Simulated Plant Growth

Environmental Factors

Introduction

- Probabilistic growth using random perturbing and best fit trial

- Often complex models reflecting the intricate design of plants

- Visually pleasing models using the actual growth of the plant

    1. Growth functions generated by observation and measurement give very realistic results within the data provided but may pose unreliable on the outside

    2. Biological based growth takes environmental factors like space, light and biomechanics influences into account

    3. Growth becomes highly manipulable by creating different scenarios using the implemented factors

Growth Model

- **Stem Growth**

  - Increase in height through additional internode segments

  - Lateral growth by increasing segment width
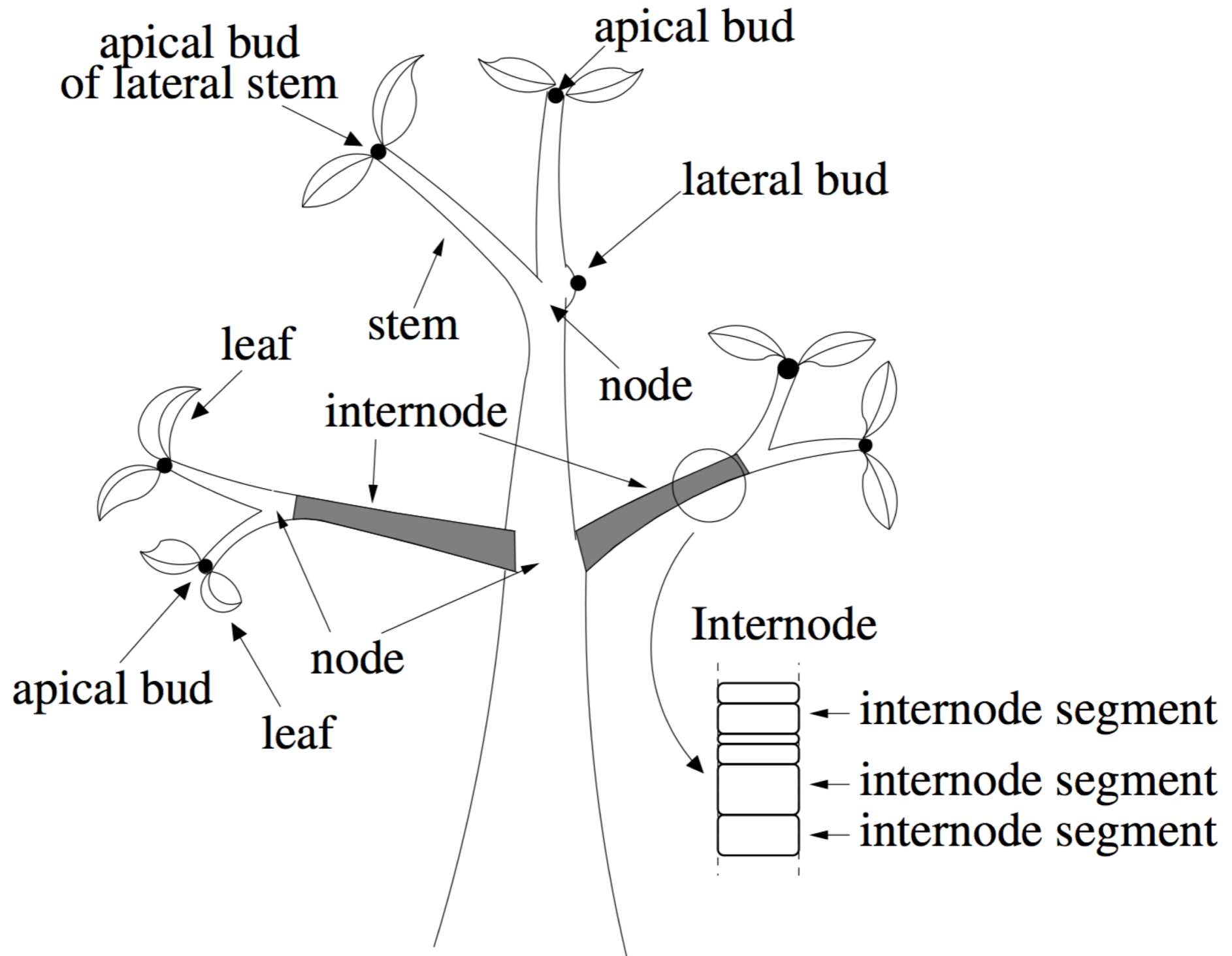
- **Apical bud movement**

  - Remains at tip of stem

- **Nodes**

  - Follows stem growth and its generic internode length

- **Branching Angles**

  - Lateral stems form at certain angles to their parent stem

apical bud
of lateral stem

apical bud

lateral bud

stem

leaf

node

internode

node

apical bud

leaf

Internode

internode segment

internode segment

internode segment

[Zhuming Lam & Scott A. King 2005]

Phototropism

- Considered one of the most important factors

- Stem bends in response to lighting conditions

- Growth mechanism to maximize resources → Photosynthesis

- Light-sensitive components cause differential growths

- One-sided cell expansion along the stem causes change in direction

- Simulated using light exposure and intensity to apical bud

  - Theory by Kendrick and Kronenberg (1994) states light actually inhibits the growth process while less exposure increases stem growth

Water Allocation

- Required resource for storing and transporting essential minerals

- Used to regulate the temperature within the system

- Stomates located in the leaves monitor and control flow and pressure

- Water is allocated effectively to maximize growth

- Proportional to light exposure and evaporation rate

- Calculate water pull of a branch by accumulated light energy

  1. Higher exposure raises water distribution in branch

  2. Distribution therefore reflects rate of growth

  3. Longer internode segments and faster leaf development

Space Tropism

- Space represents a potential of light and collision avoidance

- Mechanism of space detection is uncertain → Phototropism

- „Random Walk" can be considered sufficient for certain scenarios

Gravity

- Force on connecting point increases with mass of branch

- Propagate forces inwards to determine force on internode segment

- Calculation through volume and horizontal distance to connecting point

Photosynthesis

- Carbohydrates (sugars) are produced from carbon oxide, water and light

- Stores energy for later use to maintain plant and support growth

- Production highly depends on amount of exposed light

Internal Factors

- Auxin Chemical process of information transport by hormones

- Self Pruning Loose stems and leaves becoming a liability to the system

- Limiting Branch Prevents indefinitely growth of branches

References

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