SENSOR AND LOCOMOTIVE CONCEPTS USING SEWER ROBOT

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Abstract- The sewer pipe inspection deals with a design and motion planning algorithm of a caterpillar based pipeline robot which will be used for inspection of 80 to 100mm pipeline. It uses drives to steer the robots and spring loaded four bar mechanism to assure that robots expand to grip the pipe walls. The unique features of this robot are the caterpillar wheels, analysis of four bar mechanism supporting the treads, kinematic approach and also a new motion planning is proposed to co-operatively navigate through difficult segment of pipes like bends, curve or branch. Several tools and sensors are initialized in this system, with the joystick interface or Bluetooth device; it can be worked according to the user. The four bar wheel system are used to increase or decrease the wheel suspension of the robot which can grip to the inner wall of the pipe. To analyze the smoke and gas, MQ4 gas sensor is used in this robot. According to the turns and bends, IR sensor is used to change the direction for moving the robot in the valid ways. ARM7 TDMI processor is used for speeding up the processing work of the robot.

I.INTRODUCTION

The usage of tethered, remotely controlled robot platforms in sewer pipes has become widely accepted.[3] Research and development in engineering have moved the original application field of merely visual inspection to manipulative tasks such as the actual repair of pipe sections, installation of cable, e.g. for communication.[3][4] Despite all engineering advances in the mechanical design of the platforms and improvements of the video equipment, these efforts are directed to increase the quality of the data provided to the human operator.[7] Yet the potential for automatic processing and data analysis in combination with hardware platform, as well as the application of IT technology for the Development of an integrated sewer information system is neglected. Sewer systems are prone to damages due to aging, traffic, geological change, to name a few. [8][9] Due to these damages, the groundwater is increasingly contaminated. Furthermore, heavy rainfall events may lead to inroad of the systems, resulting in overflow. In the case of separate sewer system as widely present in Japan results in the undesired mixture of wastewater and rainwater. Thus, in order to ensure an optimal functioning sewer measurement.[11] Tethered mobile robots used for visual inspection in municipal and industrial sewer networks are one example. Beyond this classic task of application of the tethered robot as an extended tool of the human operator, new fields have emerged. Due to ongoing research and development of the mechanical design, tethered robots are now able to perform repair tasks with varying degree of complexity. [8][6]Other emerging fields of application are the installation of communication cable in the sewer system as well as the encasement of inner pipe walls during renovation or repair. [13]

II.PROPOSED SYSTEM

The proposed system is to build a sewer robot which is capable of cleaning the blocks in the sewer pipe without employing humans. [1] System includes an ARM7 processor for fast computation and for low consumption of power. [4][5] MQ4 sensor interfaced has high sensitivity towards harmful methane gas and other hazardous gases. Bluetooth connection is established between PC and robot for communication between them. Additional features are cutting and hammering tools for cleaning the blocks. The robot is designed to gain control in greasy environment, vertical pipes and in curved bends using silicon caterpillar wheels. The four bar wheel system are used to increase or decrease the wheel suspension of the robot which can grip to the inner wall of the pipe. [6] The intelligent robot system is capable of taking turns in all kinds of bends like T section, Elbow and Branches with zero error and even at zero curvature of pipes.

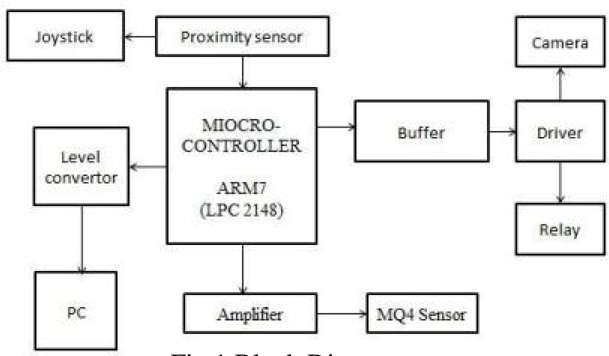

Fig 1.Block Diagram

According to the turns and bends, IR sensor is used to change the direction for moving the robot in the valid ways of avoiding the sharp edges and objects which are the major blocks in the pipeline. [6][8] The robot system has a special night vision camera which enables the robot to undergo image capturing of the blocks in the pipe even when it is dark. [11][12] The intelligent robot system is capable of taking turns in all kinds of bends like T section, Elbow and Branches with zero error and even at zero curvature of pipes.

