Robotic Eves-Dropper

Prof. Col. Narendra Kumar
Director (Research & Development)
Noida International University, Gautam Buddha Nagar
1/17 A, Yamuna Expressway, Greater Noida, Uttar Pradesh, India

Abstract - Eavesdropping activity are best performed in secure ends of electromagnetic spectrum. It may be effectively carried out using the GPS system with Robotics and Control mechanism to make some mobile device (robot of various size/ shape) that can be controlled from afar to move into the area of interest and transfer the required data (voice, video et. al.) quickly (preferably in bursts) to avoid detection. The robot/ mobile element can be controlled from a static/ not-so-mobile platform stationed at a suitable place so that it can program/ alter the parameters remotely, to enhance survivability.

Robotic Eavesdropper can be utilized for many tasks. The concept can be extended to combine the actions of movement of robotic-part with triggers that can even neutralize bombs, explode mines safely or initiate/ actuate retaliatory fire. Apart from its use by the security forces for tackling the terrorist threat , without actually moving into a volley of fire, the concept can be utilized by some of the Companies to gain entry into inaccessible areas and obtain live pictures of the designated places for their operational tasks.

The mobile platform can also be used to advantage for gaining intelligence about the adversaries. Some of the uses may not meet the legal or ethical norms but we got to live with it like so many of the new systems including Cellphones with Camera – the good, bad and the ugly kinds all included.

Keyword : Lat-long - latitude and longitude, SNMP - Self Navigating Mobile Platform, COTS - Commercially Off The Shelf, GPS - Global Positioning System, Tx-Rx: Transmitter-Receiver System, PDA/ PC – Personal Digital Assistant / Personal Computer / Notebook/ Tablet/ ¾ G Mobile / iPhones, etc..

I. INTRODUCTION

Bonafide or malafied intensions of a group be it a govt or non-govt Organisation like Security forces, Terrorists, Anti-social elements, misdirected youths, Naxalites etc cannot be easily curbed. But we may devise means to gain intelligence for our Rapid Deployment Teams, Security Forces, Organisation to contain the damage, minimize the imminent threats and co-ordinate actions to enhance our capability. A low priced mobile surveillance platform that can be remotely piloted to a given area based on predefined coordinates and relay back real time data/ image to enable us to act swiftly in the most befitting manner and be prepared for all contingency.

The Global Positioning System (GPS) being the key for navigation and used to pinpoint the position accurately - usually within a few yards or meters and available 24x7 to everyone, everywhere almost free has established itself firmly in our midst be it the military, para-military, police-force, security-agencies et al as also the civilian users across the world in recent times. It basically uses a constellation of 24 satellites in precise orbits of approximately 11,000 miles above the earth. These GPS satellites transmit data via high frequency radio waves back to Earth and, by locking onto these signals, a GPS receiver can process the data to find its precise location on the globe.

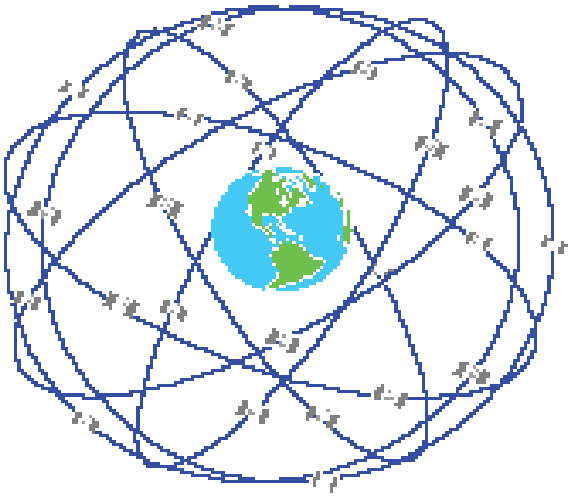


Figure 1. Constellation of 24 Satellites

By obtaining the inter-locking signals from a minimum of three different satellites, a GPS receiver can easily calculate 2D (two-dimensional) position of the designated device, obtaining the latitude and longitude. By locking onto a fourth satellite, the GPS can compute a 3D (three-dimensional) fix, calculating altitude as well as positional latitude and longitude (lat-long).

