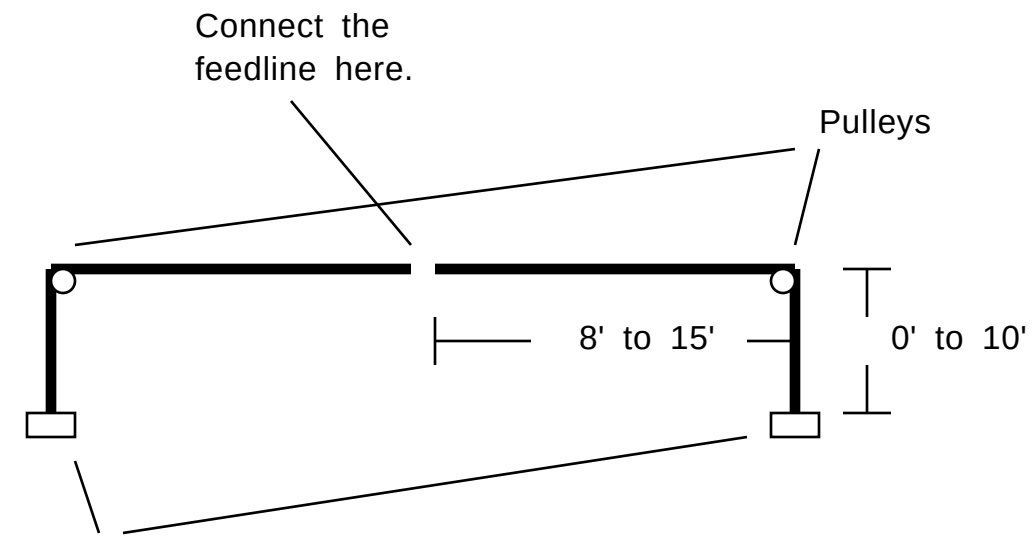
Automatically Tunable Antenna

Antennas are the transducer between guided electromagnetic waves on a transmission line and electromagnetic waves in free space. They are often made up of long skinny conductors that are resonant at the frequency of radiation. An antenna works best at one frequency. In addition to this, any conducting structures placed in close proximity to an antenna become part of the antenna, due to capacitive and inductive coupling. If these structures are large enough to be resonant at the frequency of operation the effect is more pronounced. These facts produces a challenging situation when it is desired to use a wide range of frequencies with antennas placed on one tower, especially where the frequencies are often harmonically related, as the amateur radio bands are. If you erect multiple antennas, you must contend with the interactions, especially if they are within a quarter of a wavelength of each other. In addition to this, the multiple antennas often make a much larger wind load on a tower, and not all of them can be at the best position on the top of the tower. A number of ingenious ways have been devised to deal with this problem. They all have some drawbacks. One of the more recent ways has been to construct an automatically tunable antenna where the lengths of the antenna elements are adjusted using stepper motors. See http://www.steppir.com/. There are some revealing pictures at http://www.vinecom.co.uk/steppIR.html.

One of the joys of amateur radio is building your own equipment, especially antennas. At this time, I know of no plans for homebrewing anything similar to this antenna. I would like to construct a dipole/half quad antenna that is adjustable for frequencies from 14.0 to 30.0 MHz as shown below.



The idea is that the antenna will be able to retract so that the total length will be anything between 16 and 36 feet. It will be retracted normally so that the wind load will be minimum. It will only be extended during use. The features desired are listed below with an importance weighting for each. I have available some sturdy hollow fiberglass poles with the following dimensions:
1" outside diameter, 0.75" inside diameter, 8' long. I also have some fiberglass poles that telescope inside of those that are 0.5" inside diameter.

1. It must be durable and reliable. This is important because it is a pain to repair something that is 100 feet in the air up on a tower. Also, the wind up there is a lot stronger than on the ground. The wind will produce a lot of fatigue in items that are blown back and forth. *Very important.*

2. Electrical conductivity of the element material > .5 x 10^6 Siemens/meter. If this number gets much below this, the efficiency of the antenna suffers a lot. *Important.*

3. It needs to be adjustable so that the total frequency coverage is from 14.0 to 30.0 MHz. The formula for the total length (in feet) of a dipole made of wire is 468/f(MHz). I may sacrifice the 28.0 30.0 MHz if I need to. *Important.*

4. It is important to know within half an inch exactly how long the dipole is

because I want to couple the antenna to the radio so that as the radio changes frequency, the antenna will automatically adjust to the proper length. The stepper motor can help here. It may need a re-calibration method, so that every time it is rolled up it recalibrates itself. If you cannot figure out a good way to do this, we may be able to do it electronically using optical mice to track the length, but I'd prefer not to have to do this, as it adds complexity and it may be prone to RFI (radio frequency interference). *Somewhat important.*

5. I would like to minimize the number of wires going down the tower. *Not very important.*

6. The cost to build this dipole should be much below $500. (That is the price of the one from Steppir.) I would like to shoot for a cost of about $100. *Important.*

7. The electrical connections to the center of the antenna need to be low resistance at all times, less than 1 ohm (hopefully much less). *Important.*

8. The construction would be best if it could be accomplished with tools that are available in most home shops. *Important.*

9. It should be safe to build. Note that machining BeCu is problematic, because of the toxic nature of that material. *Very Important.*