A.LPC2148

The LPC2148 microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. [6] For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. [6] Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of –sale. A blend of serial communications interfaces ranging from USB 2.0 Full Speed devices, multiple UARTs, SPI, SSP to I2CS and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, [15] providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

B. Thumb 16-bit instructions

With growing code and data size, memory contributes to the system cost. The need to reduce memory cost leads to smaller code size and the use of narrower memory. [11] Therefore ARM developed a modified instruction set to give market-leading code density for compiled standard C language. There is also the problem of performance loss due to using a narrow memory path, such as a 16-bitmemory path with a 32-bit processor. [14][15] The processor must take two memory access cycles to fetch an instruction or read and write data. To address this issue, ARM introduced another set of reduced 16-bit instructions label Thumb, based on the standard ARM 32-bit instruction set. For Thumb to be used, the processor must go through a change of state from ARM to Thumb in order to begin executing 16-bit code. This is because the default state of the core is ARMING Therefore; every application must have code at boot up that is written in ARM. If the application code is to be compiled entirely for Thumb, then the segment of ARM boot code must change the state of the processor. Once this is done, 16-bit instructions are fetched seamlessly into the pipeline without any result. [6][9] It is important to note that the architecture remains the same. The instruction set is actually a reduced set of the ARM instruction set and only the instructions are 16-bit; everything else in the core still operates as 32-bit.An application code compiled in Thumb is 30% smaller on average than the same code compiled in ARM and normally 30% faster when using narrow 16-bit memory systems.[15]

C. Debug extensions

The Debug extensions to the core add scan chains to monitor what is occurring on the data path of the CPU. Signals were also added to the core so that processor control can be handed to the debugger when a breakpoint or watch point has been reached. This stops the processor enabling the user to view such characteristics as register contents, memory regions, and processor status.

D. Embedded ICE logic

In order to provide a powerful debugging environment for ARM-based applications the Embedded ICE logic was developed and integrated into the ARM core architecture. It is a set of registers providing the ability to set hardware breakpoints or watch points on code or data. The Embedded ICE logic monitors the ARM core signals every cycle to check if a breakpoint or watch point has been hit. Lastly, an additional scan chain is used to establish contact between the user and the Embedded ICE logic.

