Design of Low Cost Outdoor Surveillance System using MEMS

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***Abstract*—The paper presents the innovative way to design a Surveillance system based on Micro-Electro-Mechanical Systems and Sensors. MEMS is an enabling technology allowing the development of smart products, augmenting the computational ability of microelectronics with the perception and control capabilities of micro sensors and expanding the space of possible designs and applications This surveillance system colloquially known as MIRASS which stands for MEMS IR based airborne surveillance system which detects the remote detection of hazardous/radio active materials, real time IR and optical spectral graphic observation and inspection of critical assets like top secrete machines and devices.**

***Keywords*—MEMS, Photolithography, Bulk Micromachining, LOWTRAN 7.**

I. INTRODUCTION

In the modern era, with the advancement of technology, research areas in MEMS opened a new path for fabricating the application oriented products.MEMS are the compromise between science and engineering which provides an intimate interaction with the physical world and leading towards miniaturization. MEMS devices include integrated system technology where sensing part and control electronics part are fabricated on the same chip and they has generated intense interest due to its remarkable properties like small size, batch fabrication and low cost[1].

The surveillance system is focused to acquire and verify information about enemy capabilities and positions of hostile targets.One of the key advantages of MEMS based device is their ability to bridge the gap between the physical and logical worlds, by gathering certain useful information from the physical world and communicating that information to more powerful logical devices that can process it.In this paper, we described the design and fabrication of energy-efficient surveillance based on lithographic technique. The system allows a group of cooperating sensor devices to detect and track the positions of moving vehicles in an energy efficient and stealthy manner.

II. PRINCIPLE USED IN SURVEILLANCE SYSTEM

In micro mechanism fabrication, one of the predominant process techniques is known as “photolithography”. The basic process of photolithography involves a substrate (wafer of silicon or some silicon compound) that is coated with what is known as a “photo resist.” A photo resist is simply a material whose solubility to certain solvents changes upon exposure to certain wavelengths of light. A positive photo resist becomes less soluble with exposure to light and a negative photo resist becomes more soluble with exposure. Then, after the photo resist is applied to the substrate, the photo resist is exposed to light through a mask (designed especially for themechanism being made) and the mask blocks light from hitting some of the photo resist. Then with the solubility changed only in certain parts, a solvent wash is applied and a pattern is left on the substrate.

The basic approach used in the design of micro electro mechanical systems based device is to take a piece of raw material (generally a wafer of silicon substrate) and then selectively add and remove layers of material to produce a structure by means of etching mechanism The technique used for the fabrication of this system is bulk micromachining. In this process, there is selective etching inside the substrate. Silicon wafers are used as substrates for bulk micromachining, as they can be anisotropically wet etched, forming highly regular structures.this process is performed to transfer a pattern from a mask to the surface [2].

III. SYSTEM ARCHITECTURE

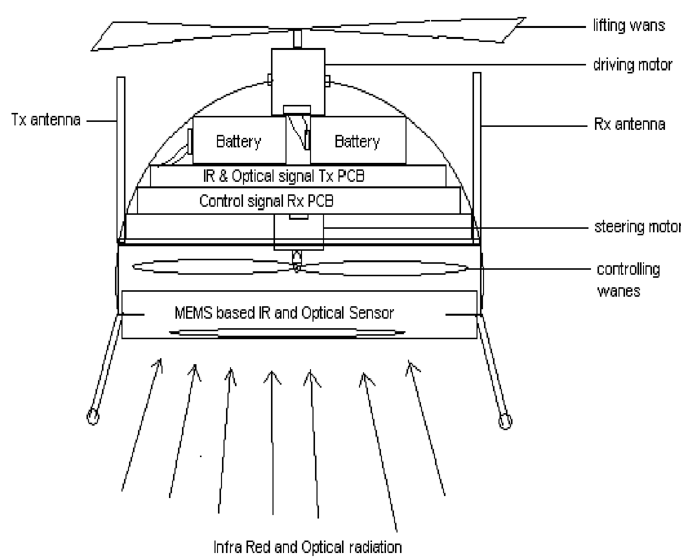

Fig.3.1 Layout of Surveillance system (FLIER)

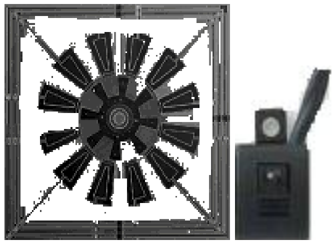

Fig 3.2 Optical Sensor IR Sensor

The MIRASS consist of following components:

3.1 Sensor system

IR Sensor system:The IR sensor system includes the mirror elements in mirror array for reflecting IR energy beam collected from field of view and an IR energy detector for detecting IR energy reflected by MEMS array & converting IR energy to output signal. A processor adjusts an angle of elements of MEMS mirror array by varying control signal or by switching from one to another focusing element. The IR system provides spectral data collection and spectral imaging. The mirrors used are polymer deformable mirrors or Bragg mirrors.

