (Bedini, 1999). Then in 1921, a Czech writer Karel Capek introduced the word "Robot" in his play "R.U.R" (Rossum's Universal Robots). In 1926, Fritz Lang released his movie "Metropolis", in which "Maria" the female robot in the film was the first robot to be projected on the silver screen. In 1940, Issac Asimov, a science fiction writer
produced a series of short stories about robots for Super Science Stories magazine. The first one was "A strange playfellow" later called "Robbie". It is the story about a robot and its affection for a child that it is bound to protect. Asimov introduced the term "Robotics" which he first used in his book "Runaround" in 1942. But Asimov's most important contribution to the history of the robot is the creation of his three laws of robotics (Dowling, 1996):
· A robot may not injure a human being, or, through inaction, allow a human to come to harm.
· A robot must obey the orders given to it by human beings except where such orders would conflict with the first law.

A robot must protect its own existence as long as such protection does not conflict with the first or second law. Asimov later added a "zeroth law" to the list, which is stated as follow:
· A robot may not injure humanity, or, through inaction, allow humanity to come to harm.

In the 60's a number of robotic research centers and companies were formed, and the first industrial robots appeared on the scene in the automotive industry. Since the n, the field of robotics has evolved a lot. Most of the research focus is in the direction of Machine and Artificial intelligence at this actual time (Brief history of artificial intelligence, 2004).

ROBOT DESIGN
General system

Generally, the design of a robot requires a main control unit, sensors, input and output interfaces, response units, and a power supply. Figure 2.3 is a general block diagram of a robot.
The mainframe: It is the mechanical housing and the supporting framework for the machine. Much of the machine's physical appearance is dictated by the nature of the mainframe assembly.

Internal power supply: This is the source of electrical power. It directly supplies all internal electrical circuits and external response mechanisms.
External power supply: This is used to recharge the internal batteries and provide electrical power for test and troubleshooting procedures.

The internal response mechanisms: These are devices that provide responses relevant to the machine's internal operation. The external response mechanisms: These are devices such as motors and loudspeakers that provide the means for making responses that alter the machine's external environment (Heiserman, 1981).

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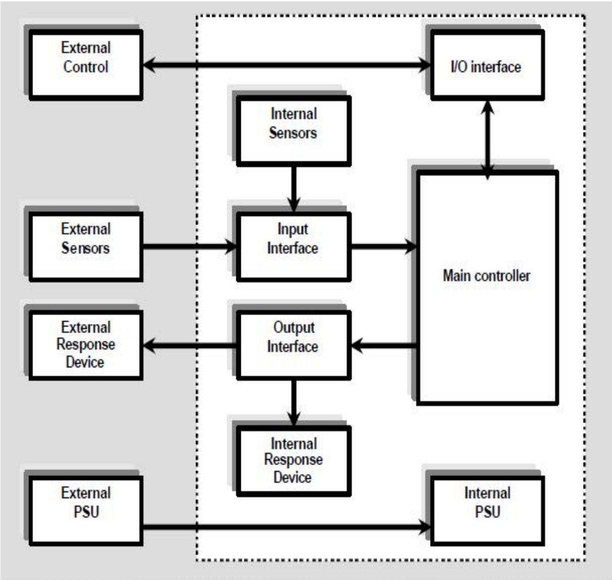

IV. ROBOT GENERAL BLOCK DIAGRAM

The design of robots in general and of mobile robots in particular, is based on the use of some kind of drive to power the system (motors), sensors, software and control techniques and algorithms. The following section will discuss the devices, tools and techniques most used in the design of robots.

Actuators or drive systems used

A drive system is basically a device used to make a robot move and perform tasks such as lifting or moving other objects. There are many types of drive systems in use, the three main types are:

· Hydraulic
· Pneumatic
· Electric motor

Electric motor drives

Electric motor drives are mostly used where mobility and precision are required rather than big force. Electric motors are by far the most common drive system to be found in mobile (and hobby) robots. These motors can work with very great accuracy, controlling movements up to some fractions of a centimeter but when a very big force is needed, electric motors tend to get very bulky, and the power-toweight ratio is no longer interesting (Warwick & Garrod, 2001 N°5:3-4).

a) Different types of motors

There are many different types of DC motors. The most used one's in the field of robotics are simple DC motors, stepper motors and servo-motors.

b) Selecting DC motors

In order to implement some mechanical motion in any project, there is a need for drive systems like motors, hydraulic, or pneumatic drives. Motors are the most used except in some specific cases where the size to force ratio for motors is not interesting anymore. Motors might be fairly large or rather small, depending on the amount of mechanical loading that will be applied to them. One of the important requirements for selecting a motor is to get one that is large enough for the job at hand, but not excessively large.