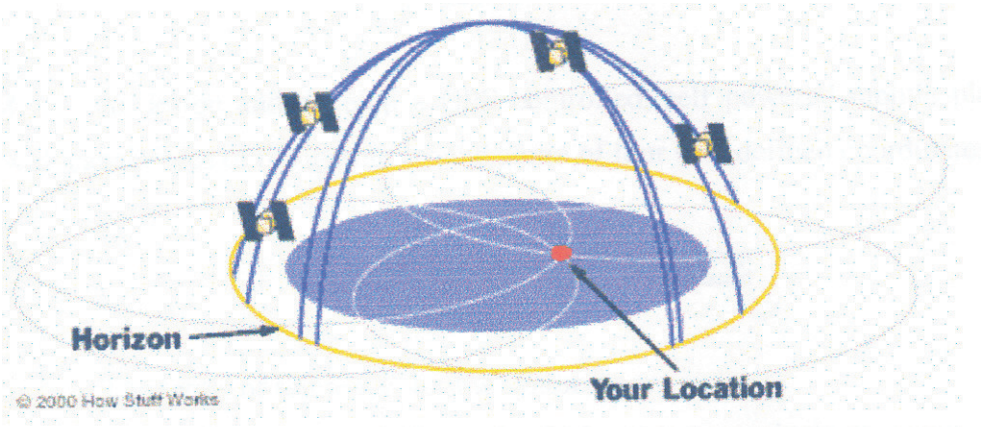


Figure 2.Locking on to Satellites

A GPS Interfaced platform can be used for navigation of unmanned mobile platforms accurately in any threatened location/ high risk environment with a high degree of precision.

Operation. The hardware operates on specific control algorithms, real time vision algorithms for object detection, motion sensors, vision output for robust positioning and high-speed real time processing of the data. This remotely controlled platform fitted with a suitable camera, can also be easily operated by a distant PC/ Notebook. The theory of a typical design is delineated ahead. It is based on a GPS controlled, self powered mobile platform with capabilities of navigating around four user defined coordinates, relay back real time data/ video images from the given area and return to a safe/ starting place on completion of the task.

Hardware. The hardware requirements entail these steps :-

(a) Select a camera which can transmit the image on wired / wireless basis.

(b) Interface a GPS to obtain starting and reference Grid Reference at any instance.

(c) Design a microcontroller-based interface to define four coordinates. Once obtained the microcontroller should be able to do the following.
  (i) Start the prime mover from the starting point and steer to the first coordinate reference.
  (ii) Calculate the deviation and generate error signal to steer the platform continuously till it reaches the defined coordinate.
  (iii) After touching the defined coordinate it should automatically steer the platform to the next coordinate.

  (iv) Once all coordinates are touched the platform should be automatically steered to the starting point.

(d) During this complete movement the camera should be able to relay continuously the image captured to a receiving station. A user friendly PC based MMI needs to be developed for this.

(e) Select a prime mover, preferably rechargeable battery driven, with steering capability. The prime mover must have a payload capacity of a camera, GPS, battery and other relevant accessories. The prime mover should be able to move on undulating ground.

The direction of the camera should be controlled by the microcontroller through a PTZ assembly. The MMI should offer control buttons for the same.

Technology. The Self Navigating Mobile Platform (*SNMP*) entails six major technical areas of work.

(a) *Platform fabrication*. A mobile platform needs to be fabricated which would house the various components.

(b) *Power pack.* Since the mobile platform is required to be self-powered, suitable DC power pack is required to be used.

(c) *Platform Drive and Speed Control. Two* Servo motors will be used, one for movement of the platform and the other for direction control. Both are required to be interfaced with the processing unit.

(d) *GPS Selection and Interfacing.* The suitable GPS has to be interfaced with a suitable processing unit in order to feed the current position of the mobile platform in terms of Lat- Long for further processing.

(e) *Processing Unit.* A suitable processing unit needs to be selected and all the subunits need to be interfaced with the same.

(f) *Camera, PTZ and Tx-Rx Unit.*

(g) *Interfacing Tx-Rx Unit with PC.*

(h) *Control Unit.* Selection and interfacing with processor and PC.

Analysis.. The alternatives for designing the subsystems of the surveillance system were considered under the main parts enumerated ahead.

Mobile Platform. The basic options available are either to design/ fabricate or get Commercially Off The Shelf (*COTS*).