Optical Sensor: Optical sensors include passive and active radiometric systems. The nomenclature is based on whether the light source is independent of the sensor or is an integral component of the system.

3.2 IR and Optical signal transmitter:

The circuit presented here is a simple audio/video transmitter with a range of 3 to 5 meters. The A/V signal source for the circuit may be a VCR, a satellite receiver or a video game etc. A mixer which also operates as an oscillator at VHF (H) channel 5 TV frequencies is amplitude modulated by video signal and mixed with frequency modulated antenna, which contains video carrier frequency of 175.25 MHz and audio carrier frequency of 180.75 MHz.

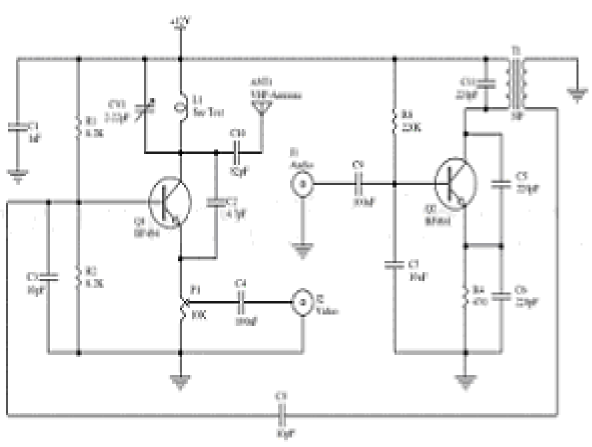

Fig.3.3 Schematic of IR and optical signal transmitter

The circuit consists of transistor Q1 with its resonant tuned tank circuit formed by inductor L1 and trimmer capacitor VC1, oscillating at VHF (H) channel 5 frequency. Transistor Q2 with its tuned circuit formed using SIF coil and inbuilt capacitor forms oscillator. The audio signal applied at the input to Q2 results into frequency modulation of 5.5 MHz oscillator signal. The output of 5.5 MHz FM stage is coupled to the mixer stage through capacitor C8 while the video signal is coupled to the emitter of Q1 via capacitor C4 and variable resistor Inductor L1 can be wound on a 3mm core using 24SWG enameled wire by just giving 4 turns.

3.3 Remote Control Transmitter:

When the levers in the Remote Control Unit are pushed electrical contacts are made connecting the 9V battery power to the transmitter and indicating which commands the user wants sent to the flier. Upwards/downwards commands are controlled by different levers and use different sets of electrical contacts that are used to encode a sequence of electrical pulses; the number of pulses depends on which command is being sent.

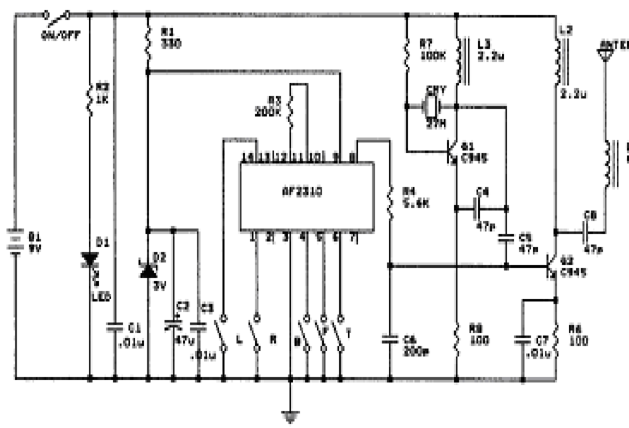

Fig 3.4Schematic representation of Transmitter Circuitry

An electrical circuit that is tuned to a frequency of 27.9 MHz creates a signal that is sent to the antenna when the pulses are active. The antenna converts this electrical energy into radio energy, creating a stream of radio energy bursts, which travel through the air and are picked up by and understood by the radio receiver in the flier.