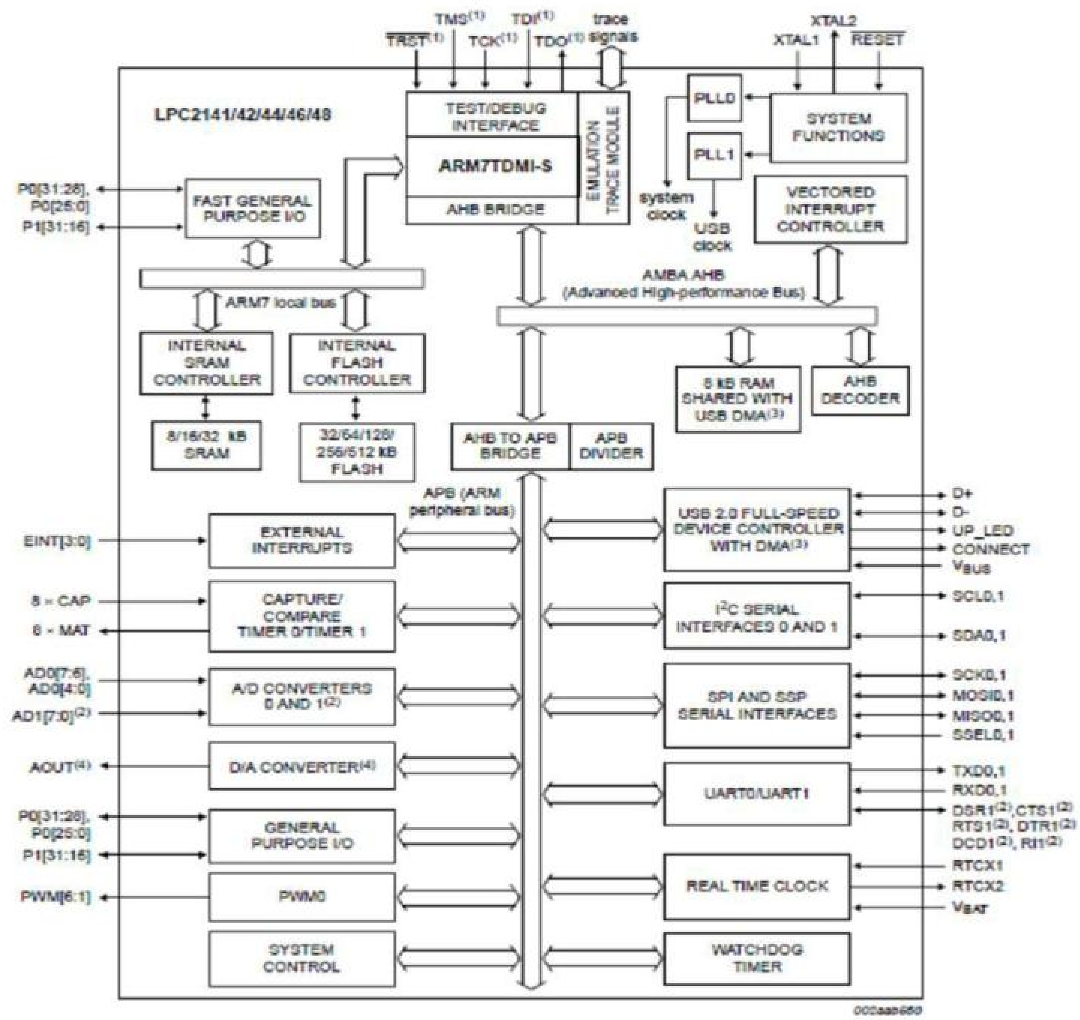

Fig4.LPC2148Architecture

Communication with the Embedded ICE logic from the external world is provided via the test access port, or TAP, controller and a standard IEEE 1149.1 JTAG connection. The advantage of on-chip debug solutions is the ability to rapidly debug software, especially when the software resides in ROM. This is critical in shortening the development cycle. [10] The use of Multi-ICE and Embedded ICE provides full debug capabilities for a processor integrated deep inside an ASIC, even in a production version of a consumer product.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Some microcontrollers may use 4-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (single-digit mill watts or microwatts). [13][16] They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just Nan watts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption.

E.ARM7TDMI-S

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. [2][3][13] Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. [2][5] Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as THUMB, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind THUMB is that of a super-reduced instruction set. [13]

Essentially, the ARM7TDMI-S processor has two instruction sets:

• The standard 32-bit ARM instruction set.

• A 16-bit THUMB instruction set.

The THUMB set's 16-bit instruction length allows it to approach twice the density of standard ARM code while retaining most of the ARM's performance advantage over a traditional 16-bit processor using 16-bit registers. This is possible because THUMB code operates on the same 32-bit register set as ARM code. THUMB code is able to provide up to 65% of the code size of ARM, and 160% of the performance of an equivalent ARM processor connected to a 16-bit memory system.

F. Control models for simulation

There are a number of possible control models for a VJ driven robotic arm. For this preliminary work, we extend the system to simultaneously control three joint angles, but limit the simulated environment to only two dimensions.Wetest three ways of determining joint angles for our simulated robot, known as kinematic models. In this section, we present the control models, leaving details of the simulated environment for the Experimental Design section. [11][1] It is manufactured a silicon gate CMOS process, requires no external components, and is compatible with TTL/CMOS components and chip-on-glass technology. [10] The USB function supports Control, Interrupt, Bulk, and Isochronous data-transfer modes. Designers can choose between Good Link and Soft Connect functionality.

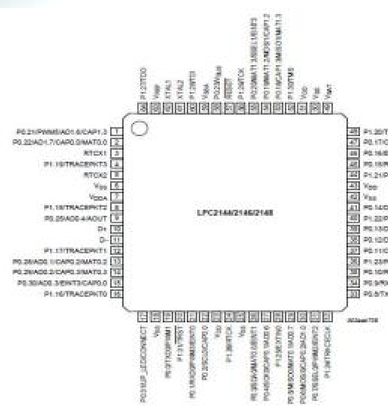

Fig2. Pin diagram of Lpc2148

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G.MQ4 sensor

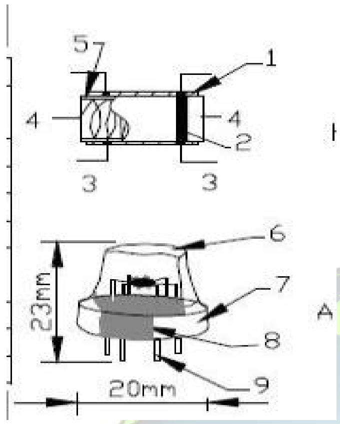

Fig3. MQ4 sensors

Structure and configuration of MQ-4 gas sensor is shown as Fig. 3.5 (Configuration A or B), sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into crust made by plastic and stainless steel net. [1][14][10] The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-4 has 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. It makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue.

H. Features

* High sensitivity to CH4, Natural gas.

* Small sensitivity to alcohol, smoke.

* Fast response.

* Stable and long life

III. RESULT AND DISCUSSION.

Thus the hardware interfacing of "SENSOR AND LOCOMOTION CONCEPTS USING SEWER ROBOT" based on the ARM was created. ARM core processor and the caterpillar type wheel system were engaged to increase gripping while climbing vertical pipes and to avoid collisions in slippery environment. The robot is capable of moving in all the branches like T, L and in Elbows with the help of four bar mechanism. The buffer, driver and relay section is added to enrich voltage throughout the mechanism. The system was developed with low cost and the inspection of pipes can be effectively done without any manual supervision. Using the four bar mechanism, the robot system can expand and shrink their wheel suspension together its own movement

The lab view simulation will be done based on the hardware interfacing. The system that shows the locomotive concepts of sewer robot visualized by the lab view. The sewer robot motion will followed according to the instructions.

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