Team Description Murphy / Murray Humanoid League Robocup 2003

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Abstract.

Murphy/Murray are the main focus in large project taking place the last semester at the Master of Science in Information Technology engineering at Uppsala University. Murray is the head of the humanoid robot Murphy.

The main research areas are embedded systems, speech recognition and voice control of the robot and simultaneous moves of several joints of the body. Sound localization is performed with a Digital Signal Processor to give Murphy knowledge about where a human talking to him is located, in order to face him when responding.

Three DC motors are used for head movements. Murphy has 21 joints degrees of freedom and are based on hydraulic cylinders with a potentiometer to precisely control the aluminium skeleton position.

There are five two-axis accelerotmeters placed in each foot, leg and one in the body. Under the feet there are four pressure transducers in each corner.

1 Murphy and Murray

Murphy is a 180 cm tall and 130 kg heavy humanoid who is equipped with muscles able to pull about 4000 N.

Murray is the head of Murphy and is the communication gateway to Murphy through human abilities like speech, hearing and seeing. One goal is that commands should be given to Murphy orally and that corresponding actions shall be taken. Another goal is to have meaningful conversation with Murphy, i.e. get relevant answers to your questions.

Members: Ted Björling, Andreas Bran, Sandra Brolin, Robert Hadefjell, Kristin Johansson, Fabyanna Knutar, Åsa Odell, Magdalena Psaros, Magnus Sundin, Rikard Swahn and Jenny Tapani all studying at Uppsala University.

2 Hardware

Murphy's skeleton is built from aluminium profiles (45*45 mm) consisting of 21 joints, giving 21 degrees of freedom. Each joint is powered by a hydraulic cylinder controlled by a servo proportional valve (Moog). The hydraulic pressure is maximum 200 bar, but most of the time it is run on 70 bar. Each joint also has an Atmel AVR microcontroller, a potentiometer and a CAN-interface (MCP2510. There are five accelerometers (each 2-axis) and they are placed on each foot (to keep the foot horizontal when lifting the leg) and one in each upper part of the leg (for both balance and free orientation). Finally ane is placed in the body. Under each foot there are four pressure sensors, two in the front and two in the back. These are used to keep Murphy in balance by finding the projection of the mass centre on the ground.

The main control structure that acts as the central nervous system, is run on a PC104 computer with a CAN-controller that handles the communication with microcontrollers.

Murphy's brain, which controls the human abilities, is run on another PC/104. There are three microphones placed to enable hearing and location calculation. A Digital Signal Processor is used to perform the calculation from where the sound is located. Two digital cameras are used to accomplish stereo vision but are not yet implemented. The head has three degrees of freedom to imitate human head movements, which are controlled by three stepper motors. A PCMCIA lapcan card is used to connect the PC/104 with the CAN bus which handles all communication in the system.

3 Software

Murphy's movements are controlled by a neural network. It is implemented in Ada and has been trained using simulation software from Yobotics. This net will constantly be learning by doing. The neural net will not be disabled until a somewhat stable walk has been developed.

Murphy will primarily use stereo vision to gather information about the world when playing football and hearing will be used when Murphy is communicating with humans. The primary outputs are speech and motions. The neural network will teach Murphy to interpret the input from vision and hearing.

For voice recognition, a program called Sphinx2 is used which is written in C. Sphinx2 comes with a library of English phonemes which it uses in the recognition of words. A phoneme is the smallest unit of sound in the language. In order for Sphix2 to recognize words it needs a dictionary which maps words to a sequence of phonemes. The recognition engine compares the input sounds with the phonemes in its database and tries to match it to words in its dictionary, thus transforming a spoken utterance into a match string. All programs concerning interpretation of speech is written by the students in Ada. These programs consists of a database of words that Murray knows, a procedure that creates all possible permutations of the three sentences Sphinx creates and chooses the most probable one based on probability and grammatical correctness, long term and short term memory handling and procedures to control the moving of the head.

For speech synthesis, a program called Festival is used. This program has support for adding new voices so a Swedish MBROLA voice (sw1) has been added. As an English voice, a voice that came with the Festival distribution (Alan) is used. Festival is running in command mode right now, because the TTS mode (where texts are synthesized instead of interprented as commands) does not work properly.

Algorithms for locating the sound are written in Matlab and will be translated to C when implemented in the DSP. These algorithms will make Murray be able to locate where a person stands when talking to him. Murray has three microphones and with these as sound input, the time delay to each microphone is calculated. From these time delays, the angle between Murray's head and the person talking can be found, and the position is sent to the motorcontrol.

The software for controlling the engines that enables the head to move in three directions is written in C. All cards are connected and communicates through a CAN bus with a speed up to 1Mbit/s. Code for communicating and message handling have been written from scratch with code for automated intercommunication; enabling the brain to have information about the exact position of all potentiometers.

All of these programs are running on top of a lightweight Linux kernel.