The disadvantages of COTS could be :

(a) High Cost.
(b) Toy models have no operational reliability.
(c) Falling back to source on failure.
(d) Procurement problems and low response from the foreign firms for single demand.
(e) Extensive modification needed.

It is best to fabricate the mobile platform. In order to keep the weight of the platform light as far as possible, aluminium superstructure with fibre or other lighter material would be used with appropriate size wheels.

Power Pack. Power requirements on the mobile platform are for the following components.

(a) Servo Motors (Two) - 5 V DC each.
(b) Microcontroller module - 6V DC.
(c) GPS Module - 6V DC.
(d) Camera module – 6 VDC.

Thus the team has decided to use two sets of 2x 12V rechargeable dry batteries.

Drive. In order to provide drive to the platform there are two options:

(a) Stepper motor

(b) DC servomotor

It is prudent to use DC servomotors because compared to stepper motor they provide higher speed and torque.. The options available in DC servomotors are.

(a) Rotomag - PMDC Motor 24v200w.
(b) DC servo motor 150 W.

Rotomag - PMDC Motor 24V 200W has the following advantages :-

(a) High Torque (3.2 kg/cm).
(b) Low cost.
(c) Easy interfacing.
(f) Standard Power requirement (works on 24V DC).
(f) Variable RPM.

GPS. The options available for GPS are as follows.

(a) GPS Global Map-l00 from Lawrence Electronics Inc.
(b) PG-11 SMA R/A Type 4
(c) PG-11 MCX R/A Type 1
(d) TF-IO GPS Receiver Module.

The PG-11 is a Credit card sized, 12 channel GPS receiver based on the star II chip set. It offers fast re-acquisition, low power consumption. This "ALL-in-View" GPS module offers not only superior performance but also high reliability. The module is best suited for outdoor navigation and location identification.

GPS Interfacing. In order to maintain simplicity while achieving the aim, the team plans to use RS232 serial interface between GPS and the processing unit.

Processing Unit. There are two options available in this regard.

(a) Micro Controller.
(b) Micro Processor.

Use of micro-controllers offer following advantages.

(a) It is cheap.
(b) Reduces size and weight of the system.
(c) Not many supporting chips required.

Options in micro-controllers could be short-listed as below :-

(a) PIC 16F877.
(b) RABBIT 2000.

RCM2200 Features. The tech features are as follows:-

(a) Small size: 1.60" × 2.30" × 0.86"(41 mm × 58 mm × 22 mm)
(b) Microprocessor: Rabbit 2000 running at 22.1 MHz
(c) 26 parallel I/O lines: 16 configurable for input or output, 7 fixed inputs, 3 fixed outputs
(d) 8 data lines (D0–D7)
(e) 4 address lines (A0–A3)
(f) Memory I/0 read, write
(g) External reset input
(h) Five 8-bit timers (cascadable in pairs) and two 10-bit timers
(j) 256K–512K flash memory, 128K–512K SRAM
(k) Real-time clock
(l) Watchdog supervisor
(m) Provision for customer-supplied backup battery via connections on header J5
(n) 2 Rabbit Core RCM2200
(o) 10Base-T RJ-45 Ethernet port
(p) Raw Ethernet and two-associated LED control signals available on 26-pin header
(q) Three CMOS-compatible serial ports: maximum asynchronous baud rate of 691,200 bps, maximum synchronous baud rate of 5,529,600 bps.
(r) Six additional I/O lines are located on the programming port, can be used as I/O lines when the programming port is not being used for programming or in-circuit debugging.
(s) One synchronous serial port can also be used as two general CMOS inputs and
(t) One general CMOS output, and there are two additional inputs and one additional output.

Advantages of the RCM 2200

(a) Faster time in using a fully engineered, "ready to run" microprocessor core.
(b)Competitive pricing when compared with the alternative of purchasing and assembling individual components.
(c)Easy C-language program development and debugging, including rapid production loading of programs.
(d)Generous memory size allows large programs with tens of thousands of lines of code, and substantial data storage.
(e) Integrated Ethernet port for network connectivity, royalty-free TCP/IP software.

Pin- diagram of **RCM 2000** (is at Appendix 'A').

Camera. *Web Camera are* quite cheap and easily available but their range is very less, (2-3meters) also it can't send real time signals and has a poor image resolution hence it may not be suitable for finer tasks.

