Lay Summary

In recent times modern smartphones became a part of almost everyone's daily life. They are used both at work and at home to organise appointments, answer emails, play games, video chat with your family, observe the stars and much more. To be able to execute applications of different complexity and to provide smooth graphics, mobile phone technology improved much over the last years. Screens became larger and memory capacity increased as well as computational speed. These improvements, however, come with a cost. They need a constant energy supply from the phone's battery. A mobile phone from 15 years ago had a battery lifetime of almost a week. Unfortunately, with improved technology and a broader application selection, modern phones usually last no longer than a day before their batteries need to be recharged.

Since battery technology does not improve as fast as computational technology, researchers focus on reducing battery consumption by writing software which uses mobile components in a more energy efficient way. This thesis looks at the phone's processor in particular. It is at the centre of most computing devices and needs high amounts of energy. A common technique to reduce the processor's energy consumption is to change its computation speed depending on how much work the mobile phone currently needs to do. The slower a processor works, the less energy is needed to drive it. However, when the speed is too low, mobile users can perceive applications as slow and unresponsive. When the speed is higher than necessary, energy is wasted. An efficient processor speed selection technique must be able to find a good balance between those two extremes to save energy and satisfy the end user.

This thesis presents methods and tools necessary to develop such a technique. In the first part of this thesis, a method is introduced which can automatically decide if a particular processor speed selection technique does a good job in terms of user satisfaction and battery consumption. It is used to find the theoretical maximum amount of possible processor energy savings which can be achieved without slowing application responsiveness to a degree noticeable by the mobile phone user. In the second part a processor speed selection technique is developed which directly considers how a user perceives application responsiveness. It automatically learns which speed settings lead to a good balance between application responsiveness and energy consumption. In so doing, it manages to improve processor energy efficiency compared to current standard techniques whilst providing a satisfying experience to the end user.