IOT Based Omni Directional Robot Control by Using ARM-Series

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Abstract— On this research, controlling the omni directional mobile robot is divided by two controls, high level control which covers positioning and path tracking, also the low-level control which covers omnidirectional kinematic, speed control, heading lock and communication. This also covers thread management, priority fixation and stack memory fixation. Program is divided into several main threads, i.e., IMU, speed controller,
communication and motion thread (kinematic). Stack memory configuration for the above threads can be allotted as IMU thread with 1024 bytes of stack memory, speed control with 512 bytes, motion management with 512 bytes, communication with 128 bytes. IMU execution time lapses for 5.6uS, speed control elapses for 19.7uS, whereas motion elapses for 11uS and communication elapses for 1.2mS. Robot’s low-level control which includes robot movement kinematic (e.g., heading lock, speed control etc) is required to support the predefined system and enhance the robot sensor’s response in navigation.

Keywords: IMU, speed control, communication, kinematic

1. INTRODUCTION

In this paper, fabrication of omni-directional robot can be done to control the robot by using the low-level control which includes kinematic like heading lock, speed control etc., support in the robot navigation. High-level control comprises path tracking as well as positioning. Both low-level and high-level programming are commonly done sequentially which will not be ideal for mobile robot. Hence RTOS is needed for robot task management due to its ability to perform priority-based multitasking. The low-power embedded memory and an ARM Cortex-M0 core that operate at 30 MHz were fabricated in combination with a 60-nm c-axis aligned crystalline indium–gallium–zinc oxide FET and a 65-nm Si CMOS. The embedded memory adopted a structure in which oxide semiconductor-based 1T1C cells are stacked on Si sense amplifiers. This memory achieved a standby power of 3 nW while retaining data and an active power of 11.7 μW/MHz by making each bitline as short as each sense amplifier. The M0 core adopted the flip-flop in which an oxide semiconductor-based 3T1C cell is stacked on the Si scan flip-flop cell without area overhead and achieved a standby power of 6 nW while retaining data. The combination of the embedded memory and the M0 core provided high-performance, low-power Internet of Things devices operating with a broad range of active standby power ratios [1].16.07pJ/cycle 31MHz ARM Cortex M0 core in 40nm CMOS. The system was designed using differential transmission gates in an extended standard cell flow, taking into account variability, speed, energy and scalability. Extensive measurements over a range of 25 dies show it achieves sub-20pJ/cycle operation in a 330-500mV 10-48MHz range and is fully functional down to 190mV. Compared to state-of-the-art, a 40x speed and 4.8x EDP improvement is reported at the MEP. With low variation (σ/μ) on the clock frequency (3.5% at the MEP) and energy consumption (18.2% at the MEP), it combines the low variability, high speed and low energy of full custom work with the ease and design time of standard cell design [2].

This research aims to create a RTOS-based mobile robot so that there will be better and much easier performances of the program multitasking like distance calculation, path tracking etc.

2. LOW-LEVEL CONTROL

A. IMU thread

Initial thread used is the IMU thread, which performs tasks and process the IMU data by using the MPU-6050 microcontroller. IMU stack memory. IMU thread is used to measure the angular rate, robot body’s specific force and sometimes magnetic field around the robot by using the accelerometers and gyros which are inbuild within the IMU [6].

B. Speed control

Speed control thread has the second highest priority in real time. The stack memory allotted for speed control is 512 bytes. It will process the rotary encoder data of the three motors and uses them as input of PID controller. It takes 25ms to get the rotary encoder data. The set point value for all three motors will be given by motion thread [8].
C. Motion thread

Motion thread accesses the IMU thread and also the kinematic of the robot. It takes the third highest priority in real time. The stack memory allocated for motion thread is 512 bytes.

D. Communication thread

It is purely used for communicating with IMU thread to send IMU data and speed control thread to get the motor speed data for monitoring in PC. This takes the fourth priority in real time and the stack memory allocated to communication thread is 128 bytes.