Digital Camera. A 1/4" CCD, 350 TVL, 1 Lux, 6-60mm, 1/3" format motorized auto iris zoom lens in outdoors camera is very costly compared to the web camera but offers many advantages. It can zoom an object upto ***100-150 meters***, its area of coverage is much more than a web camera and has better resolution. Also it is more durable but it requires comparatively higher intensity of light and hence can't be used in bad weather conditions. Its resolution is not good enough to match detailed requirements perfectly and the zooming range is less than effective range of small arm to be used (i.e. 200m).

Day and Night Digital Camera. A 1/3" CCD C mount color camera, 480 TVL, 0.01 lux, with external 6-96mm motorized auto iris zoom lens in outdoor is comparatively costly but it meets detailed requirements quite well as it can zoom up to ***200-300 meters***. Also it is weather proof (withstand adverse weather conditions) and requires less intensity of light to operate satisfactorily, so we can see objects even in darkness.

High Speed Dome Camera. A 1/4" CCD colour with built in pan / tilt zoom, 128 x zoom lens, 240deg /sec pan speed, 90deg /sec tilt speed, 60 preset positions, 5 lux is one of the best in terms of resolution, range etc and has a built in pan / tilt zoom facility. So there is no need for external PTZ unit but it is very costly and bulky. The inbuilt pan / tilt unit can't be interfaced with weapons as weapon are required to be mounted on a PTZ base. ***Samsung ptz-rm16*** video camera with pan, tilt and zoom is comparatively low cost, low weight and a standard equipment.

Pan Tilt Zoom Unit . Pan/tilt Unit1, a indoor pan/tilt unit, medium duty, weighing 6 kgs etc., with controller, 6 degree/sec pan, and 4 degree/sec tilt-SECURA is cheap, made up of plastic and it can take a payload of 6kgs which is adequate for many tasks but plastic can break under stress of recoil of the weapon. Hence, a Pan/Tilt Unit2 , outdoor pan/ tilt unit heavy duty motors, 35kgs load, 230volts AC-SECURA though costlier than unit 1, is made of steel and can take payloads of 35 kgs which should meet most requirement. Also it can withstand adverse weather conditions and degree of movement is equivalent to that of unit 1 i.e. 6 degree /sec pan and 4 degrees/sec tilt. So it can handle weapon system recoil also quite well and meets all specifications.

Control Tx-Rx Unit. The complete system needs to be wireless to avoid the additional wire and spool weight and also enable the system to move in difficult terrain, populated/ built up areas. Remote data Transmitter / receiver - RDR 1W may be used with 24 VDC, 5VPP, at ranges of 300 feet with Data speeds of 1200 bps and it can be easily connected to controller or PC on serial port as shown at Appendix 'B'.

Cost Analysis. The cost estimate of best of the line is at Appx 'E' .

II. CONCLUSION

. The eavesdropper uses micro-electronics, robotics, computer hardware and programming extensive apart from fabricating a mobile platform that also integrates the best of the line electrical and mechanical engineering principles. The concept of using a GPS to move an unmanned platform to a pre-determined location may not be new, but to utilize them without detection entails top of the line secure wireless communication. The better it is the best suitable it will be for saving assets including precious lives. Legitimate use of robotic eavesdropper has the potential to revolutionize the electronic-world.