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Overly large motors add needless bulk to the project and, in many cases, waste valuable electrical power. Another part of motor selection is to come up with a motor system that runs at the desired speed. Motors that are not geared down to achieve lower operating speeds are rarely useful in robot projects. The speed adjustment is generally achieved by the use of gear motors.
The ideal situation is to calculate the speed and torque requirements for the motors and then purchase the motors according to those requirements. In practice, it is extremely expensive to buy new motors according to specifications, especially when more than one motor is needed.

So it sometimes becomes necessary to use surplus motors or gear motors. The amount of current that a motor can draw from the voltage source is equal to the voltage divided by the winding impedance. This means that the motor current is directly proportional to the amount of applied voltage. The running speed of a motor is proportional to the applied voltage and inversely proportional to the mechanical loading on the shaft. Also the current demand of the motor is inversely proportional to the running speed and proportional to the mechanical loading. Torque is the measure of the ability of the motor to do useful work. In other words, it is an indication of the motors twisting force or power.

Sensors

What makes a robot versatile, powerful and fascinating is its ability to collect data, and react or change its behaviour based on that data. Much of the information a robot requires to perform its job comes from sensors.

These are devices that collect information about the robot itself or some part of the world around it, and transmit it to the robot’s computerized controller. Without sensors a robot would be nothing more than an automated machine. Sight, hearing, touch and other senses, though, give it the means to think for itself (Warwick & Garrod, 2001-6: 9).

Sensors are transducers that convert a certain measurable quantity in the real world into an electric signal. There are many different types of sensors that can be used in robotic applications but they can be divided in 4 main groups: Light sensors, sound sensors, force sensors and position sensors.

Ultrasound sensors

Ultrasound is very high frequency sound that cannot be heard by humans.

Ultrasonic sensors rely on a principle known as echo-location to locate an obstacle. An ultrasonic sensor has two parts, a transmitter and a receiver. The transmitter sends out a signal as continuous pulses of ultrasound. If the pulses hit an obstacle they are reflected back towards the sensor. The time it takes for the signals to bounce back is converted into an exact measure of distance.

Ultrasonic sensing depends on the reflective surface or object’s density, which affects its ability to reflect sound. Providing an object is dense enough to return the sound signal, ultrasonic sensors can tell whether the object is there, whether it is see-through or not. So ultrasonic sensors are the best choice for industrial robots designed to work with clear glass or plastic bottles and containers, which lasers, for example, may not detect. Ultrasonic detectors also work in fire or smoke-filled environments.

Ultrasonic sensors use sound waves above the range of human hearing. As the sound signal returns after bouncing off an object, it is collected and the time measured for it to return can be easily converted into a measure of distance (Warwick & Garrod, 2001-6:10).

Power supply

For a robot to operate properly, there is a need for a power system to supply electrical power to the motors, relays, electronic circuits, and other electrical devices.

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The main power supplies for robotics applications are either the standard utility power sources or batteries. The big disadvantage of the utility power source is that the robot will be limited in its motion by a power cable. So the most suited type of power supply for a mobile robot are on-board batteries. Battery operated mobile robots require a power scheme with the following components:

· On-board batteries
· Battery recharging system
· Power distribution and control system

In order to simplify the design of the power supply scheme, it is essential to consider using a battery which voltage rating matches that of the motors and most of the other devices to be powered in the system (Heiserman, 1981:49).
There are two possible configurations when using batteries. The first configuration is to use a single battery to supply the entire system, and the second configuration is to use two or more batteries.

ROBOTS AND CONTROL

Many trends and many different approaches have emerged over the years in robot design. It will not be practical not even possible to go through all that has been done in the field of robotics until now, but an overview of some approaches can be given. In this section, examples of a passive system and a very complex and advanced controlled system are discussed.

PASSIVE SYSTEM

The passive system considered here is the "passive dynamic walker". This robot is capable of walking down an incline without any actuation and without control. In other words, there are no motors and there is no microprocessor on the robot; it is brainless, so to speak.

This passive motion has been achieved by exploiting the dynamics of the robot, its body and its limbs. This kind of walking is very energy efficient and there is an intrinsic naturalness to it.

COMPLEX SYSTEM

In this second case, reference will be made of Asimo, designed by Honda's Engineers using a different approach than the passive dynamic walker. Asimo was designed to perform a larger number of different types of movements.

This Honda robot is able to do things such as walk up and down stairs, push a cart and open a door. "The methodology was to record human movements and then to reproduce them on the robot which leads to a relatively natural behavior of the robot.

V. CONCLUSION

Designing a mobile robot to be used as a "GSM technology demonstrator" and assessing its performance was the main objective of this project. The design of the complete system was discussed. In this chapter, all the conclusions drawn from the design and implementation of subsystems as well as the integration of the complete system are described.

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