3. DESCRIPTION

The robot mannerisms controlled by the IMU, speed, motion and communication threads are operated using the arm cortex M4STM32F407VGT6 microcontroller. The instructions to the microcontroller can be given by using the mobile phone by interfacing each other with Bluetooth technology [11]. This robot will have three wheels which rotate with the help of motors within it. Each wheel will have ultrasonic sensors which is solely used for obstacle detection.

![Fig 1 Block diagram of omni directional robot using ARM 7](image)

4. HARDWARE DESCRIPTION

- ARM CORTEX M4
- MPU 6050
- Ultrasonic sensors
- Bluetooth
- Motors and Wheels
- Gears and Battery

A. ARM controller

The controller in this project is from ARM family and in detail the chip used is LPC2148. The program designed using the Keil software is dumped into ARM controller LPC 2148. The entire control of the omni
directional robot is done by using this controller. It has 8 to 40 Kb of on-chip static RAM and 32 to 512 Kb of memory for flash program. It has power saving mode which includes Idle and power-down. Processor is moved from power saving by using external interrupts, USB, Brown-Out Detect and Real-Time Clock. CPU operating voltage is in the range of 3.0V to 3.6V with 5V tolerance.

B. MPU 6050

The MPU 6050 is used to calculate angular rate. It has an accelerometer and gyroscope. The MPU-6050 devices combine a 3 wheeled gyroscope and a 3 wheeled accelerometer on the same silicon die which processes complex 6-axis Motion fusion algorithms. MPU-6050 allows the devices to gather a full set of sensor data without intervention from the system processor.

C. Ultrasonic sensors

It has three ultrasonic sensors, each having four pins (Vcc, TRIG, ECHO, GND). An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending the sound waves at fixed frequency and waiting for that sound waves to reflect back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. We send the sound waves using the TRIG pin and observed the distance where it turns out to be echoed. The ECHO pin is used to calculate the distance from which the waves are being reflected. The formula used to calculate the distance can be inferred as, Distance = (pulse start time + pulse end time) * 17150. The same is repeated for all other sensors in all directions.

D. Bluetooth

In our project, Bluetooth is used to establish the connection between the microcontroller and the mobile phone and control the robot or send instructions to the robot. An application called Arduino Bluetooth is used to send the control to the robot using the Bluetooth connection.

E. Motors and Wheels

In this project, four motors are used out which three are 60rpm DC geared motor and one is the 3.5RPM DC geared motor. The three 60rpm motors are fixed to the three wheels which will used to rotate and move in different directions, these three motors are uniform in direction which means that they all move in the same direction at a time. The other 3.5rpm motor will be placed at the centre of the robot which proved the mechanical strength for the dinion gears to rotate and transmit energy from battery to the 60rpm DC geared motors. Three 3*4 motor wheels are used for the movement of the robot fixed with the 60rpm motors each.

F. Gears and Battery

The power supply to the robot will be provided by the 12V1.3amp battery. Seven dinion gears will be mounted on the top of the robot where the middle most gear is connected to 3.5RPM motor. These gears will be connected in a triangular shape in coordination with each other and finally will be connected to wheels via 60rpm motors. The purpose of these gears is to transfer power from the battery to the wheels and this is done by using the motors as intermediate.

5. SOFTWARE DESCRIPTION

- Keil
- Flash magic
• OrCAD

A. Kiel
Kiel is used for developing IDE (Integrated development environment) in this project. The IDE provides the development of software to be written to the microcontroller. A single program can be used for all types of functionalities. Modifying, compiling, debugging etc., is done at a time using Kiel software.

B. Flash Magic
Flash magic is used to dump the code created by the Kiel into the microcontroller chip.

C. OrCAD
OrCAD is used design a PCB board. The OrCAD PCB design supports a full suite of photo tooling and bare-board fabrication, test outputs can be generated and bare-board test in a variety of formats can be done.

6. RESULT
In this project we finally made the navigating robot which automatically diverts and takes the shortest path to its destination by detecting the obstacles.

Fig 2 Flow Chart of omni Directional Robot

Fig 3 Hardware connection
Here we observe the shortest distances calculated by the ultrasonic sensor in all the directions. The code for short distance is compiled in python code. The output of the sensor can be observed from fig 6.2.

Fig 4 Simulation Output

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