III. ACKNOWLEDGEMENT

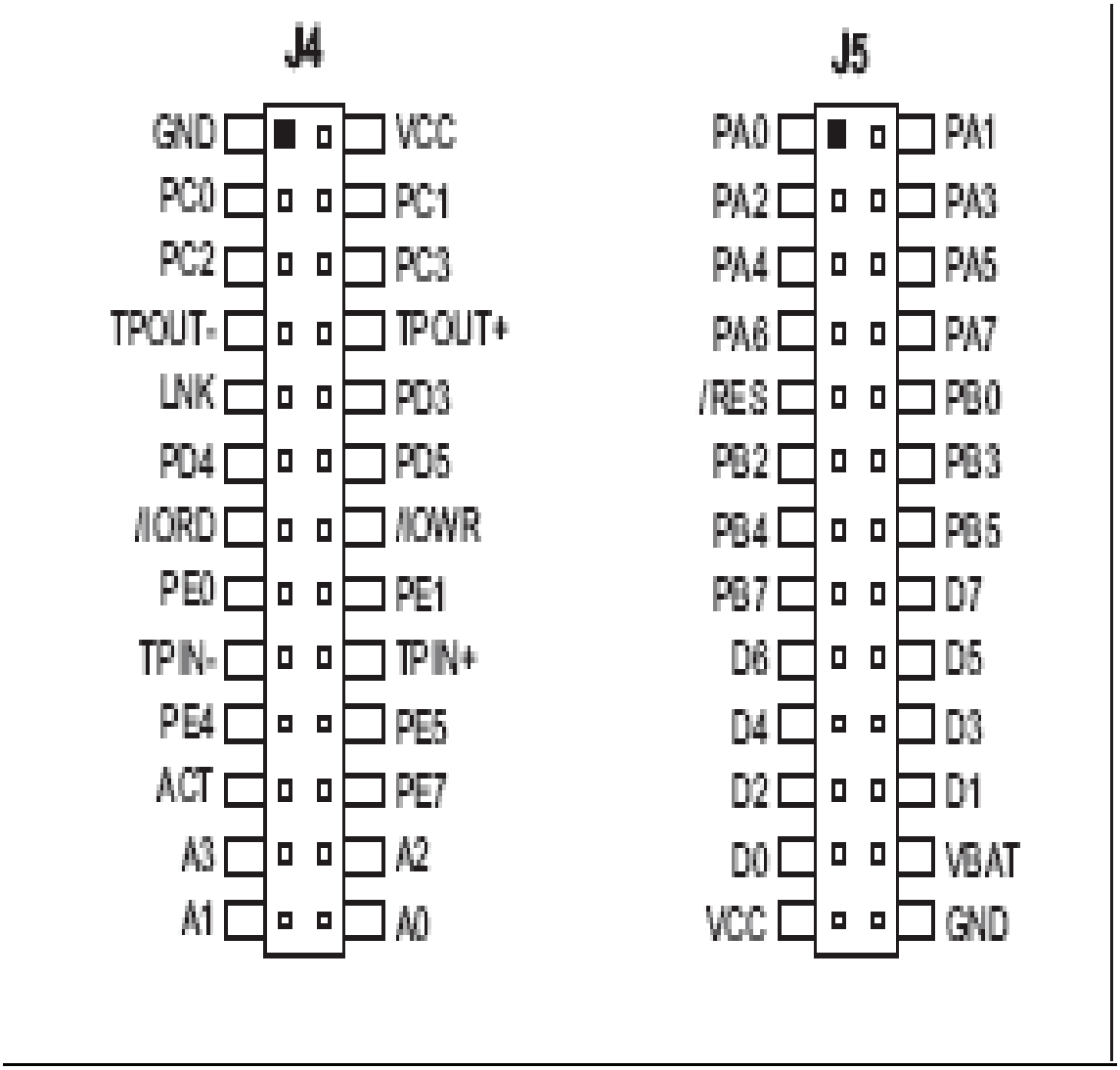
The gadget ibid were fabricated from COTS equipment and launched in terrorist infested areas with the help of para-military forces of the Indian Republic. The eves-droppers were hidden / interwoven / incorporated in periodically / daily use household-goods / items

REFERENCES

[1] S. M. Metev and V. P. Veiko, *Laser Assisted Microtechnology*, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[2] J. Breckling, Ed., *The Analysis of Directional Time Series: Applications to Wind Speed and Direction*, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.
[3] . Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," *IEEE Electron Device Lett.*, vol. 20, pp. 569–571, Nov. 1999.