3.4 Radio Receiver:

The flier antenna collects radio energy and converts it back into electrical energy; the energy here will always be much less than the energy originally applied to the transmitting antenna.The receiver is basically a filter, which is tuned to amplify any energy around 27.9 MHz and block energy the antenna picks up outside this region[3]. If the Remote Control Transmitter is sending commands then its radio signal will be picked up by the receiver and converted back into the original pulse sequence.

Decoding circuitry then determines which commands measuring the number of received pulses in the sequence sent. Signals are then sent to the motors to execute the commands.

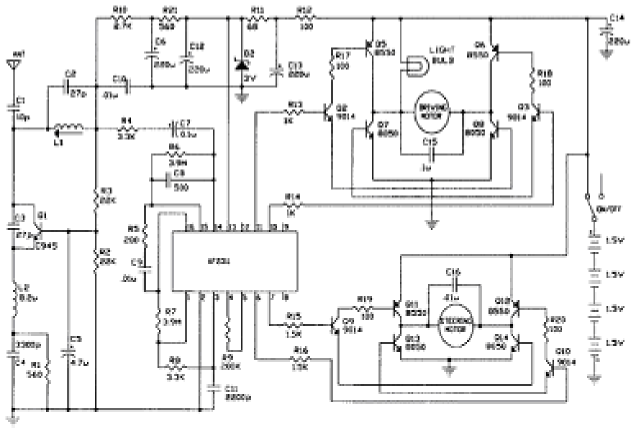

Fig. 3.5 Schematic representation of Receiver Circuitry

This system contains following parts: High Quality 2-channel transmitter and receiver ,Fast Charger for Transmitter and Receiver pack (operates off a 12 volt DC power source) ex. car or motorcycle battery ,Two high impact Rotor blades ,Two high speed motors ,Two motor drive gears ,One CPU control system ,One lightweight "tough" frame ,One NiCad Rechargeable battery pack ,Four ball bearings for motor drive units etc Airborne hardware includes communications devices: Radio Modem (Data link) & RC Receiver (Safety Link). Any wireless device providing a serial link can be used for the telemetry and the telecontrol (Data link). The Airborne software consist of features like RC receiver (PPM signal) decoding ,Servos and motor controller (PPM signal) control ,Manual control with the RC ,Control with augmented stability.

Also an FPGA-based architecture can also be made for the fabrication of surveillance system which is completely flexible and customizable, while at the same time offering the peace of mind of being implemented on a standard, well-understood silicon platform.

3.5 Ground Computer

The software is developed to be run on an i386 architecture with the operating system. However a Live CD including all the software is provided: it should be able to boot any standard laptop. This software provides compiling tools to produce the airborne code from the configuration; a GUI to control and interact with the MIRASS during flight; a basic simulator to ease the development of flight plans. LOWTRAN 7, a propagation model and computer code is used for predicting atmospheric transmittance and background radiance from 0 to 50,000 cm -1 at a resolution of 20 cm -1.

IV. RESULTS AND DISCUSSION

The surveillance system is designed under the consideration of various factors and parameters i.e. compact size, light weight, low cost and ease of fabrication. The windows based documentation software displays all relevant data and records all transmitted video footage. All data is filled within a database and linked to a project which contains time, data and GPS location of the recording. The software also monitors battery status, flight data, distance and GPS position for better orientation during flight under "out of sight" conditions it has a display of flight direction by point of compass. A back track system makes it easy for operator to steer the unit back in original location. The user interface is straight forward, all information and controls are available from single window. The software can be used in conjugation with the laptop computer as a part of base station with documentation or it can be installed on a windows computer system. The software feature includes live video display; GPS signal strength, GPS data compass, backtracks etc.

V. CONCLUSION

The proposed system has the advantages ofhigh reliability, low power operation, small size, low cost to manufacture, and high scalability to volume.MEMS are an emerging field technology. MEMS have adopted the lithographic and etching technologies from IC fabrication. The trend of growth in MEMS sector is predicted in a diverse range of application areas like biological and biomedical systems optical communications and portable power production[4]. Future MEMS applications will be driven by processes enabling greater functionality through higher levels of electronic- mechanical integration to enable a complex action.

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