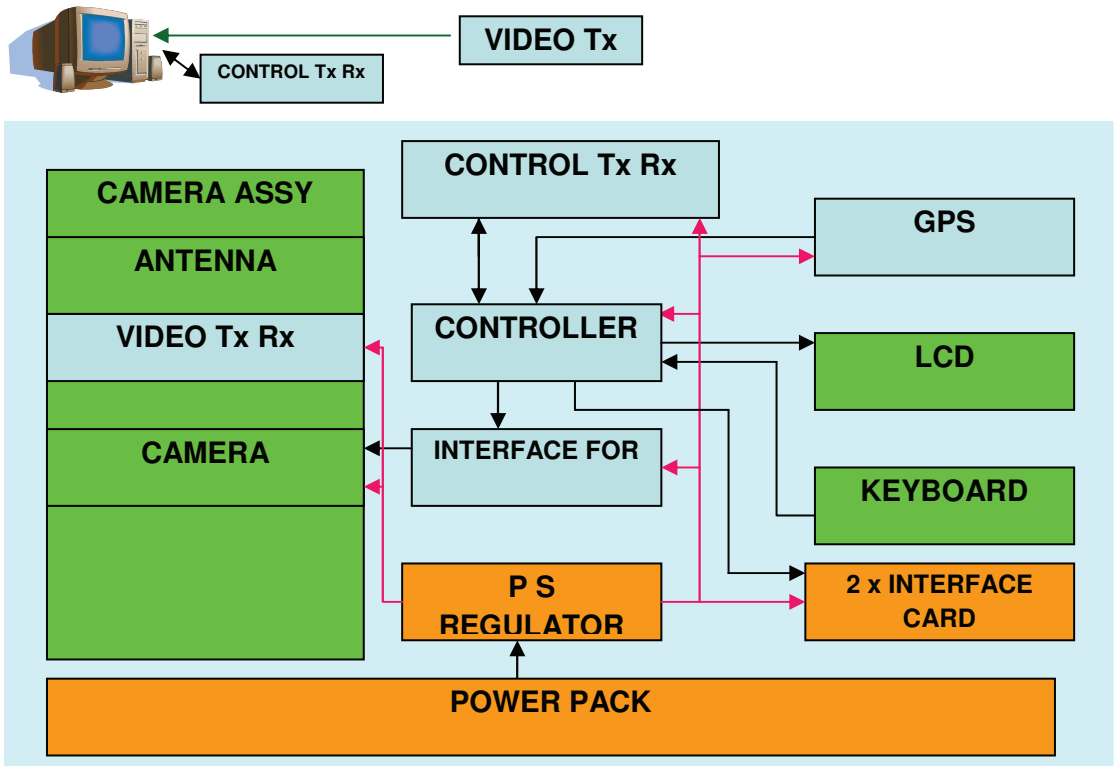
Appx'A'

PINOUT DIAGRAM



Appx'B'

FUNCTIONAL BLOCK DIAGRAM



Appx'E'

COST ANALYSIS

S No	Nomenclature	Qty	Price/ Unit	Total Cost	Source
Superstructure					
1	Mild steel frame work with powder coating.	1	4000	4000	
2	Plat form tyres PT8	4	450	1800	
3	Shafts to mount wheels 25 mm X 400 MM	2	800	1600	
4	Bearing housing with bearing 25 mm X 65 mm	4	150	600	
Power					
5	Battery 12VDC dry	2	1800	3600	
6	Battery Charger	1	350	350	
Drive					
7	Motor PMDC Servo Motor ST200-24	2	17500	35000	
8	Controller for ST200-24 Dual channel for two motors	1 pair	10000	10000	
9	Cables, Connector and Interfaces	-	2000	2000	
10	Electromagnetic clutch for steering	2	750	1500	
11	Gear train in aluminium 120,40	2	400	800	
GPS					
12	GPS module	1	19000	19000	
			Total	80250	

S No	Nomenclature	Qty	Price/ Unit	Total Cost	Source
Processor					
13	Rabbit processor with interface connector.	1	7900	7900	
14	LCD Display with Controller	1	450	450	
15	Keypad (3x4) Feather Touch	1	750	750	
16	PCB Card design 150 mm X 125 MM	2	3250	6500	
17	Glass epoxy PCB making charges	1	1200	1200	
18	Prototype PCB for electronics assy.	1	1200	1200	
Control					
19	Remote data Transmitter and receiver	1 Pair	13000	13000	CS Dept
Video					
20	Video camera with pan+ tilt and zoom motorised. Samsung	1	39000	39000	CS Dept
21	Video Transmitter and receiver Pair	1 Pair	22500	22500	CS Dept
22	PAL-VGA Interface to PC	1	2400	2400	CS Dept
23	PC	1	-	-	CS Dept
Software					
24	Dynamic C	1	9000	9000	CS Dept
25	Stationary		2000	2000	CS Dept
			Total (in Rs)	186150	

*The rates are without tax/VAT